Application of GIS in Rural Road and Habitation Mapping

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FORWARD

I hereby forward this Seminar Paper on Project titled "Application of GIS in Rural Road and Habitation Mapping", submitted by Shubhajit Saha and Shamsher Alam under my guidance and supervision in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Civil Engineering from Bengal Engineering and Science University, Shibpur, Howrah – 711103.

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CERTIFICATE OF APPROVAL

The foregoing Seminar Paper on Project titled "Application of GIS in Rural Road and Habitation Mapping", was carried out and presented satisfactorily to warrant its acceptance as a pre-requisite to the Degree of Bachelor of Engineering (Civil Engineering) of this University. It is understood that by this approval the undersigned do not necessarily approve of any statement expressed and any conclusion drawn but approve this seminar paper on thesis only for the purpose for which it is submitted.

Board of examiners

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1 Introduction

1.1 General

The development of any country depends on the infrastructural facilities available therein. Good road network facilities plays major role here. The developed countries have good road infrastructure not because of the fact that they are wealthy; instead they become developed because of good road infrastructure. Over the last few decades, lack of transportation infrastructure has affected the economic growth and development of India. Rural India does not have all-weather road connectivity for marketing agricultural products and existing highway network in the country is inadequate and insufficient. Moreover the main roads in India are under huge pressure and in great need of modernization in order to handle the increased requirements of the Indian economy. In addition to maintenance, the expansion of the network and widening of existing roads is becoming increasingly important. This would then enable the roads to handle increased traffic, and also allow for a corresponding increase in the average movement speed on India's roads.

Realizing this fact an ambitious and biggest ever infrastructure development project in India (expected cost of $26 billion) named as Pradhan Mantri Gram Sadak Yojana (PMGSY) under ministry of Rural Development was conceptualized and launched on 25th December, 2000 to provide connectivity to unconnected rural habitations as part of a poverty eradication measure.

1.2 Condition of road network of India

Almost 80% of passenger traffic and about 65% of freight movement is handled by this vast network.

In general, roads in India are primarily bitumen-based macadamized roads. However, a few of the National Highways have concrete roads too. In some locations, such as in Kanpur, British-built concrete roads are still in use. Concrete roads were less popular prior to 1990s because of low availability of cement then. However, with large supplies of cement in the country and the virtues of concrete roads, they are once again gaining popularity. Concrete roads are weather-proof and require lower maintenance compared to bituminous roads. Because bitumen is obtained mostly from imported crude oil, and due to other factors, concrete-based roads will prove to be more cost-effective in future. Apart from these, one also comes across unpaved dirt roads in the countryside, which is fast getting converted to paved roads.

Table 1 Indian road network

Class	Length (km)
Access Controlled Expressways	200 km (120 mi)
4-6 lane Divided Highways (with service rd in crowded areas)	10,000 km (6,200 mi)
National Highways	66,590 km (41,380 mi)

State Highways	131,899 km (81,958 mi)
Major district roads	467,763 km (290,654 mi)
Rural & other roads	2,650,000 km (1,650,000 mi)
Total (approx)	3,300,000 km (2,050,000 mi)

Table 2 State-wise Road Network

State/UT	National Highways (km)	State Highways (km)	Major District Roads (km)	Other District & Link Roads (km)	Total surfaced length (km) as on March 31, 2002	Total length (km) as on March 31, 2002
Andaman & Nicobar	300				1,180	1,180
Andhra Pradesh	4,472				1,19,857	1,96,172
Arunachal Pradesh	392				5,689	18,365
Assam	2,836				12,882	89,486
Bihar	3,642				32,858	76,065
Chandigarh	24				2,045	2,045
Chhattisgarh	2,184				24,476	35,372
Dadra & Nagar Haveli					580	580
Daman & Diu					324	414
Delhi	72				23,274	28,508
Goa	269				6,830	9,672
Gujarat	3,245				1,24,295	1,37,617
Haryana	1,512				26,311	28,203
Himachal Pradesh	1,208	2,160	2,240		16,754	29,617
Jammu & Kashmir	1,245				9,943	23,429
Jharkhand	1,805				2,840	11,486
Karnataka	3,843				1,04,241	1,52,599
Kerala	1,457	4,006	23,702		50,164	1,50,851
Lakshadweep					150	150
Madhya Pradesh	4,670				78,191	1,60,968
Maharashtra	4,176	33,705			2,09,559	2,67,452
Manipur	959				3,863	11,434
Meghalaya	810				6,560	9,565
Mizoram	927				2,877	5,075

Nagaland	494				6,451	21,021
Orissa	3,704				52,245	2,37,034
Puducherry	53				2,115	2,571
Punjab	1,557	2,166	1,799	34,997	52,747	61,530
Rajasthan	5,585				82,456	1,32,482
Sikkim	62				1,546	2,019
Tamil Nadu	4,462	7,163	7,362	40,963	1,54,958	1,91,947
Tripura	400				4,393	16,296
Uttarakhand	1,991				10,730	33,547
Uttar Pradesh	5,874				1,66,659	2,48,481
West Bengal	2,524				49,517	92,023
Total	66,754					

By acting as the link between the rural and urban areas, the State Highways and Major District Roads contribute significantly to the development of the rural economy and industrial growth of the country. It is estimated that the secondary system carries about 40 per cent of the total road traffic and comprises about 20% of the total road length.

1.3 Road Transport in West Bengal

The total length of surface road in West Bengal is over 92,023 km; national highways comprise 2,377 km and state highways 2,393 km. The road density of the state is 103.69 km per 100 km²; higher than the national average of 74.7 km per 100 km². Average speed on state highways varies between 40–50 km/h; in villages and towns, speeds are as low as 20–25 km/h due to the substandard quality of road constructions and low maintenance.

Table 3 List of National Highways in West Bengal

Srl No.	NH No.	Route	Length (km.)
1	2	From Jharkhand border-Barakar-Asansol-Raniganj-Durgapur-Panagarh-Palsit-Dankuni near Culcutta/Kolkata	235 km (146 mi)
2	6	From Jharkhand Border-Kharagpur-Debra-Panskura-Kolaghat-Bagnan-Dankuni near Kolkata	161 km (100 mi)
3	31	Dalkhola-Kanki-Panjipara-Islampur-Bagdogra-Sevok-Mainaguri-Gairkata-Falakata-Cooch Behar-Tufanganj up to Assam Border	366 km (227 mi)
4	31A	Sevok-Namthang up to Sikkim Border	30 km (19 mi)
5	31C	Galgalia-Naxalbari-Bagdogra-Chalsa-Nagrakata- Gairkata- Alipurdura up to Assam Border.	142 km (88 mi)
6	32	From Jharkhand Border-Goorinathdham -Puruliya- Kantadih-Urma-Balarampur up to Jharkhand Border	72 km (45 mi)
7	34	Dalkhola-Karandighi-Raiganj-Pandua-Ingraj Bazar-Morgram-Baharampur-Palashi-Krishnanagar-Barasat-Kolkata	443 km (275 mi)

8	35	Barasat-Gaighata-Bangaon-Petrapole on India-Bangladesh border.	61 km (38 mi)
9	41	Junction with NH-6 near Panskura-Tamluk-Mahishadal-Haldia Port.	51 km (32 mi)
10	55	Siliguri-Kurseong-Darjeeling	77 km (48 mi)
11	60	From Orissa Border-Dantan-Belda-Kharagpur-Midnapore-Bankura-Mejia-Raniganj and terminating at its junction with NH 2	389 km (242 mi)
12	60A	Bankura-Chhatna-Hura-Landhurka-Puruliya	100 km (62 mi)
13	80	Farrakka up to Bihar Border	10 km (6.2 mi)
14	81	From Bihar Border-Harishchandrapur-Kumangarj-Malda	55 km (34 mi)
15	117	Setu-Kolkata-Diamond Harbour-Kulpi-Namkhana-Bakkhali	138 km (86 mi)

1.4 Pradhan Mantri Gram Sadak Yojana (PMGSY)

1.4.1 Objective

1. The primary objective of the PMGSY is to provide Connectivity, by way of an all-weather Road (with necessary culverts and cross-drainage structures, which is operable throughout the year), to the eligible unconnected Habitations in the rural areas, in such a way that all Unconnected Habitations with a population of 1000 persons and above are covered in three years (2000-2003) and all Unconnected Habitations with a population of 500 persons and above by the end of the Tenth Plan Period (2007). In respect of the Hill States (North-East, Sikkim, Himachal Pradesh, Jammu & Kashmir, Uttaranchal) and the Desert Areas (as identified in the Desert Development Programme) as well as the Tribal (Schedule V) areas, the objective would be to connect Habitations with a population of 250 persons and above.
2. The PMGSY will permit the Upgradation (to prescribed standards) of the existing roads in those Districts where all the eligible Habitations of the designated population size have been provided all-weather road connectivity. However, it must be noted that Upgradation is not central to the Programme and cannot exceed 20% of the State's allocation as long as eligible Unconnected Habitations in the State still exist. In Upgradation works, priority should be given to Through Routes of the Rural Core Network, which carry more traffic

1.4.2 Guiding principles

1. The spirit and the objective of the Pradhan Mantri Gram Sadak Yojana (PMGSY) is to provide good all-weather road connectivity to unconnected Habitations. A habitation which was earlier provided all-weather connectivity would not be eligible even if the present condition of the road is bad.
2. The unit for this Programme is a Habitation and not a Revenue village or a Panchayat. A Habitation is a cluster of population, living in an area, the location of which does not change over time. Desam, Dhanis, Tolas, Majras, Hamlets etc. are commonly used terminology to describe the Habitations.

3. An Unconnected Habitation is one with a population of designated size located at a distance of at least 500 metres or more (1.5 km of path distance in case of Hills) from an All-weather road or a connected Habitation.
4. The population, as recorded in the Census 2001, shall be the basis for determining the population size of the Habitation. The population of all Habitations within a radius of 500 meters (1.5 km. of path distance in case of Hills) may be clubbed together for the purpose of determining the population size. This cluster approach would enable provision of connectivity to a larger number of Habitations, particularly in the Hill / mountainous areas.
5. The eligible Unconnected Habitations are to be connected to nearby Habitations already connected by an All-weather road or to another existing All-weather road so that services (educational, health, marketing facilities etc.), which are not available in the unconnected Habitation, become available to the residents.
6. A Core Network is that minimal Network of roads (routes) that is essential to provide Basic access to essential social and economic services to all eligible habitations in the selected areas through at least a single all-weather road connectivity.
7. A Core Network comprises of Through Routes and Link Routes. Through routes are the ones which collect traffic from several link roads or a long chain of Habitations and lead it to Marketing centers either directly or through the higher category roads i.e., the District Roads or the State or National Highway. Link Routes are the roads connecting a single Habitation or a group of Habitations to Through Routes or District Roads leading to Market Centers. Link routes generally have dead ends terminating on a Habitation, while Through Routes arise from the confluence of two or more Link Routes and emerge on to a major Road or to a Market Centre.
8. It should be ensured that each road work that is taken up under the PMGSY is part of the Core Network. While keeping the objective of Connectivity in view, preference should be given to those roads which also incidentally serve other Habitations. In other words, without compromising the basic objective (covering 1000+ Habitations first and 500+ Habitations next and 250+ Habitations where eligible, last), preference should be given to those roads which serve a larger population. For this purpose, while Habitations within a distance of 500 meters from the road is considered as connected in case of plain areas, this distance should be 1.5 km (of path length) in respect of Hills.
9. The PMGSY shall cover only the rural areas. Urban roads are excluded from the purview of this Programme. Even in the rural areas, PMGSY covers only the Rural Roads i.e., Roads that were formerly classified as 'Other District Roads' (ODR) and 'Village Roads' (VR). Other District Roads (ODR) are roads serving rural areas of production and providing them with outlet to market centres, taluka (tehsil) headquarters, Block headquarters or other main roads. Village Roads (VR) are roads connecting villages / Habitation or groups of Habitation with each other and to the nearest road of a higher category. Major District Roads, State Highways and National Highways cannot be covered under the PMGSY, even if they happen to be in rural areas. This applies to New Connectivity roads as well as Upgradation works.
10. The PMGSY envisages only single road Connectivity to be provided. If a Habitation is already connected by way of an All-weather road, then no new work can be taken up under the PMGSY for that habitation.

2 Geographic Information Systems (GIS)

2.1 Brief

Geographic information systems (GIS) or geospatial information systems is a set of tools that captures, stores, analyzes, manages, and presents data that are linked to location(s). In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology. GIS may be used in archaeology, geography, cartography, remote sensing, land surveying, public utility management, natural resource management, precision agriculture, photogrammetry, urban planning, emergency management, navigation, aerial video, and localized search engines.

Raster and vector are the two basic data structures for storing and manipulating images and graphics data on a computer. All of the major GIS (Geographic Information Systems) software packages available today are primarily based on one of the two structures, either raster based or vector based, while they have some extended functions to support other data structures.

2.2 Raster data

In computer graphics, a raster graphics image or bitmap is a data structure representing a generally rectangular grid of pixels, or points of color, viewable via a monitor, paper, or other display medium. Raster images are stored in image files with varying formats (see Comparison of graphics file formats).

A bitmap corresponds bit-for-bit with an image displayed on a screen, generally in the same format used for storage in the display's video memory, or maybe as a device-independent bitmap. A bitmap is technically characterized by the width and height of the image in pixels and by the number of bits per pixel (a color depth, which determines the number of colors it can represent).

The printing and prepress industries know raster graphics as contones (from "continuous tones") and refer to vector graphics as "line work".

2.3 Vector data

Vector graphics is the use of geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical equations, to represent images in computer graphics.

Vector graphics formats are complementary to raster graphics, which is the representation of images as an array of pixels, as it is typically used for the representation of photographic images.[1] There are instances when working with vector tools and formats is the best practice, and instances when working with raster tools and formats is the best practice. There are times when both formats come together. An understanding of the advantages and limitations of each technology and the relationship between them is most likely to result in efficient and effective use of tools.

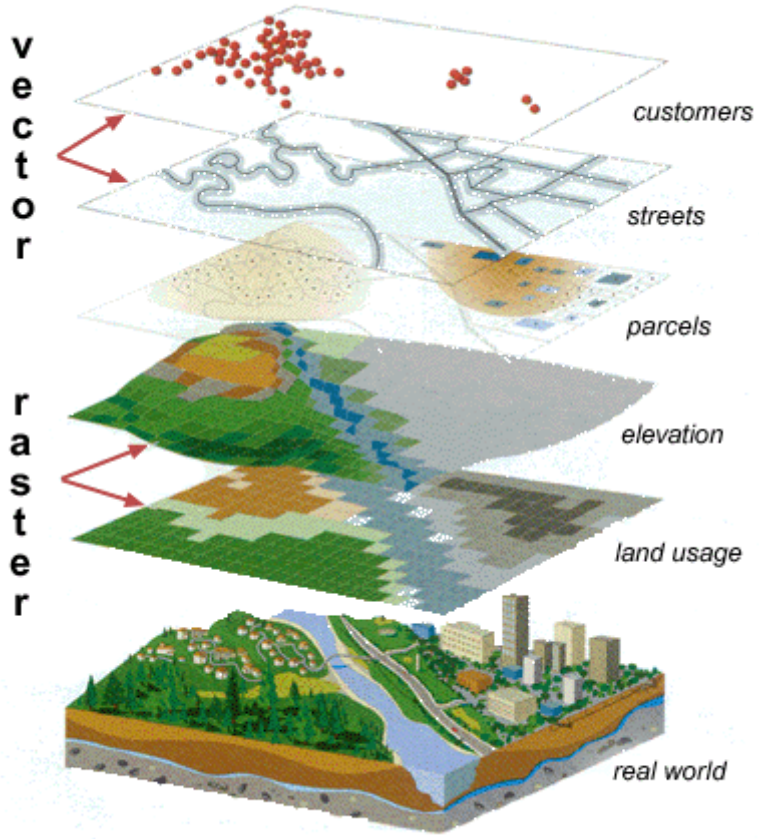


Figure 1 Raster and Vector data

2.3.1 Different kinds of Vector data

2.3.1.1 Points

Points are used to display individual locations, or data sampled at specific points, such as temperature, pH, and conductivity.

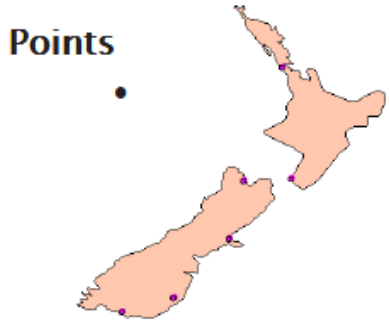


Figure 2 Point example

2.3.1.2 Lines

Lines represent linear features, such as roads, trails, streams, and contour lines.

Figure 3 Line example

2.3.1.3 Polygons

Polygons are closed figures and represent areas of the Earth's surface. These may be lakes, cities, shopping malls, national parks, or any feature that can be described by area. The figure above shows lakes (blue) and part of the land area (green) of Ireland as polygon data.

Figure 4 Polygon example

2.4 GIS in the field of transportation

Using GIS in the field of transportation opens up a wide range of possible applications, as diverse as the field of transportation itself. Whether these are cars and trucks along a road, trains along a track, ships across the sea or airplanes in the sky, all applications have one thing in common: They are objects that move along a path in space. A GIS can provide a valuable tool for managing these objects in a spatially referenced context, viewing the paths as a transportation network.

3 Objective

- To develop habitation database and rural road network database in block level.
- To identify the unconnected habitation in the block
- To identify the growth centre in block level based on socio-economic parameters.

3.1 Scope of the work

The database development is very much useful for problem identification of rural road network planning, allocation of resources and also for future maintenance of the road system. It directly helps the villagers to upgrade living quality in terms of livelihood, medical, educational facilities as well as other socio-economical parameters.

4 Present Study

4.1 Study Area

Geography: Arambagh is located at 22.88°N 87.78°E. It has an average elevation of 15 meters (118 feet). It is located on the bank of the Dwarakeswar River.

This sub-division is actually the westernmost part of the District of Hooghly. The river Damodar forms the eastern boundary of the Arambagh Sub-Division. Arambagh Sub-Division is one of the four Sub-Divisions of Hooghly District – the remaining three being Sadar (Chinsurah), Serampore and Chandannagore. Arambagh is located on the western front of Hooghly District and is being bordered by four districts viz Burdwan, West Midnapore, Bankura and Howrah.

Geographical area of Arambagh being: 322.53 km^2

Perimeter = 133.99 km

Demographics: As of 2011 India census, Arambag had a population of 3,47,225. Males constitute 62% of the population and females 38%. Arambag has an average literacy rate of 82%, higher than the national average of 59.5%; with 79% male literacy and 58% of female literacy. 17% of the population is under 6 years of age.

Climate: The maximum temperature during summer rises up to 38 °C while minimum temperature during winter comes down to 8°C. Average annual rainfall is 1600 millimeters.

Economics: This is a rice and potato agricultural area with several cold storages.

Civic Administration: Arambagh municipality is divided into 18 wards.

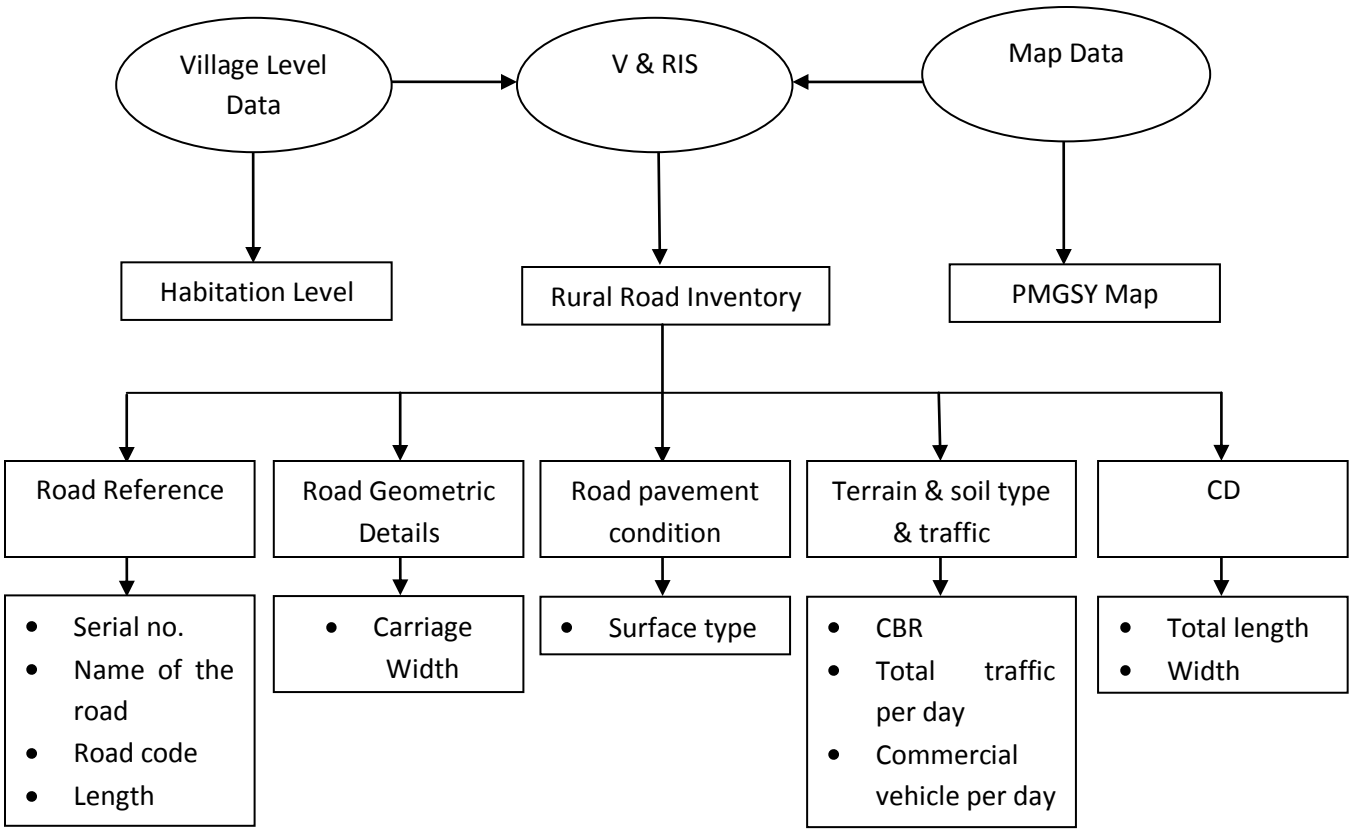
In the present study, an attempt is being made to develop an information system for road network planning using GIS for a particular block in rural area under PMGSY program.

4.2 Data collection

Various data items required for the development of the comprehensive rural road planning and development can be broadly categorized under three categories

1. Village Data
2. Rural Road Data
3. Map Data

Flowchart for Rural Road Inventory



4.2.1 Village Data

Database developed above has been applied to the Arambagh block in Hoogly District of West Bengal. The block has 242 villages with a total population of 233094. The block has 11 Gram Panchayat headquarters.

A habitation can be defined as a cluster of population, living in an area, the location of which change over time.

Table 4 Habitation Intensity

Srl No.	Name of Block	Total No of Habitations	Category				
			1000+	500 - 999	250 - 249	< 250	Total
1	Arambagh	242	139	55	31	17	242

Table 5 Habitation Facilities

Facilities	Number
School and education centre	115
Health centre	103

Market centre	17
Gram Panchayat Headquater	11
District Headquater	0
Block Headquater	1

4.2.2 Rural road Data

The road inventory data is essential for planning, management of the road system and planning of rural connectivity. 14 Through route (T1 to T14) and 48 link routes (L021 to L068) are well connected to state highway and other district roads the proposed roads prove to be beneficial to the village. The total existing road length is 282.15 Km.

Total length of Through Routes = 50.5 km

Total length of Link Routes = 131.65 km

T - Through Routes - Through routes are the ones which collect traffic from several link roads or a long chain of habitation and lead it to marketing centers either directly or through the higher category of road i.e. the district roads or state or national highway.

L - Link Routes - Link routes are the routes connecting a single habitation to Through Routes or District Roads leading to a market centers. Link route is the newly constructed road. Link route generally have dead ends terminating on a habitation while Through Routes arise from the confluence of two or more Link Routes and emerges on to a major Roads or to a Growth Centers.

4.2.3 Map Data

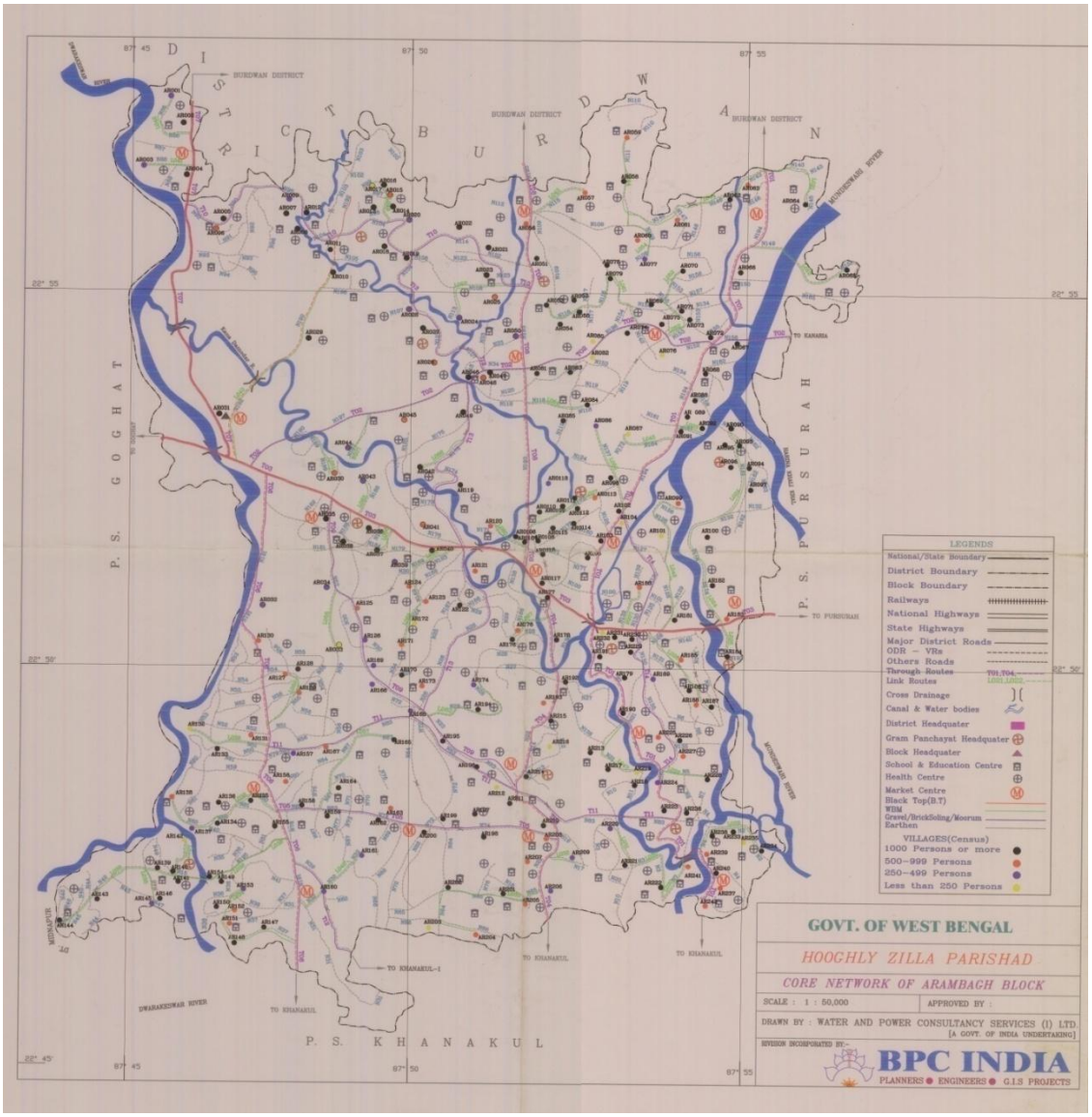


Figure 5 Map of Arambagh Block (Scale 1:50,000)

5 Procedure of work

5.1 Geo Referencing using ERDAS Imagine

The scanned map of Arambagh was Geo Referenced using ERDAS Imagine.

5.2 Application of Arc View GIS

Arc View is a useful software or desktop GIS and mapping. It is a product of Environmental System Research Institute (ESRI). Arc view GIS is a powerful software that provides for visualizing, querying, exploring, and analyzing data geographically. Arc view is a powerful GIS tool that can display information (which resides locally or over a distributed network), read spatial and tabular information from a variety of data formats, access external databases, produced thematic maps (use colors and symbols to represent features based upon their attributes), perform spatial queries, connect spatial information to data attributes, provides several analytical tools and allows for a high degree of customization using Avenue. Using Arc View, we can understand the geographical context of our data, allowing us to see relationship and identify patterns in new ways.

5.3 Creating Point, Line or Polygon Themes

Creating new data such as point, line, or polygon themes, the shapefile created will be stored in the same projected units as the existing data sources. That means further, the data created will merely be displayed correctly with themes based on data sources that are also stored in the same projecting units (here: UTM meters); and additionally it means, there is no necessity to adjust the projection of any new theme if the new theme is added to an already existing data.

5.3.1 Creating Point Themes

Creating point themes is necessary if we want to add e.g. important buildings (health centre, schools etc.) to a map for a better orientation. Peaks of mountains can also be displayed as point themes. When creating a map of a certain catchment area, where erosion control activities takes place, also a single checkdam or microbasins can be displayed as point themes. To create a point theme click '*View*' '*New theme*', choose the feature type we want (here: point) and confirm choice by clicking '*OK*'. Store the theme under *GIS projects**Enabered**MyData* and name it '*Health Centre*'. Then, choose at the tool bar the very right symbol for digitizing point themes and click where we want to have displayed any kind of building, no matter if schools, churches or other buildings. After having finalized digitizing buildings we want to have displayed on our own map click *Theme**Stop editing* and confirm that the changes in the shapefile are stored.

5.3.2 Creating Line Themes

To add a new line theme do the same steps as described before, instead of choosing create point theme choose line theme. Click the tool bar and choose '*Draw line'*. Now a line shaped feature such as roads or rivers can be drawn. But before start drawing a line feature in the map, adjust the '*snapping'* feature. It is important that all line features belonging to the same feature class, such as rivers resp. gullies, share the same endpoint, and for there to be overshoots or undershoots. The most comfortable snapping tool is the 'interactive' snapping environment. To activate that, first make the new line theme active and click under *Theme**Properties**Editing* the field '*interactive'*.

Have set the interactive snap enjoinment as described above, then while adding line hold down the right mouse button to display the popup menu, and choose one of the following snapping options to control how the next vertex shall snap to the existing line:

- Snap to Vertex: Snaps the next vertex to the nearest vertex in an existing line,
- Snap to Boundary: Snaps the next vertex to the nearest line segment in an existing line,

The other options are of negligible importance, since they are covered by the option '*snap to vertex'*.

After having activated the entire necessary fields the lines can be drawn with clicking with the left mouse button at the starting point and set other vertices along the line where it is needed to draw the line. To end the line feature double click at the endpoint. When different lines have a shared endpoint click, before reaching the endpoint respectively the end line or boundary to set the last vertex, the right mouse button an choose '*Snap to Vertex*', then click as near as possible to the vertex at the endpoint to end the line.

5.3.3 Creating Polygon Themes

When creating polygon themes the snapping tool should be used to guarantee correctness as well as to prevent gaps and overlaps. Follow the steps as described in the chapter before and define general snapping or the interactive snapping environment. Especially when creating polygons, snapping is essential if one wants to utilize maps for further analyses, otherwise calculations will not be correct.

Note that snapping is possible merely if work within one theme. Snapping within and between two different themes is not possible. Thus, generalize in the beginning of creating maps as much as possible. E.g. to create a map which shows the existing land use types of one area better digitize the different land use types of one area in one theme and divide them later on by marking them with the single marking tool (tool bar) and convert them into shapefiles (*Theme**Convert to Shapefile*) instead of creating single land use type themes from beginning on.

Table 6 Different Themes used in the block

Theme type	Category

Point	Habitation Health centre School Market place Gram panchyat Block head quarter
Line	Through route Link route
Polygon	Block boundary

5.4 Calculating Length, Area of different theme layers

Calculations can be performed in the Attribute Table surface. Activate the Theme to analyse and click to the Attribute Table. Start editing under menu Table and add a new field under menu Edit. Define that have a number field and determine the field width. Then activate the new field (it appears dark grey instead of light grey), here: Area, and click the calculator. Enter the formula [*Shape*].ReturnArea and confirm with *OK*. Precondition for any calculation is that the map is adjusted in correct map units. Adjust under *View**Properties* and define maps units, which should be *meters*.

6 Results

6.1 Habitation Data

The road inventory as well as village level data has been developed through ArcView GIS software as shown in figure and mapping as done as per population.

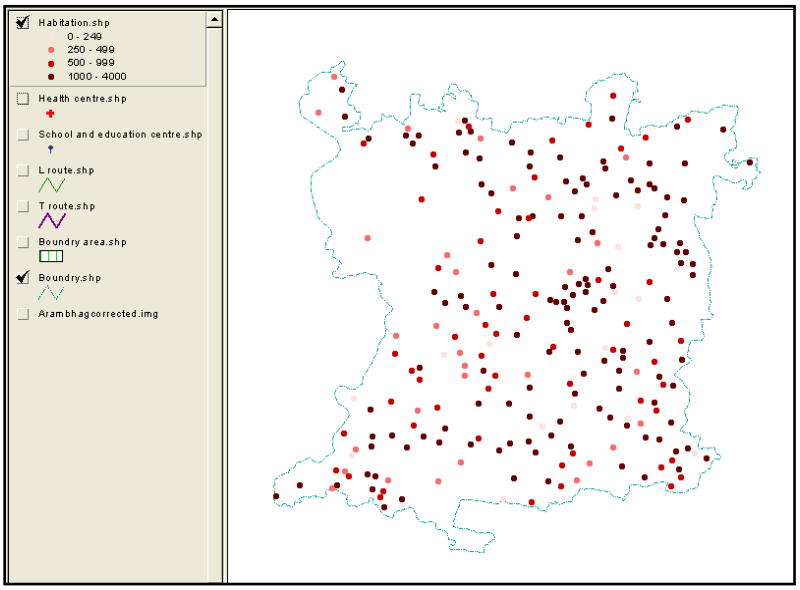


Figure 6 Habitation mapping as per population

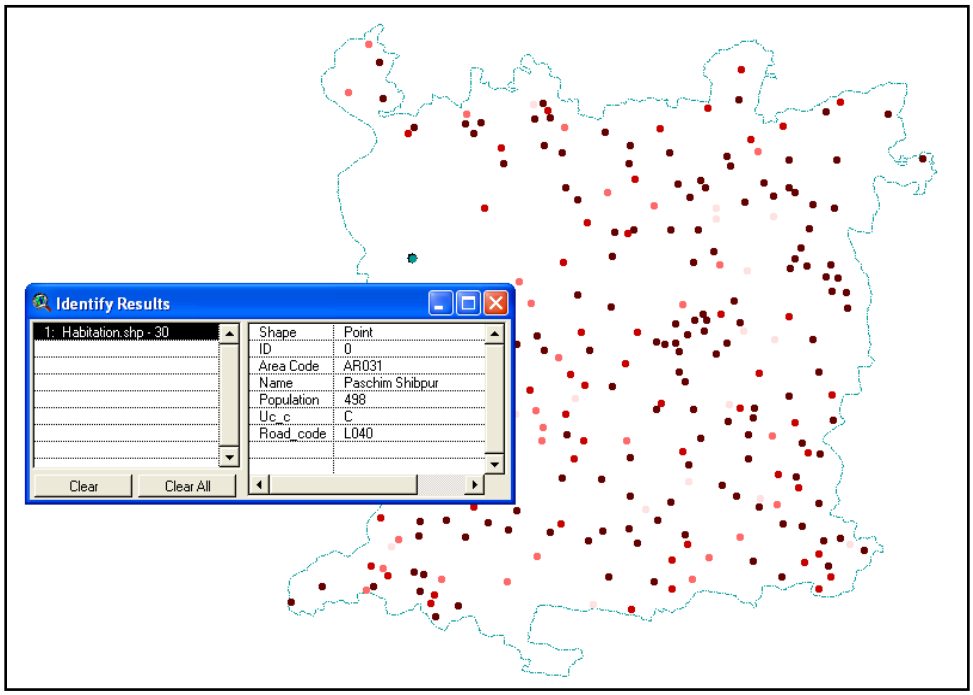


Figure 7 Habitation Data of a selected point (shown in Green)

Table 7 Sample Attribute Table of Habitation

AREA_CODE	NAME	POPULATION	UC_C	ROAD_CODE
AR001	Bhabapur	253	UC	L042
AR002	Maminpur	2037	C	T07
AR003	Paradra	329	UC	L041
AR004	Krithchandrapur	1154	C	T07
AR005	Manodra	1062	UC	T10
AR006	Dadanpur	639	UC	T10
AR007	Ghosh para	1051	UC	T10
AR008	Bagpara	1010	UC	T10
AR009	Daspara	390	UC	T10
AR010	Chandibati	1550	C	L040
AR011	Donga bathan	622	UC	T10
AR012	Yadpur	1049	UC	T10

UC_C = **UC** unconnected / **C** connected

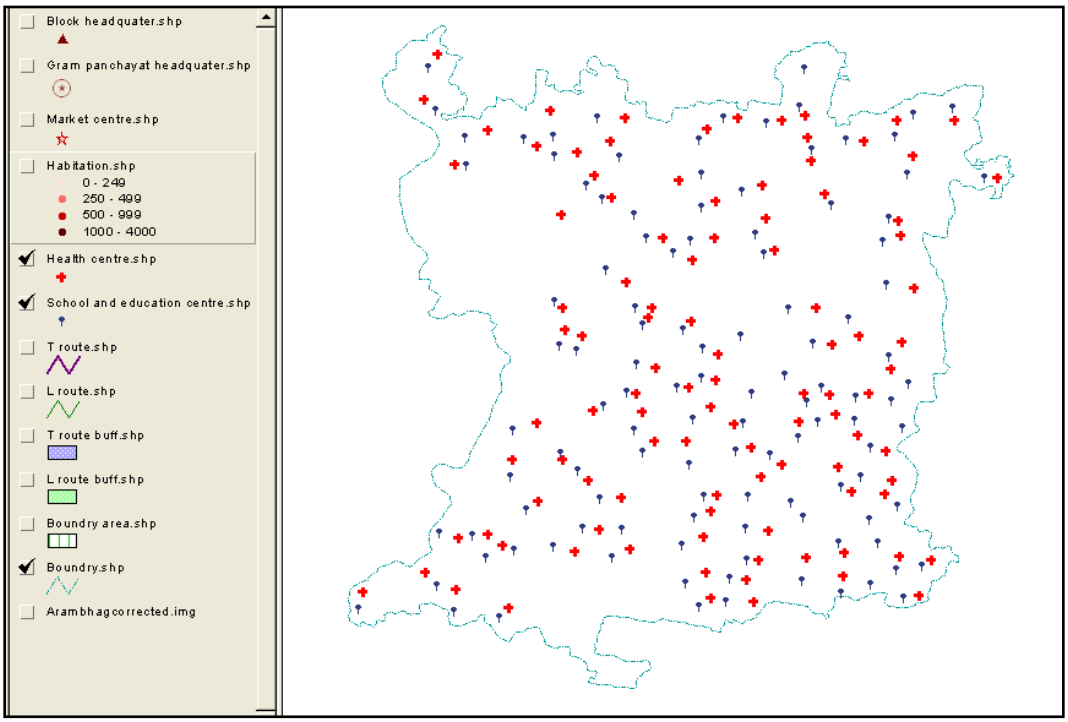


Figure 8 Schools and Health Centre

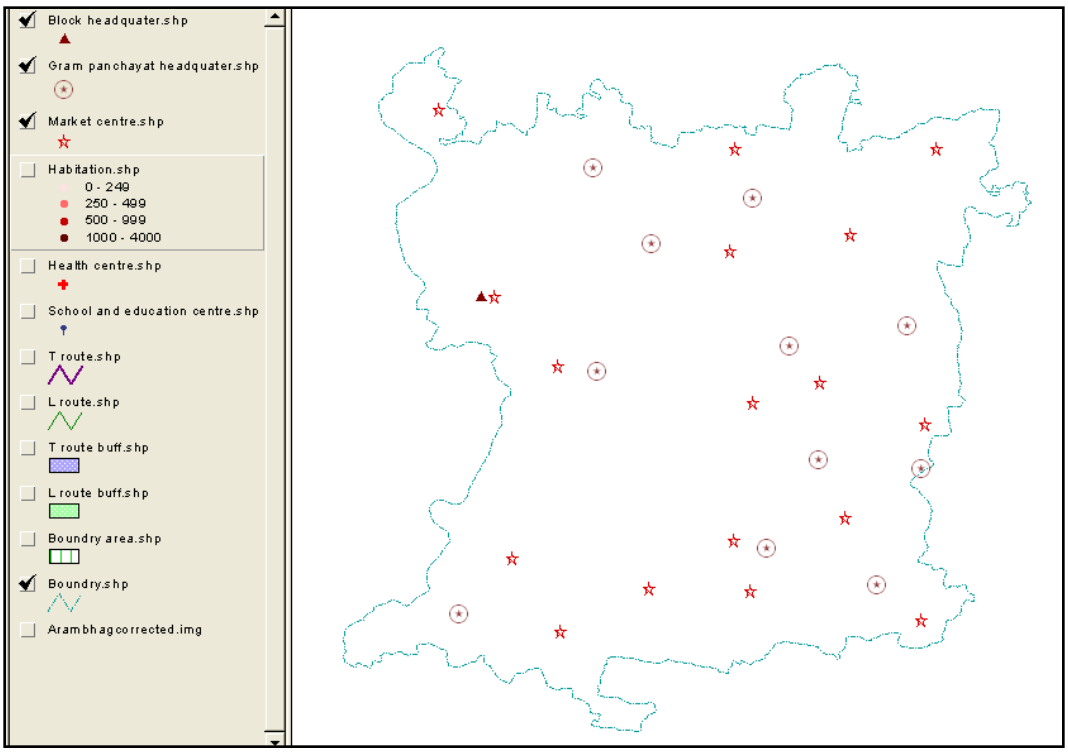


Figure 9 Block Head Quarter, Gram Panchayat and Market Centre

6.2 Through route Data

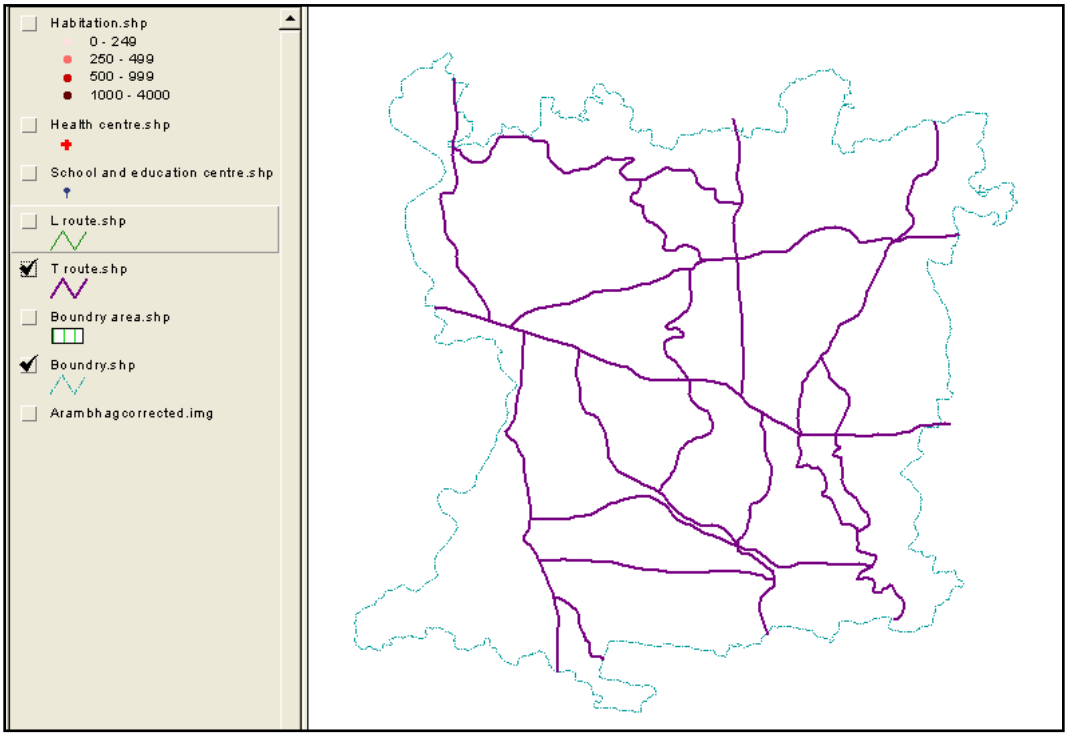


Figure 10 Through routes in the block

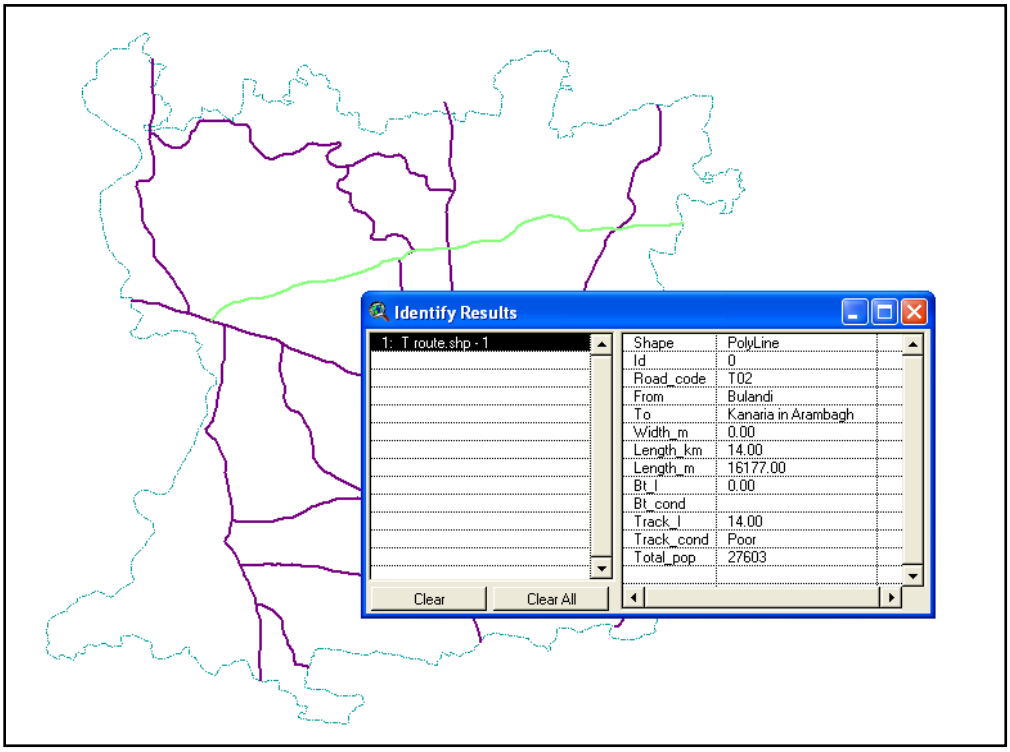


Figure 11 Road data of selected through route (shown in Green)

Table 8 Road data of Through routes

ROAD_CODE	FROM	TO	LENGTH_KM	CAL_LENGTH_M	BT_L	BT_COND	TRACK_L	TRACK_COND	TOTAL_POP
T01	Fatepur	Tilakchak	20.00	23876.00	20.00	Poor	0.00		37783
T02	Bulandi	Kanaria in Arambagh	14.00	16177.00	0.00		14.00	Poor	27603
T03	Pallishree (Arambag)	Amgram (Continuation of Goghat)	8.50	18369.00	8.50	Good	0.00		39417
T04	Mayapur	Bhanderhati (to Garerghat)	9.00	9396.30	9.00	Poor	0.00		18609
T05	Kapshit	Samta	7.50	7942.00	0.00		7.50	Poor	12038
T06	Gourhati More (Arambag)	Ghourhati (to Bandar)	13.00	12870.00	13.00	Good	0.00		26411
T07	Pallishree (Arambag)	Maminpur (to Burdwan)	8.00	9632.00	8.00	Good	0.00		3773
T08	Satispur (From Burdwan)	Muthadanga	10.00	10075.00	10.00	Poor	0.00		20106
T09	Bikrampur Kalitala	Pandugram Bus Stand	9.50	9931.10	0.00		9.50	Poor	6922
T10	Baise Mile	Batanaal Via Seali	10.00	13480.00	0.00		10.00	Poor	17828
T11	Char Mile	Dakshin Narayanpur	12.00	12449.00	0.00		12.00	Poor	7850
T12	Gourhati Market	Radhaballavpur	5.00	3084.80	0.00		5.00	Poor	977
T13	Gholpukur Kuraui Bora	Ranhat Battala	15.50	16329.00	0.00		15.50	Poor	11293
T14	Haraditya	Sahabagh to Madhurpur	8.50	7579.90	0.00		8.50	Poor	15559

LENGTH_KM = length of the road in KM

CAL_LENGTH_KM = calculated length of the road in KM

BT_L = Black Top length

BT_COND = Black Top Condition

TRACK_L = Track length

TRACK_COND = Track condition

TOTAL_POP = Population served

6.3 Link route Data

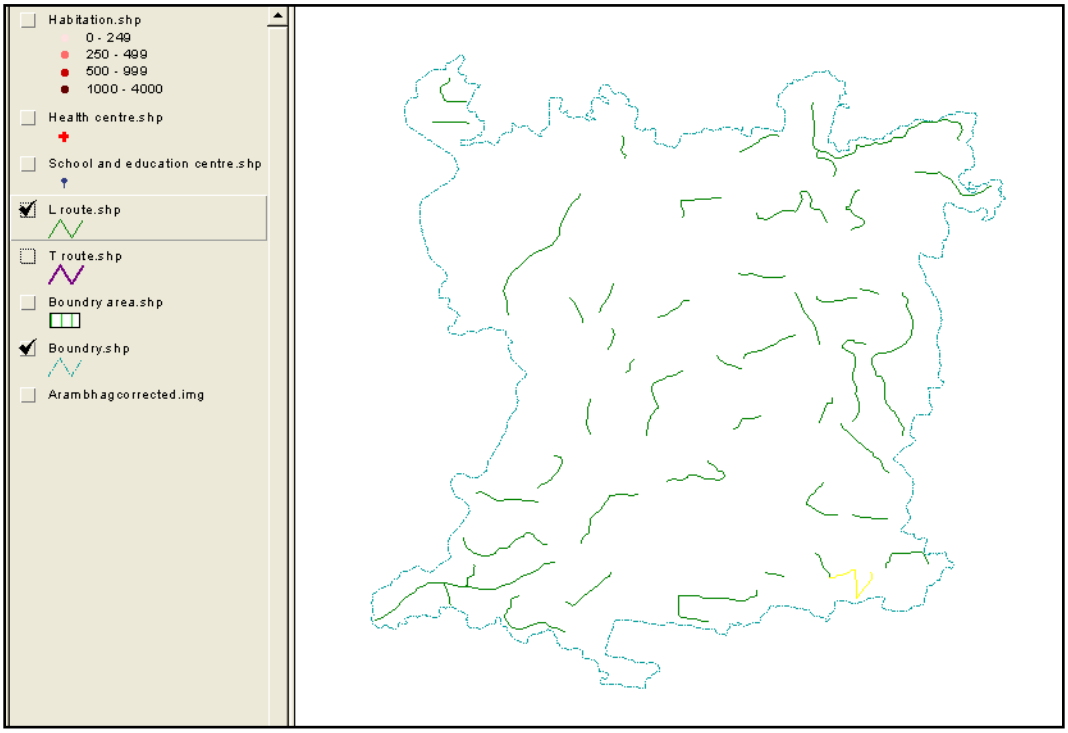


Figure 12 Link routes in the block

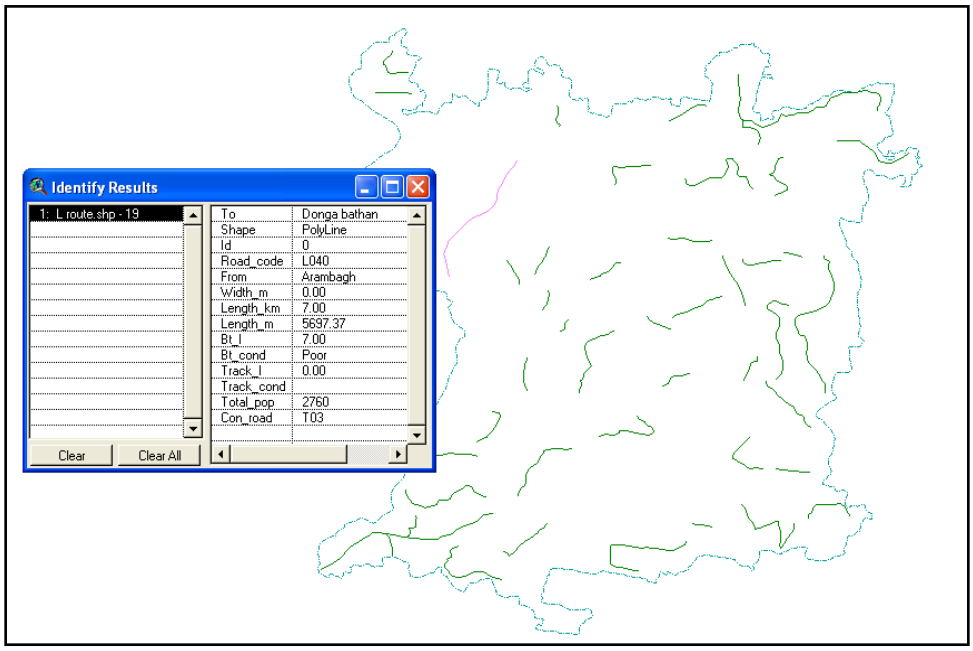


Figure 13 Road data of selected link route (shown in Pink)

Table 9 Road data of Link routes

ROAD_ CODE	FROM	TO	LENGTH_K M	CAL_LENG TH_M	BT_L	BT_C OND	TRAC K_L	TRACK_ COND	TOTAL_ POP	CON_R OAD
L021	Fatepur	Purba Haripur	1.50	1943.69	0.00		1.50	Poor	1481	T01
L022	Balia Road	Bank of Mundeswari rivers (upto Ghargohal)	3.00	3168.22	0.00		3.00	Poor	1769	T01
L023	Kesabpur Bush Road	Moyrapara	1.00	720.22	0.00		1.00	Poor	2373	T01
L024	Harinkhola	Purba Kesabchawk	8.00	6082.56	0.00		8.00	Poor	11126	T03
L025	SH Road	Amgram	1.00	698.02	0.00		1.00	Poor	1343	T03
L026	Chandra	Tajpur	5.00	2550.27	0.00		5.00	Poor	3788	T03
L027	Malaypur suripara	Malikpukur	3.00	2064.72	0.00		3.00	Poor	7063	T14
L028	Gholpura	Purbaragpur	2.00	1272.71	0.00		2.00	Poor	1033	T01
L029	Hiyatpur	Chandraban	1.50	2164.26	0.00		1.50	Poor	3474	T01
L030	Kismat Khedail	Satmasa	3.00	3153.47	0.00		3.00	Poor	3298	T01
L031	Satmasa	Arakul	1.00	1111.95	0.00		1.00	Poor	1605	L030
L032	Balaichak	Tantisal	0.75	740.98	0.00		0.75	Poor	419	T04
L033	Bhanderhati	Ragpur	5.00	4795.32	0.00		5.00	Poor	4199	T04
L034	Daharkundu	Faterchak	2.50	3517.86	0.00		2.50	Poor	6402	
L035	Atpur School	Mahisghat	2.00	914.10	0.00		2.00	Poor	1539	L036
L036	Borodongol	Srimantapur	8.50	7148.24	0.00		8.50	Poor	7483	T06
L037	Borodanghal	Dakshin Sekhpur	1.00	1102.48	0.00		1.00	Poor	156	L036
L038	Ratanpur	Paschimpur	2.90	3807.51	0.00		2.90	Poor	4815	T06
L039	Salepur	Salepur 5 Mile Bus Stop	3.50	2275.48	0.00		3.50	Poor	2189	T06
L040	Arambagh	Donga bathan	7.00	5697.37	7.00	Poor	0.00		2760	T03
L041	Kirtichandra pur	Paradra	1.25	1310.51	0.00		1.25	Poor	329	T07
L042	Mominpur	Bhabapur	1.00	1813.66	0.00		1.00	Poor	253	T07
L043	Satispur	Chakfazil	1.50	1596.63	0.00		1.50	Poor	866	T08
L044	Fatepur	Sekhpur	7.50	6331.34	0.00		7.50	Poor	7331	T14
L045	Chakanar	Kablemalaypur Road	1.50	1557.42	0.00		1.50	Poor	105	T01
L046	Shayamgram	Majafarpur	4.50	4205.84	0.00		4.50	Poor	2887	T03
L047	Katabani	Pratapnagar	4.00	2327.40	0.00		4.00	Poor	3544	T01
L048	Subhaypur	Gourhati	1.50	2220.72	0.00		1.50	Poor	498	T12
L049	Duleypara	Dharapara	2.50	915.61	0.00		2.50	Poor	2100	T10
L050	Ramnagar	Ramnagar Road	3.00	1806.15	0.00		3.00	Poor	2571	T06
L051	Raghunathpu r	BulandhiKanaria Road	1.00	1103.37	0.00		1.00	Poor	863	T02
L052	Malaypur	Chak Besia	4.00	2387.53	0.00		4.00	Poor	5683	T02
L053	Chack Madan	Batanal	5.50	2096.30	0.00		5.50	Poor	2807	T10
L054	Malaypur	Chackhazi	1.50	1447.19	0.00		1.50	Poor	1278	L044
L055	Asanpur	Jasapur	4.00	2158.91	0.00		4.00	Poor	2585	T01
L056	SH 7 Road	Tirol	1.50	1179.57	0.00		1.50	Poor	801	T03

L057	Kapsit	Beurgram	2.25	3125.33	0.00		2.25	Poor	2172	T05
L058	Chandsit	Paharchak	1.50	1396.60	0.00		1.50	Poor	396	T09
L059	Bulandikanaria Road	Raghunathpur	1.00	1223.02	0.00		1.00	Poor	444	T02
L060	Muthadanga	Mohanpur	1.25	1088.76	0.00		1.25	Poor	893	T02
L061	Malaypur	Chack Behala	3.50	4210.65	0.00		3.50	Poor	5331	T02
L062	Basulichak	Joteram	2.00	3128.69	0.00		2.00	Poor	1289	T09
L063	Dihibayra	Hatbasantapur	3.75	874.42	0.00		3.75	Poor	496	T03
L064	Narainpur	Bevkul	1.00	1659.71	0.00		1.00	Poor	2549	T08
L065	Joyrampur	Madhabpur	3.00	3305.63	0.00		3.00	Poor	2972	T03
L066	SH7 Road	Bamsaamrel	0.75	624.51	0.00		0.75	Poor	2242	T03
L067	Sahapur	Hamirbati	1.75	1191.28	0.00		1.75	Poor	2504	T04
L068	Bulundi Gokardhar	Keledona	1.00	1359.36	0.00		1.00	Poor	1343	T03

LENGTH_KM = length of the road in KM

CAL_LENGTH_KM = calculated length of the road in KM

BT_L = Black Top length

BT_COND = Black Top Condition

TRACK_L = Track length

TRACK_COND = Track condition

TOTAL_POP = Population served

7 Analysis

7.1 General

Under the scheme of Pradhan Mantri Gram Sadak Yojana (PMGSY) a massive program has been taken up to provide all-weather road connectivity to all the unconnected villages in the country. Before selecting the optimum new connecting route, one needs to identify all unconnected habitations and growth centre in the block. A habitation located beyond 500 m from existing road is considered as unconnected habitation. Growth centers are areas of concentrated activity such as office, public facilities, a range of residential development, cultural and recreational activities linked with a variety of transportation choices such as vehicular, bicycle and pedestrian. In this study, the main criteria are that to provide a all-weather connectivity from centre to single or group of unconnected habitations. In this way, the population of unconnected habitations shall have to travel to nearby growth centre to fulfill their locally unsatisfied needs.

7.2 Identification of unconnected habitation

A village or habitation located within a distance of 500 m from an all-weather road or any existing road may be considered to be already connected. The permissible maximum distance has been kept at 500m for the plain areas. With the help of GIS tool, unconnected habitation can be identified by buffering technique.

Buffering involves the creation of a zone of a specified width around a point, line, or polygon area. The resulting puffer is a new polygon, which can be used in queries to determine which entities occur either within or outside the defined buffer zone. Using these operations, the characteristics of an area surrounding in a specified location are evaluated.

7.2.1 Procedure

The link routes and the through routes are buffered to 500m range. All the habitations that lie between the buffered routes are considered as connected. So, the unconnected habitation can be found referring to figure below.

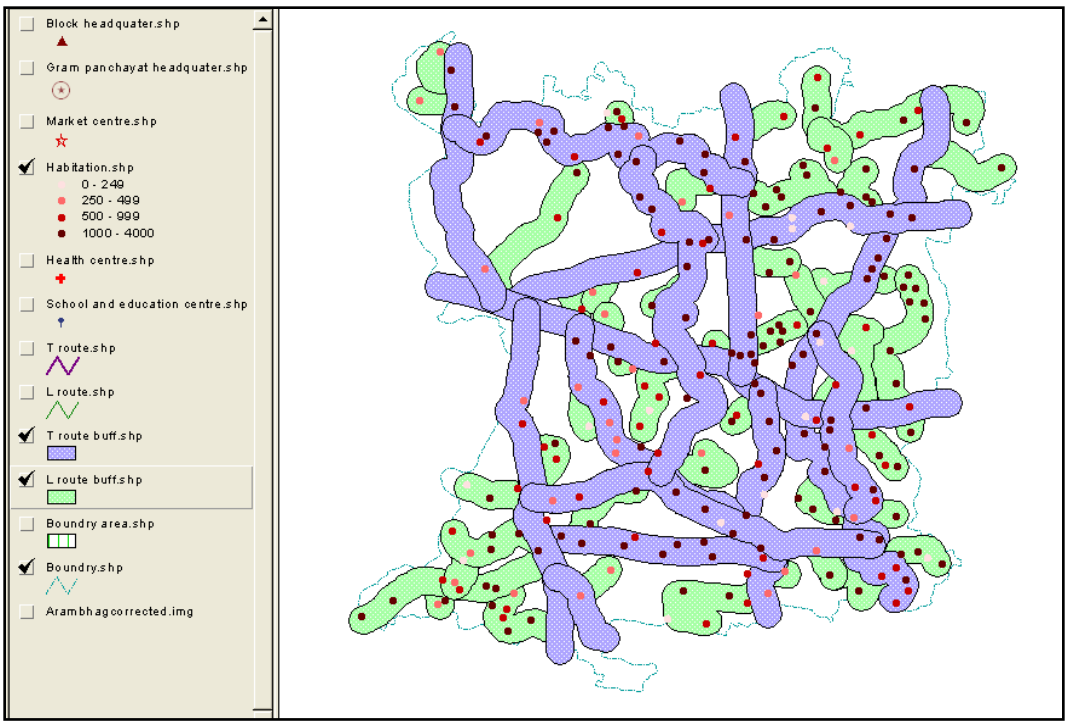


Figure 14 Buffering of all existing routes to a specified width of 500m

In above analysis it is seen that no habitation lies outside the buffered area. So, no habitation can be considered as unconnected.

7.3 Identification of Growth Center

Growth Centers are areas of concentrated activity such as office, public facilities, a range of residential development, cultural and recreational activities linked with a variety of transportation choices such as vehicular, bicycle and pedestrian.

Before, selecting the new network, one needs to identify all the Growth Centers in the Block. This is because an analysis of the transport patterns in the rural areas reveals that most of the travel is to the growth centers.

7.3.1 Procedure

- 1km buffering of health centre is being done and the habitation that falls under the buffered area is being noted (see Fig. 15)
- 1km buffering of school is being done and the habitation that falls under the buffered area is being noted (see Fig. 16)
- 2km buffering of market centre is being done and the habitation that falls under the buffered area is being noted (see Fig. 17)

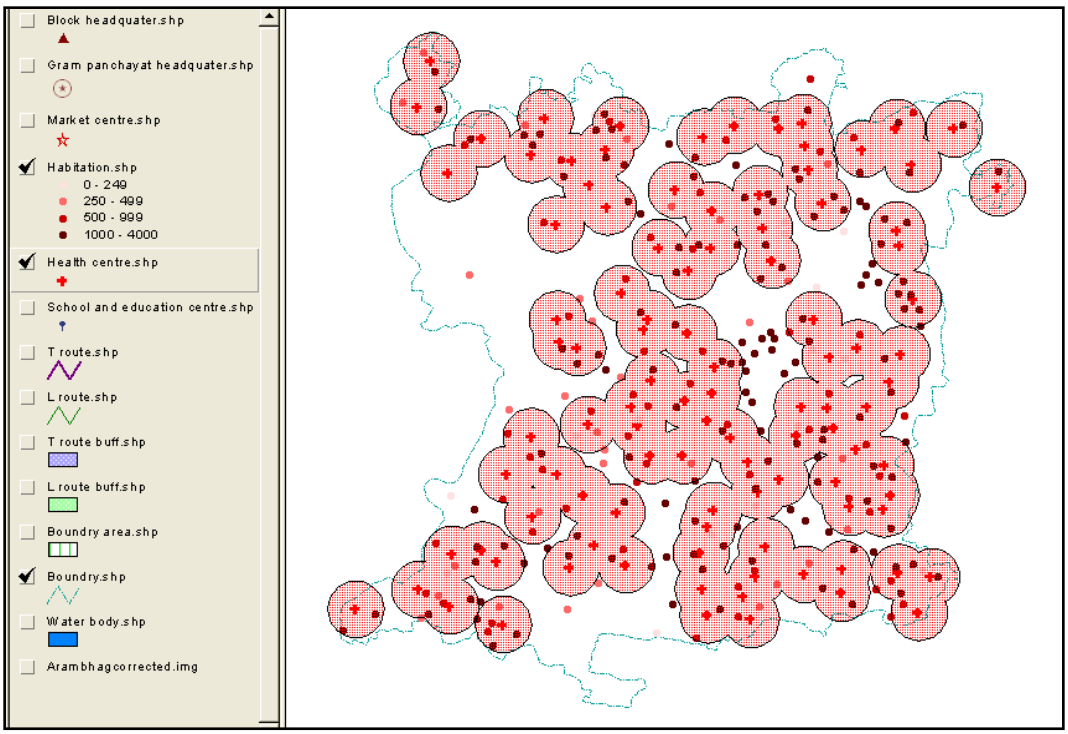


Figure 15 Health center buffered 1 km

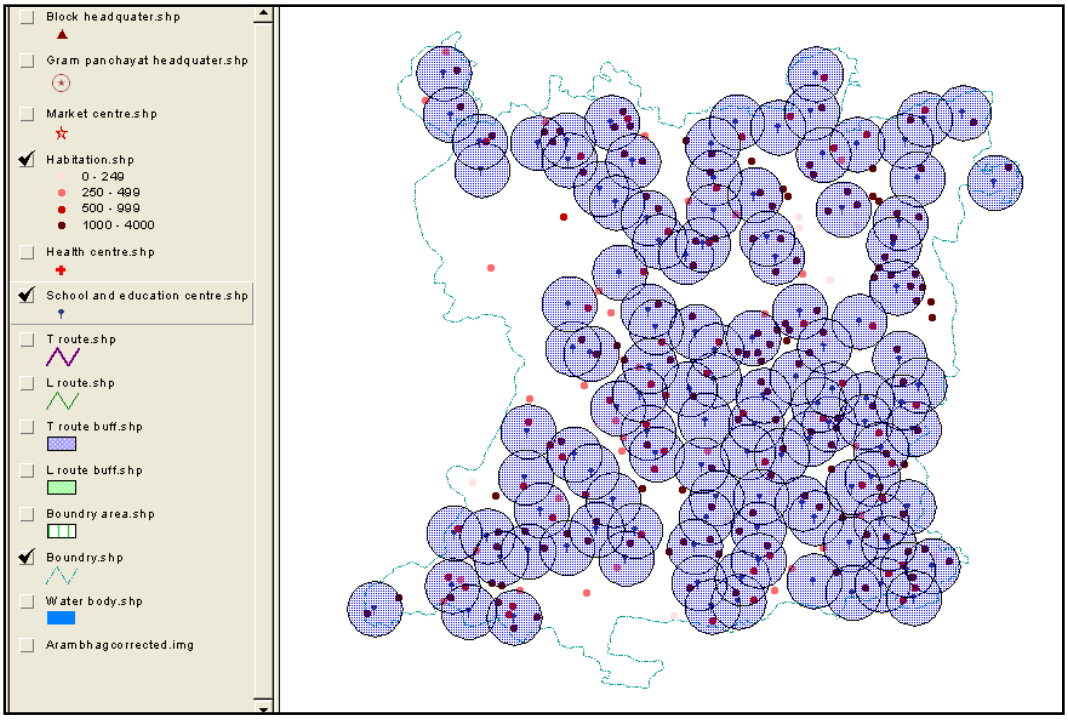


Figure 16 School buffered 1 km

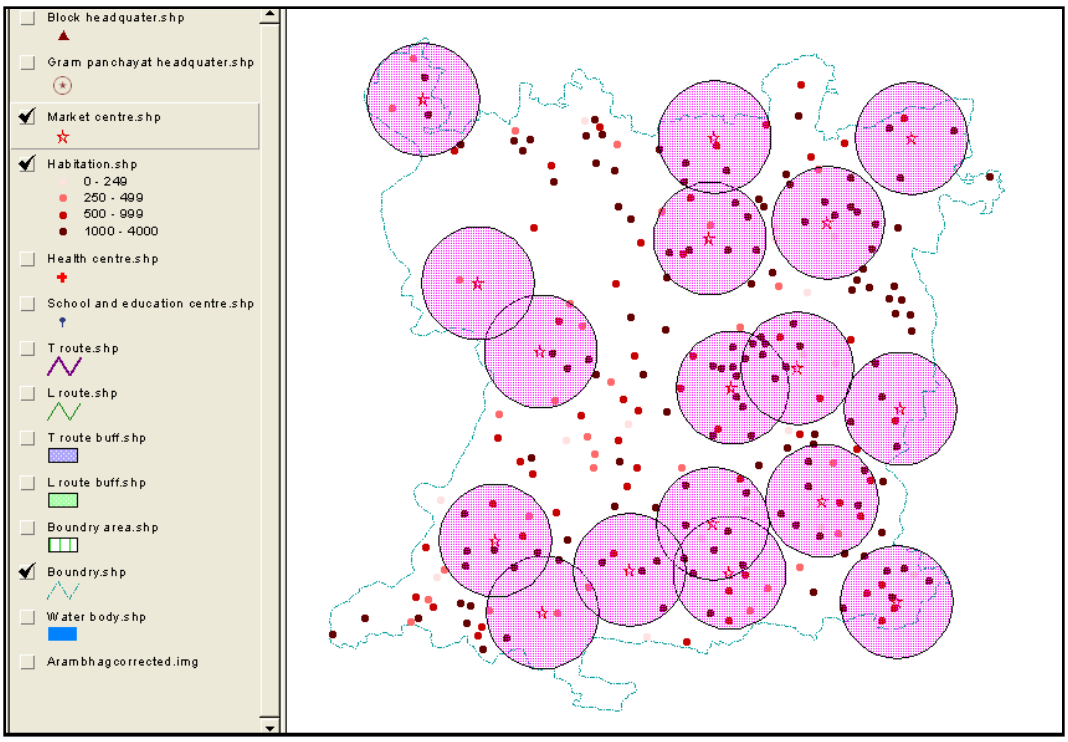


Figure 17 Market centre buffered 2 km

The Utility value for the habitation should consider a set of demographic, socio-economic. Infrastructure and level of development data. This composite measure of development may be called as HINDEX (Habitation Index) of the habitation. Selection of the variables for computation the HINDEX value may be made from the habitation level data. The chosen set of variables may be different in different part of the country based on local development aspiration. Each variable can be given a weightage based on its present level and importance in the integrated development philosophy. Table: 10 show the choices for weights and HINDEX has been calculated for all habitations. The computed HINDEX may be used for the prioritization of the habitations.

The HINDEX for habitation *i* may be computed as shown in the equation:

$$HINDEX_i = \sum_x F_{xy} \times \sum_y W_{xy}$$

$HINDEX_i$ = Habitation index for habitation *i*

F_{xyi} = Number of facility of x^{th} type with y^{th} intensity in habitation *i*

W_{xyi} = Weight for x^{th} facility of y^{th} intensity

For example if we consider a particular habitation and facility of two schools exist in that habitation, weightage value considered is 4. The HINDEX value of calculated for that particular facility is 2 × 4 = 8.

7.3.2 Sample calculation of HINDEX for Pal para habitation

Habitation Pal para (AR201) having population 1015. The habitation has one health centre, two schools and one market place. Then from table 10 we get their weightage value.

HINDEX = 6 + 6 + (2 x 4) + 0 = 20

Table 10 Weightage table

Sl No	Facility Variables of the Habitation	Weightage of Variables					
		0	2	4	6	8	Max Weightage
1	Habitation	Below 250	251 - 500	501 - 1000	1001 - 2000	Above 2000	8
2	School	No	1	>1			4
3	Health Centre	No			Yes		6
4	Market place	1	>1				2

Table 11 Percentage Habitation in HINDEX range

HINDEX range	No. of Habitation	% of Habitation
2 - 6	18	7.44
7 - 10	55	22.73
11 - 16	109	45.04
17 - 22	60	24.79
	Total = 242	Total = 100

Maximum habitation of 45.04 % falls in the HINDEX range of 11 – 16.

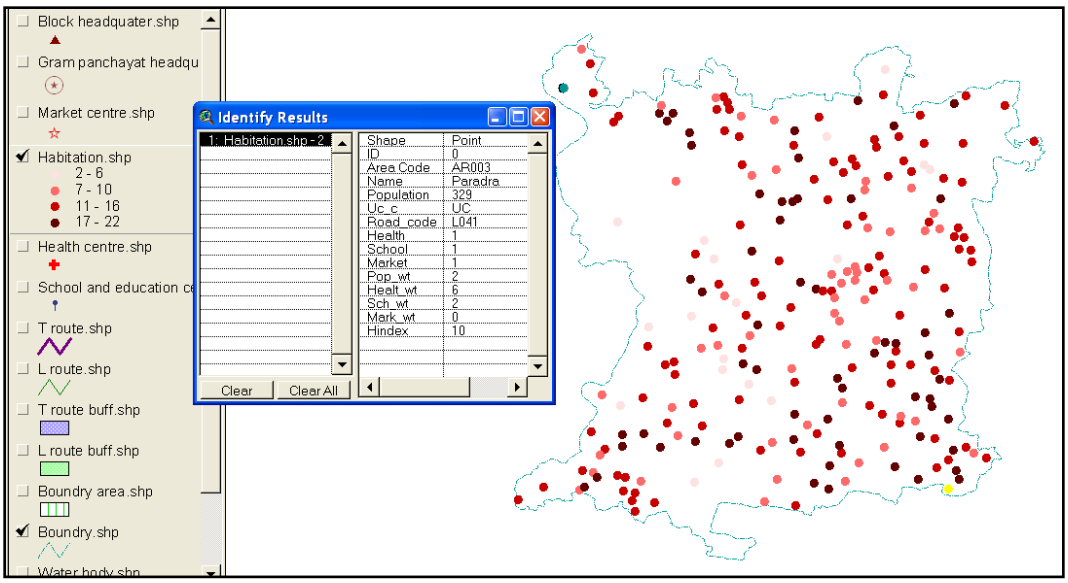


Figure 18 Habitation mapping according to HINDEX value

Table 12 Attribute table of Habitation along with HINDEX

AREA_CODE	NAME	POPULATION	UC_C	ROAD_CODE	HEALTH	SCHOOL	MARKET	POP_WT	HEALT_WT	SCH_WT	MARK_WT	HINDEX
AR001	Bhabapur	253	C	L042	1	1	1	2	6	2	0	10
AR002	Maminpur	2037	C	T07	1	1	1	8	6	2	0	16
AR003	Paradra	329	C	L041	1	1	1	2	6	2	0	10
AR004	Krithchandrapur	1154	C	T07	1	1	1	6	6	2	0	14
AR005	Manodra	1062	C	T10	1	1	0	6	6	2	0	14
AR006	Dadanpur	639	C	T10	1	1	0	4	6	2	0	12
AR007	Ghosh para	1051	C	T10	1	2	0	6	6	4	0	20
AR008	Bagpara	1010	C	T10	1	2	0	6	6	4	0	20
AR009	Daspara	390	C	T10	1	1	0	2	6	2	0	10
AR010	Chandibati	1550	C	L040	1	2	0	6	6	4	0	20
AR011	Dongabathan	622	C	T10	1	2	0	4	6	4	0	18
AR012	Yadpur	1049	C	T10	1	2	0	6	6	4	0	20
AR013	Kapalic para	1045	C	T10	1	1	0	6	6	2	0	14
AR014	Duley para	1046	C	T10	1	1	0	6	6	2	0	14
AR015	Karmakarpara	989	C	L049	1	1	0	4	6	2	0	12
AR016	Bramhanpara	1011	C	L049	1	1	0	6	6	2	0	14
AR017	Dhara para	100	C	L049	1	1	0	0	6	2	0	8
AR018	Mandalpara	1064	C	T10	1	1	0	6	6	2	0	14
AR019	Chaudhurypara	1395	C	T10	1	1	0	6	6	2	0	14

AR020	Mollapara	305	C	T10	1	1	0	2	6	2	0	10
AR021	Benga Uttarpara	1043	C	T10	1	2	1	6	6	4	0	20
AR022	Benga Dhaksinpara	1200	C	T10	0	1	1	6	0	2	0	8
AR023	Chakjalal	1681	C	L053	1	1	1	6	6	2	0	14
AR024	Chakmadan	497	C	L053	1	1	1	2	6	2	0	10
AR025	Rohitchak	629	C	L053	1	2	1	4	6	4	0	18
AR026	Bora	727	C	T13	1	2	0	4	6	4	0	18
AR027	Kurui	1867	C	T13	0	1	0	6	0	2	0	8
AR028	Golta	1205	C	T13	1	1	0	6	6	2	0	14
AR029	Chak chamrul	712	C	L040	1	0	0	4	6	0	0	10
AR030	Teghari	863	C	L051	1	1	1	4	6	2	0	12
AR031	Paschim Shibpur	498	C	L040	0	0	1	2	0	0	0	2
AR032	Parbatichak	289	C	T06	0	0	1	2	0	0	0	2
AR033	Paharchak	144	C	L058	1	1	1	0	6	2	0	8
AR034	Chandsit	252	C	L058	0	0	1	2	0	0	0	2
AR035	Mahespur	1106	C	T09	1	2	1	6	6	4	0	20
AR036	Bhargakhetri para	1067	C	L066	1	1	1	6	6	2	0	14
AR037	Uttar Pan para	1175	C	L066	0	1	0	6	0	2	0	8
AR038	Ghosh para	1025	C	T09	1	2	1	6	6	4	0	20
AR039	Bamsa Amrel	324	C	L065	0	1	0	2	0	2	0	4
AR040	Jayrampur	1148	C	T03	1	1	0	6	6	2	0	14
AR041	Gopinathpur	665	C	T03	1	1	0	4	6	2	0	12
AR042	Keledona	1343	C	L068	1	2	0	6	6	4	0	20
AR043	Kulbeyra	496	C	L063	0	0	1	2	0	0	0	2
AR044	Raghunathpur	444	C	L059	0	1	1	2	0	2	0	4
AR045	Kasthadahi	897	C	T02	1	1	0	4	6	2	0	12
AR046	Bhargakhetri Para	1002	C	T02	1	2	1	6	6	4	0	20
AR047	Muslim para	1321	C	T02	1	2	1	6	6	4	0	20
AR048	Tellipara	579	C	T02	1	2	1	4	6	4	0	18
AR049	Uttarnarayan pur	2007	C	T13	1	2	0	8	6	4	0	22
AR050	Behala	443	C	T08	1	2	1	2	6	4	0	16
AR051	Sarkar para	1020	C	T08	0	0	1	6	0	0	0	6
AR052	Esan Para	1010	C	L061	1	1	1	6	6	2	0	14
AR053	Karmakar Para	1013	C	L061	1	0	0	6	6	0	0	12
AR054	Tettulia	1014	C	L061	1	1	1	6	6	2	0	14
AR055	Khachari para	1006	C	T08	1	0	0	6	6	0	0	12
AR056	Sastipur	529	C	T08	1	1	1	4	6	2	0	12

AR057	Chakfazil Uttar	866	C	L043	1	2	1	4	6	4	0	18
AR058	Rasulpur uttar	1830	C	L044	1	1	0	6	6	2	0	14
AR059	Sekhpur	852	C	L044	0	1	0	4	0	2	0	6
AR060	Chak Ahmed	835	C	L054	1	2	0	4	6	4	0	18
AR061	Tala	997	C	L044	1	1	0	4	6	2	0	12
AR062	Bachhanari	1850	C	L044	1	2	1	6	6	4	0	20
AR063	Fatepur	524	C	L044	1	1	1	4	6	2	0	12
AR064	Purbaharipur	1481	C	L021	1	1	1	6	6	2	0	14
AR065	Ghargohal	1769	C	L022	1	1	0	6	6	2	0	14
AR066	Balia	1804	C	T01	1	1	1	6	6	2	0	14
AR067	Chakbensia	1139	C	T02	1	1	0	6	6	2	0	14
AR068	Banamalipur	1187	C	T01	1	2	1	6	6	4	0	20
AR069	Dhasksin para	1094	C	L052	1	1	1	6	6	2	0	14
AR070	Konear para	1105	C	L052	1	0	1	6	6	0	0	12
AR071	Uttarpara	1055	C	L052	0	0	1	6	0	0	0	6
AR072	Fakirdanga	1050	C	T02	1	1	1	6	6	2	0	14
AR073	Chandpara	1179	C	L052	0	0	1	6	0	0	0	6
AR074	Kailaschak	1021	C	T02	1	1	1	6	6	2	0	14
AR075	Uttarpara	1250	C	L052	1	1	1	6	6	2	0	14
AR076	Samanta para	150	C	T02	1	1	1	0	6	2	0	8
AR077	Chak Behala	443	C	L054	1	2	1	2	6	4	0	16
AR078	Uttarpara	1193	C	L061	1	1	0	6	6	2	0	14
AR079	Dhaksinpara	1101	C	L061	1	1	1	6	6	2	0	14
AR080	Kasigare	132	C	T02	1	1	1	0	6	2	0	8
AR081	Barui para	1040	C	T02	1	1	1	6	6	2	0	14
AR082	Goalapara	100	C	T02	1	1	1	0	6	2	0	8
AR083	Musalman para	1045	C	T02	1	2	1	6	6	4	0	20
AR084	Purbapara	1049	C	L064	1	1	0	6	6	2	0	14
AR085	Paschimpara	1500	C	L064	1	1	0	6	6	2	0	14
AR086	Jasapur	331	C	L055	1	0	0	2	6	0	0	8
AR087	Chakanar	105	C	L045	1	1	1	0	6	2	0	8
AR088	Gharai para	1009	C	T01	0	1	0	6	0	2	0	8
AR089	Hari para	1198	C	L023	0	2	0	6	0	4	0	14
AR090	Malpara	1002	C	L024	1	1	0	6	6	2	0	14
AR091	Saha para	1025	C	T01	0	1	0	6	0	2	0	8
AR092	Moyra para	1175	C	L023	0	1	0	6	0	2	0	8
AR093	Bene para	1205	C	L024	1	1	0	6	6	2	0	14
AR094	Kaji para	1005	C	L024	1	0	0	6	6	0	0	12
AR095	Malik para	1250	C	L024	1	1	0	6	6	2	0	14

AR096	Brahaman para	1054	C	L024	1	1	0	6	6	2	0	14
AR097	Sayer para	1200	C	L024	1	0	0	6	6	0	0	12
AR098	Asanpur	2254	C	L055	1	1	1	8	6	2	0	16
AR099	Mazaffarpur	762	C	L046	1	1	0	4	6	2	0	12
AR100	Purba Krishanapur	3058	C	L024	1	1	1	8	6	2	0	16
AR101	Purba Shibpur	100	C	T14	1	1	1	0	6	2	0	8
AR102	Koley Para	1156	C	T14	1	1	1	6	6	2	0	14
AR103	Bargakhetria para	1244	C	T01	0	2	1	6	0	4	0	14
AR104	Sen para	86	C	T14	1	1	1	0	6	2	0	8
AR105	Sarali	1117	C	T01	0	1	2	6	0	2	2	10
AR106	Surir para	1053	C	T08	1	2	1	6	6	4	0	20
AR107	Muthadanga	1020	C	T08	1	1	1	6	6	2	0	14
AR108	Brahaman para	1030	C	T08	1	1	1	6	6	2	0	14
AR109	Duley para	1005	C	L027	0	1	2	6	0	2	2	10
AR110	Simultalla	1015	C	L027	0	1	1	6	0	2	0	8
AR111	Khumbhakar para	1010	C	L027	0	1	1	6	0	2	0	8
AR112	Duttabati	1020	C	L027	0	1	2	6	0	2	2	10
AR113	Patiatamban dh	989	C	L027	1	1	1	4	6	2	0	12
AR114	Kanadighi	1011	C	L027	0	1	2	6	0	2	2	10
AR115	Muslim para	1013	C	L027	0	1	2	6	0	2	2	10
AR116	Malik pukur	1039	C	T08	0	1	1	6	0	2	0	8
AR117	Kumarpara	1165	C	T08	0	1	1	6	0	2	0	8
AR118	Susni Para	430	C	T08	0	1	0	2	0	2	0	4
AR119	Hat Basantapur	2652	C	T13	1	1	0	8	6	2	0	16
AR120	Mohanpur	893	C	L060	1	2	1	4	6	4	0	18
AR121	Rajhati	567	C	T13	1	1	1	4	6	2	0	12
AR122	Balarampur	1271	C	T13	1	1	0	6	6	2	0	14
AR123	Satpur	859	C	L065	1	2	0	4	6	4	0	18
AR124	Krishanabati	689	C	L065	1	1	0	4	6	2	0	12
AR125	Ajoypur	776	C	T09	1	1	0	4	6	2	0	12
AR126	Chandchak	409	C	T09	1	1	0	2	6	2	0	10
AR127	Bauripara	500	C	L050	1	2	0	2	6	4	0	16
AR128	Koley pukur	1271	C	L050	1	1	0	6	6	2	0	14
AR129	Malik para	800	C	L050	1	1	0	4	6	2	0	12
AR130	Mubarakpur	999	C	T06	1	1	0	4	6	2	0	12
AR131	Hazra bagan	995	C	L039	1	1	1	4	6	2	0	12
AR132	Dumdumpati	89	C	L039	1	1	0	0	6	2	0	8
AR133	Salepur	1105	C	L039	0	0	1	6	0	0	0	6

AR134	Manikpara Uttar	1017	C	L038	1	2	1	6	6	4	0	20
AR135	Manikpara Purba	1235	C	L038	1	2	1	6	6	4	0	20
AR136	Manikpara Dakshin	1265	C	L038	1	2	1	6	6	4	0	20
AR137	Partar para	307	C	L038	1	2	1	2	6	4	0	16
AR138	Paschim pur	991	C	L038	1	1	0	4	6	2	0	12
AR139	Hazra para	975	C	L036	1	1	0	4	6	2	0	12
AR140	Dey para	467	C	L036	1	1	0	2	6	2	0	10
AR141	Baradangal	925	C	L036	1	2	0	4	6	4	0	18
AR142	Dakshin Sekhpur	156	C	L037	1	1	1	0	6	2	0	8
AR143	Uttarpara	1022	C	L036	1	1	0	6	6	2	0	14
AR144	Dhaksinpara	1030	C	L036	1	1	1	6	6	2	0	14
AR145	Atpur	421	C	L035	0	2	0	2	0	4	0	10
AR146	Berabere	1118	C	L035	1	2	0	6	6	4	0	20
AR147	Dharkundu Uttar	1325	C	L034	1	1	1	6	6	2	0	14
AR148	Dhaksin	1175	C	L034	1	1	0	6	6	2	0	14
AR149	Purba	1002	C	L034	1	1	0	6	6	2	0	14
AR150	Beraber	1298	C	L034	1	1	0	6	6	2	0	14
AR151	Mondalpara	600	C	L034	1	1	0	4	6	2	0	12
AR152	Jana para	550	C	L034	1	1	0	4	6	2	0	12
AR153	Faterchak	452	C	L034	1	1	1	2	6	2	0	10
AR154	Dongal	1369	C	L036	1	1	0	6	6	2	0	14
AR155	Ratanpur	1042	C	T06	1	2	2	6	6	4	2	22
AR156	Tatarchak	621	C	T06	1	1	1	4	6	2	0	12
AR157	Helarchak	496	C	T11	1	1	1	2	6	2	0	10
AR158	Hari para	1002	C	T05	0	1	1	6	0	2	0	8
AR159	Bargakhatripara	1031	C	T05	1	2	1	6	6	4	0	20
AR160	Gaurhati	479	C	T12	0	0	1	2	0	0	0	2
AR161	Subhaypur	498	C	L048	0	1	2	2	0	2	2	6
AR162	Kharal	1153	C	T05	1	2	1	6	6	4	0	20
AR163	Paisara	666	C	T05	1	2	1	4	6	4	0	18
AR164	Gouri	1044	C	L057	1	1	0	6	6	2	0	14
AR165	Beurgram	1128	C	L057	1	0	0	6	6	0	0	12
AR166	Khorbalarurchak	428	C	T09	0	0	0	2	0	0	0	2
AR167	Mahishgot	876	C	T11	1	1	0	4	6	2	0	12
AR168	Basulichak	948	C	T11	0	1	0	4	0	2	0	6
AR169	Sonagachhi	354	C	T09	0	1	0	2	0	2	0	4
AR170	Dhaksin para	1283	C	T09	1	2	0	6	6	4	0	20
AR171	Golpukur	985	C	L065	1	1	0	4	6	2	0	12

AR172	Purbapara	115	C	L065	1	1	1	0	6	2	0	8
AR173	Ranhat	997	C	T13	1	2	0	4	6	4	0	18
AR174	Joteram	251	C	L062	1	1	0	2	6	2	0	10
AR175	Hamirbati	1553	C	L067	1	1	1	6	6	2	0	14
AR176	Krishna Ballabhpur	951	C	L067	1	1	1	4	6	2	0	12
AR177	Panpit	2192	C	T04	0	1	1	8	0	2	0	10
AR178	Sahapur	1265	C	T04	0	1	1	6	0	2	0	8
AR179	Dakshin Rasulpur	2599	C	T01	0	2	1	8	0	4	0	16
AR180	Tirol	801	C	L056	1	1	1	4	6	2	0	12
AR181	Shyamgram	2125	C	L046	1	2	1	8	6	4	0	22
AR182	Arunbera	1352	C	L024	1	2	1	6	6	4	0	20
AR183	Golamichak	846	C	T03	0	2	1	4	0	4	0	12
AR184	Amgram	1343	C	L025	0	1	1	6	0	2	0	8
AR185	Chandra	789	C	L026	1	2	0	4	6	4	0	18
AR186	Chakraborty para	1009	C	L026	1	1	1	6	6	2	0	14
AR187	Bargakhatripara	1090	C	L026	1	1	0	6	6	2	0	14
AR188	Debnathpur	900	C	L026	1	2	1	4	6	4	0	18
AR189	Birati	268	C	T14	1	2	1	2	6	4	0	16
AR190	Katabani	1435	C	T01	1	1	1	6	6	2	0	14
AR191	Pirijpur	1192	C	T01	1	2	0	6	6	4	0	20
AR192	Selalpur	1018	C	T04	1	1	0	6	6	2	0	14
AR193	Elma	703	C	T04	1	2	1	4	6	4	0	18
AR194	Madhabpur	1038	C	L062	1	1	1	6	6	2	0	14
AR195	Pandugram	1906	C	T11	0	0	0	6	0	0	0	6
AR196	Jaisinhachak	1733	C	T11	1	2	1	6	6	4	0	20
AR197	Dehibagnan Purba	1250	C	T05	1	2	2	6	6	4	2	22
AR198	Dihibagan Paschim	1300	C	T05	1	1	2	6	6	2	2	16
AR199	Dehibagnan Uttar	1450	C	T05	0	1	1	6	0	2	0	8
AR200	Dehibagnan Dhaksin	1086	C	T05	1	1	1	6	6	2	0	14
AR201	Pal para	1015	C	L033	1	2	1	6	6	4	0	20
AR202	Para Bagan	1785	C	L033	0	1	1	6	0	2	0	8
AR203	Madhya Para	52	C	L033	1	1	1	0	6	2	0	8
AR204	Bhabanipur	653	C	L033	1	1	0	4	6	2	0	12
AR205	Chunait	694	C	L033	1	2	1	4	6	4	0	18
AR206	Bhandarhati	303	C	T04	1	0	1	2	6	0	0	8
AR207	Balaichak	607	C	T04	1	2	1	4	6	4	0	18
AR208	Samta	928	C	T05	1	1	1	4	6	2	0	12
AR209	Tantisal	419	C	L032	1	1	1	2	6	2	0	10

AR210	Purba Sitalpur	1330	C	T04	1	2	2	6	6	4	2	22
AR211	Paschim Sitalpur	1301	C	T04	1	1	2	6	6	2	2	16
AR212	Kajimahal	107	C	T11	1	1	1	0	6	2	0	8
AR213	Mandaran	1171	C	L047	0	2	1	6	0	4	0	14
AR214	Sadgop para	1068	C	T04	1	2	2	6	6	4	2	22
AR215	Banerjee para	1598	C	T04	1	2	1	6	6	4	0	20
AR216	Bargakhetria para	102	C	T04	1	1	1	0	6	2	0	8
AR217	Dorjipota	1073	C	L047	0	2	1	6	0	4	0	14
AR218	Dorjipota	1220	C	L047	0	2	1	6	0	4	0	14
AR219	Goala para	80	C	L047	1	1	1	0	6	2	0	8
AR220	Arakul	420	C	L031	1	1	0	2	6	2	0	10
AR221	Satmasa	1185	C	L031	1	2	0	6	6	4	0	20
AR222	Bahukhedail	1148	C	L030	1	2	1	6	6	4	0	20
AR223	Pura	1784	C	T11	1	2	0	6	6	4	0	20
AR224	Gholpura	332	C	T01	1	1	1	2	6	2	0	10
AR225	Siara	964	C	T14	1	2	1	4	6	4	0	18
AR226	Ragpur	1018	C	T14	1	2	1	6	6	4	0	20
AR227	Gobra	673	C	T14	1	2	1	4	6	4	0	18
AR228	Purba Ragpur	1033	C	L028	1	2	0	6	6	4	0	20
AR229	Madhurpur	1040	C	T14	1	1	1	6	6	2	0	14
AR230	Sen para	1356	C	T03	1	2	0	6	6	4	0	20
AR231	Dey para	949	C	T03	1	2	0	4	6	4	0	18
AR232	Bakherchak	205	C	T03	1	1	1	0	6	2	0	8
AR233	Kotal para	1050	C	L029	1	1	1	6	6	2	0	14
AR234	Gopal Danga	1302	C	L029	1	1	1	6	6	2	0	14
AR235	Lalurchak	101	C	L029	1	1	1	0	6	2	0	8
AR236	Dakshin Narayanpur	1747	C	T01	0	2	1	6	0	4	0	14
AR237	Muslim para	945	C	T01	1	2	1	4	6	4	0	18
AR238	Sarkar para	1021	C	L029	1	2	1	6	6	4	0	20
AR239	Roy para	655	C	T01	1	1	1	4	6	2	0	12
AR240	Guchhaitpara	1105	C	T01	1	2	1	6	6	4	0	20
AR241	Kismat Khedail	545	C	L030	0	2	1	4	0	4	0	12
AR242	Tilakchak	725	C	T01	0	2	1	4	0	4	0	12

UC_C = UC unconnected **/ C** connected

HEALTH = number of Health centre

SCHOOL = number of Schools and education centers

MARKET = number of Market centers

POP_WT = Population weightage

HEALT_WT = Health centre's weightage

SCH_WT = School and education centre's weightage

MARK_WT = Market centre's weightage

HINDEX = Habitation Index

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