Application of GIS in Rural Road and Habitation Mapping

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General

- Infrastructural Facilities.
- Good Road Infrastructure.
- Highway Network in the Country is Inadequate and Insufficient.
- Bitumen-based Macadamized Roads.

Condition of road network of India

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

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)

Transport in West Bengal

- The total length of surface road in West Bengal is over 92,023 km (57,180 mi)
- National Highways 2,377 Km (1,477 mi)
- State highways 2,393 km (1,487 mi)

Pradhan Mantri Gram Sadak Yojana (PMGSY)

OBJECTIVE

- Provide Connectivity
- Upgradation of the Existing Roads.
  - In Upgradation works, priority should be given to Through Routes of the Rural Core Network, which carry more traffic.

Geographic Information Systems (GIS)

- **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).

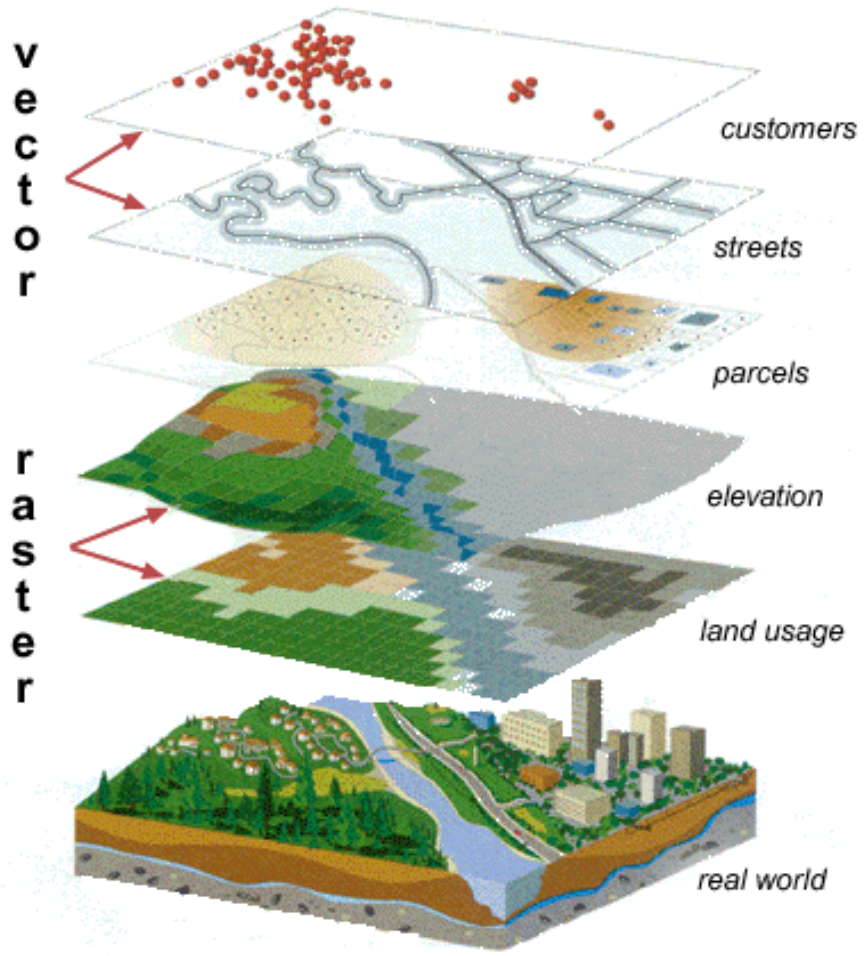


Figure 1 Raster and Vector data

Geographic Information Systems (GIS)

Raster data

- a raster graphics image or bitmap is a data structure representing a generally rectangular grid of pixels.

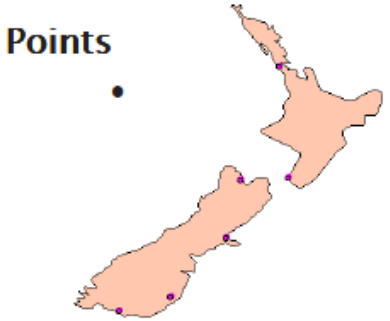


Figure 2 Point example

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

  Different kinds of Vector data

  - Points
  - Lines
  - Polygons

Figure 3 Line example

Figure 4 Polygon example

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
- A GIS can provide a valuable tool for managing these objects in a spatially referenced context, viewing the paths as a transportation network.
  - Planning and design
  - Routing
  - Navigation
  - Tracking
  - Traffic control
  - Evaluation

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.

Scope of the work

- The database development is very much useful for problem identification of rural road network planning and management.

- It directly helps the villagers to upgrade living quality in terms of livelihood, medical, educational facilities as well as other socio-economical parameters.

Present Study: Data collection

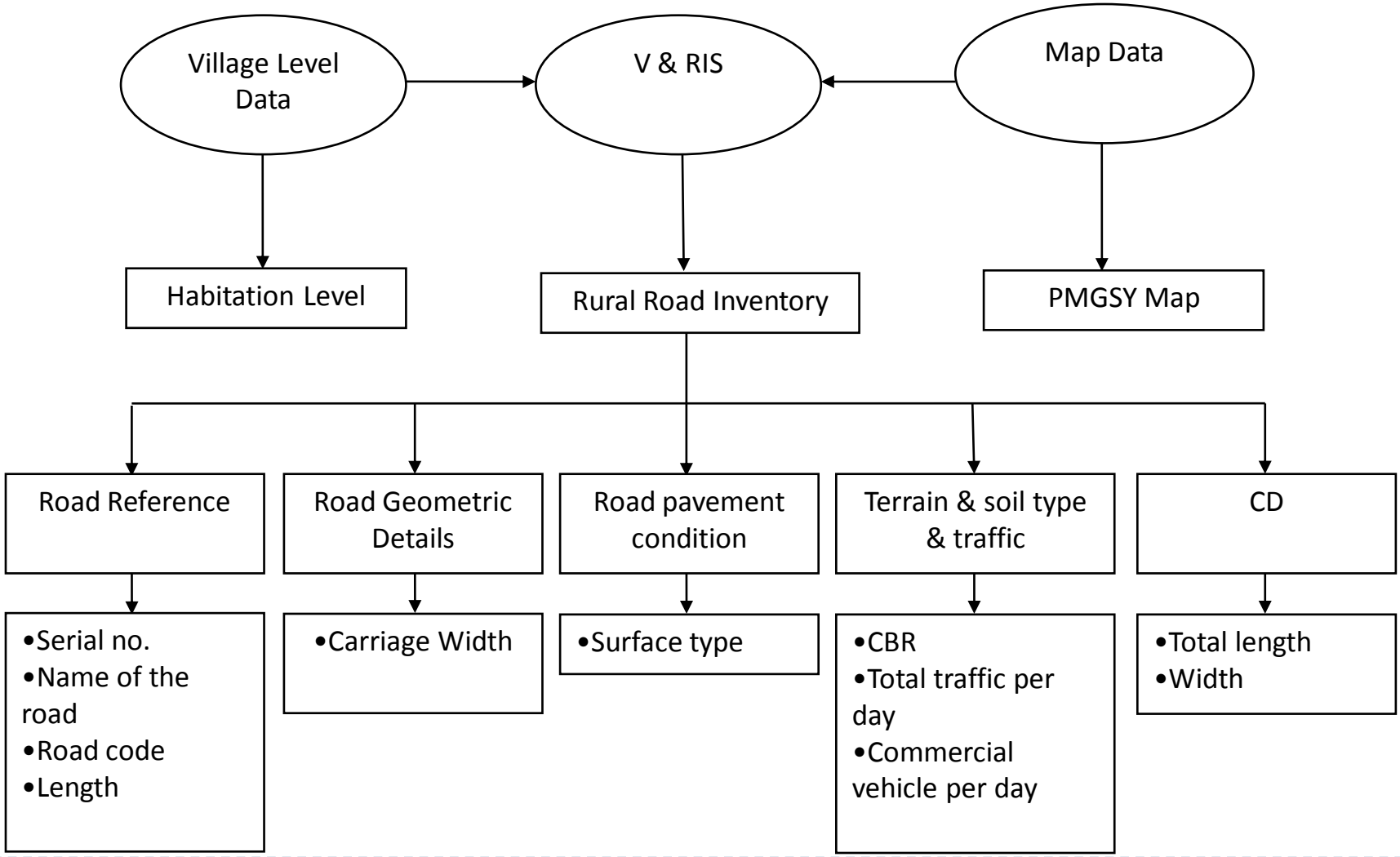
Study Area

- Geography: Arambagh is located at 22.88°N 87.78°E. It has an average elevation of 15 meters (118 feet).
- Geographical area of Arambagh being: 322.53 km^2 (32253.47 hectares)
- Perimeter = 133.99 km
- Economics: This is a rice and potato agricultural area with several cold storages.

Data collection

- Various data items required for the development of the comprehensive rural road planning and development can be broadly categorized under three categories
  - Village Data
  - Rural Road Data
  - Map Data

Flowchart for Rural Road Inventory



Data collection: Village Data

- 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 2 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

Data collection: Road Data

- The road inventory data is essential for planning, management of the road system and planning of rural connectivity.
- The total existing road length is 282.15 Km.

Table 3 Road Facilities

Type	Number	Length
T- Through Routes	14	50.5 km
L- Link Routes	47	131.65 km

Data collection: Map Data

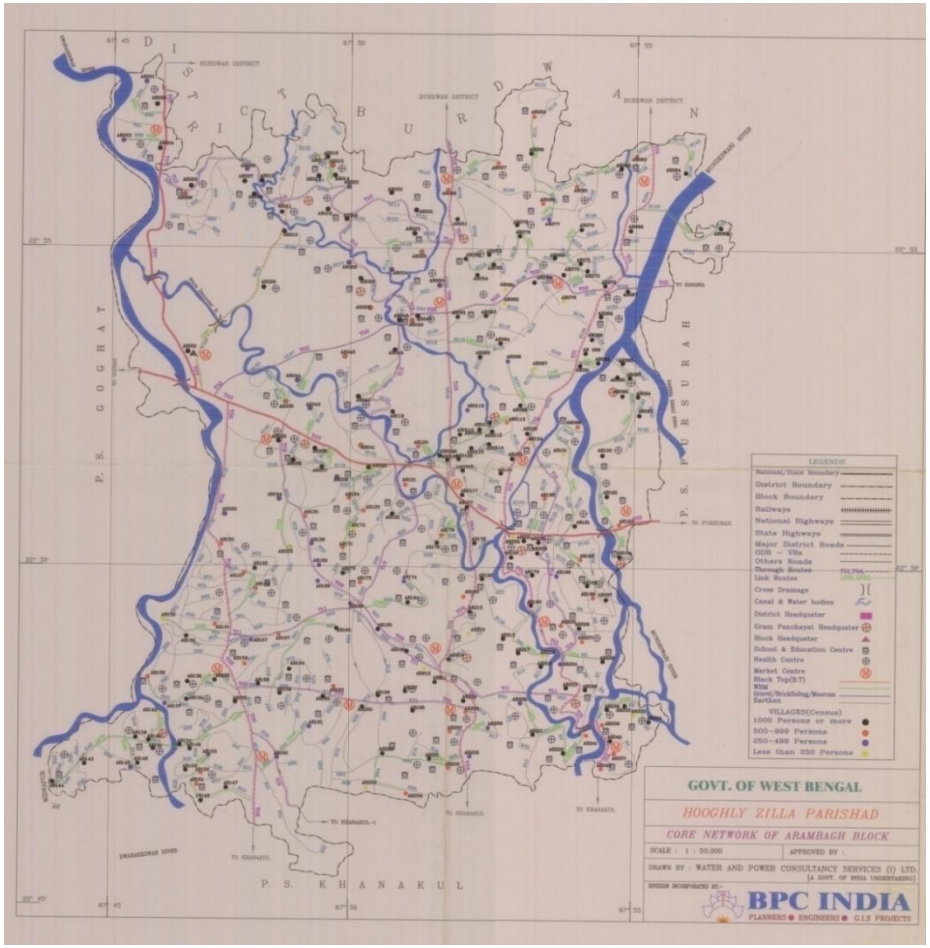


Figure 5 Map of Arambagh Block (Scale 1:50,000)

Procedure of Work

- Geo Referencing using ERDAS Imagine
- **Application of Arc View GIS**
- **Calculating Length, Area of different theme layers**

Table 4 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

Point: Habitation

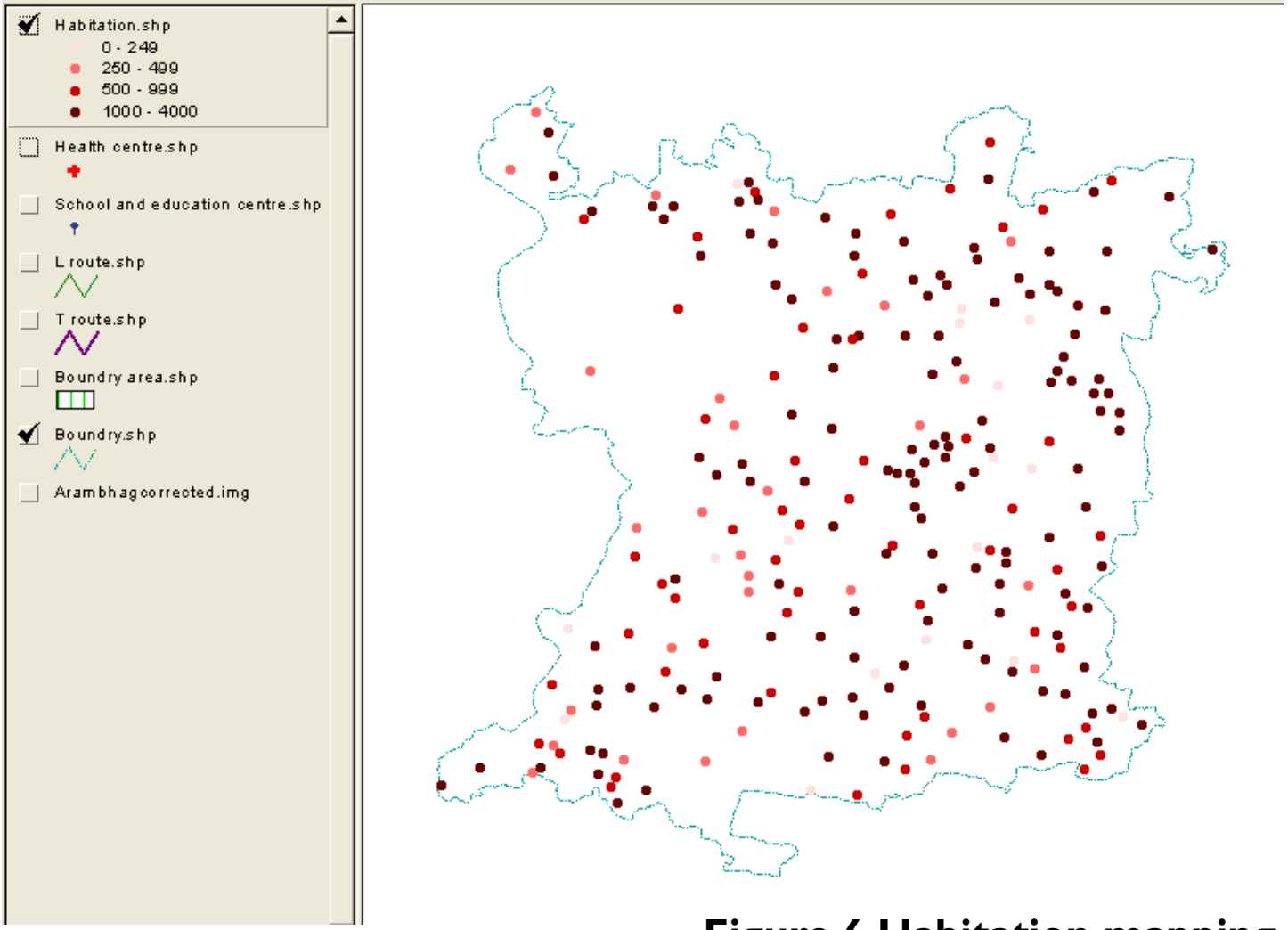


Figure 6 Habitation mapping as per population

Point: Habitation Data of a selected point

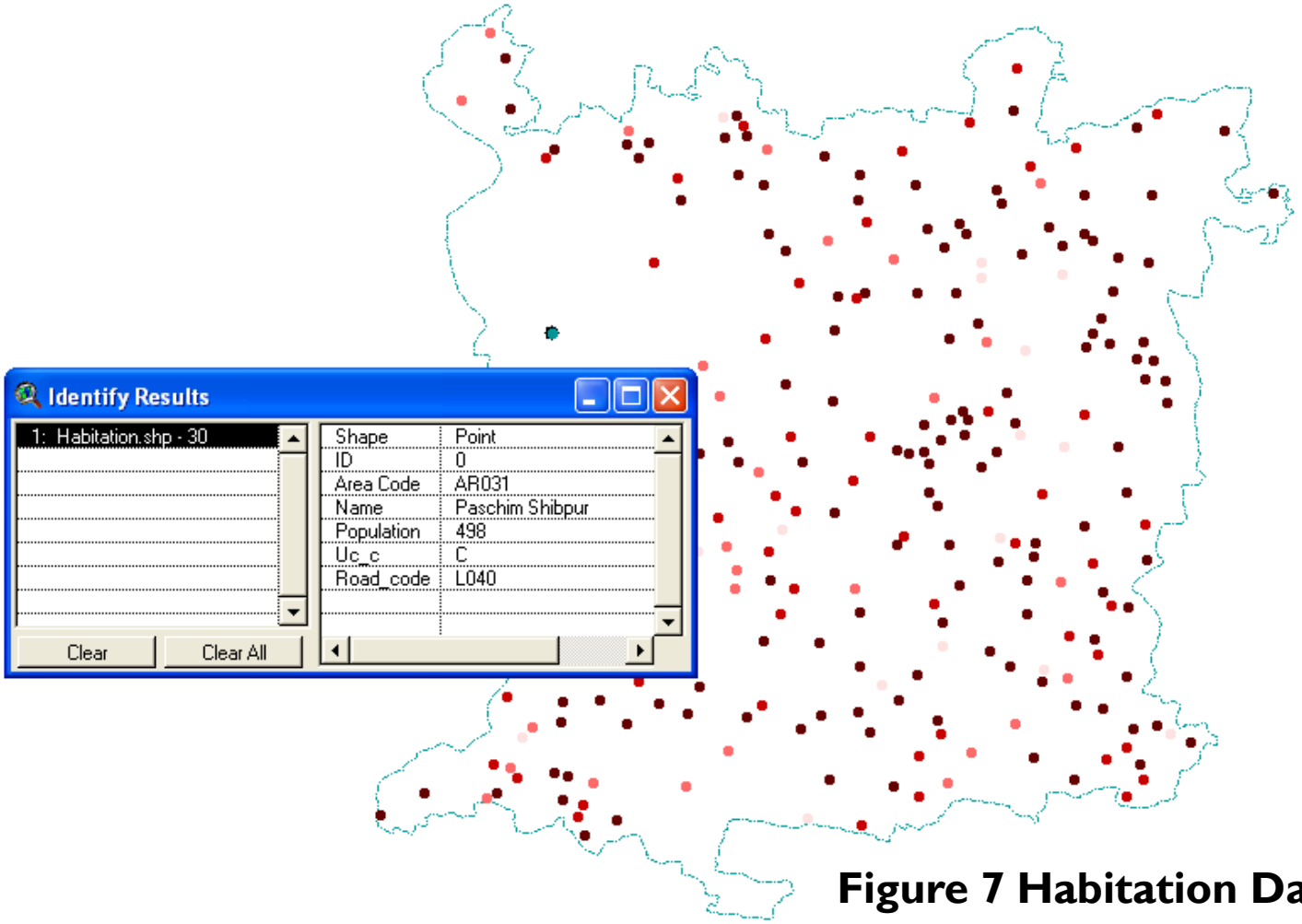


Figure 7 Habitation Data of a selected point (shown in Green)

Point: Habitation Attribute Table

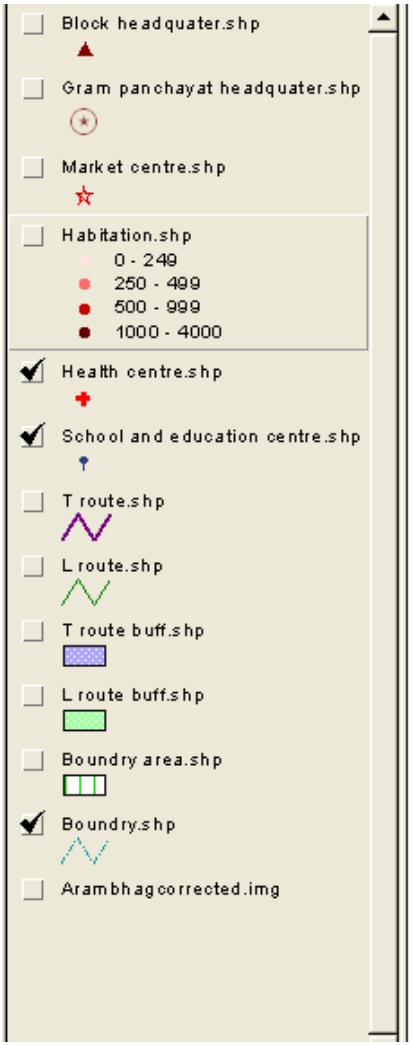
Table 5 Sample Attribute Table of Habitation

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

Table 6 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

Point: Health centre and School



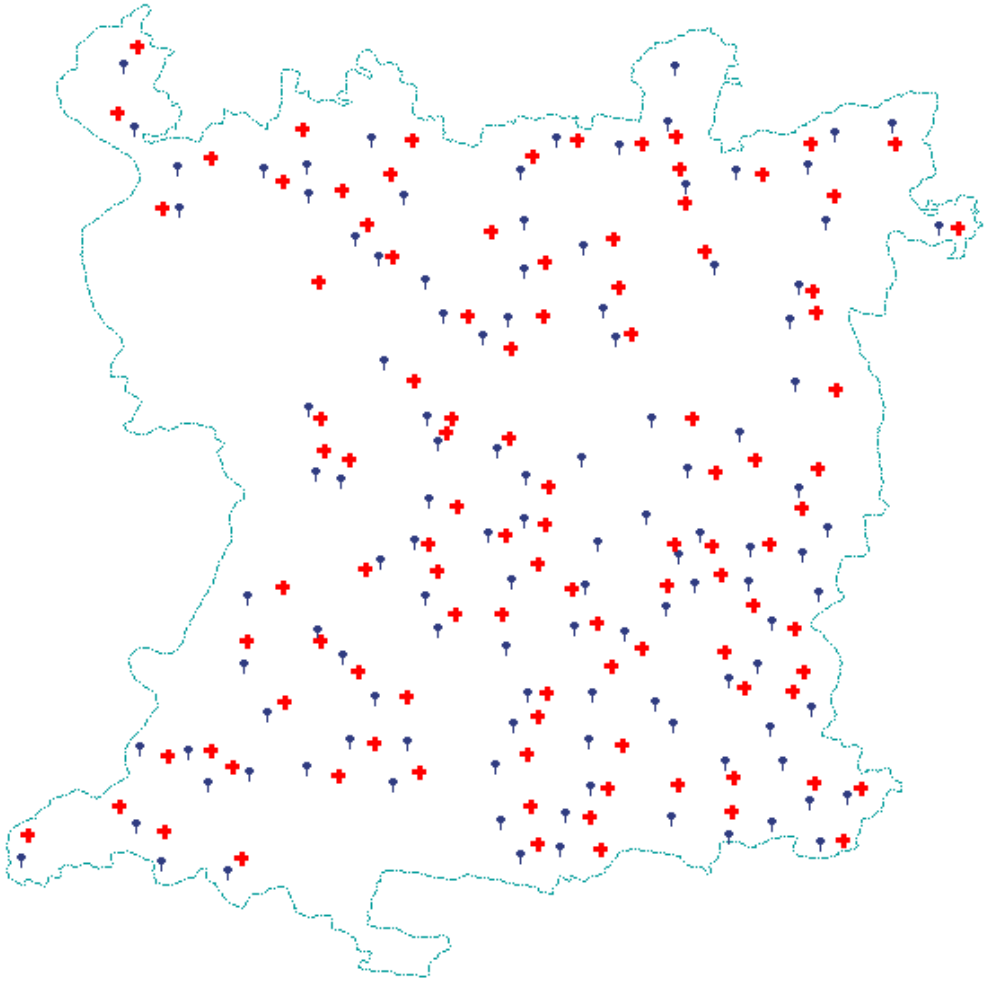
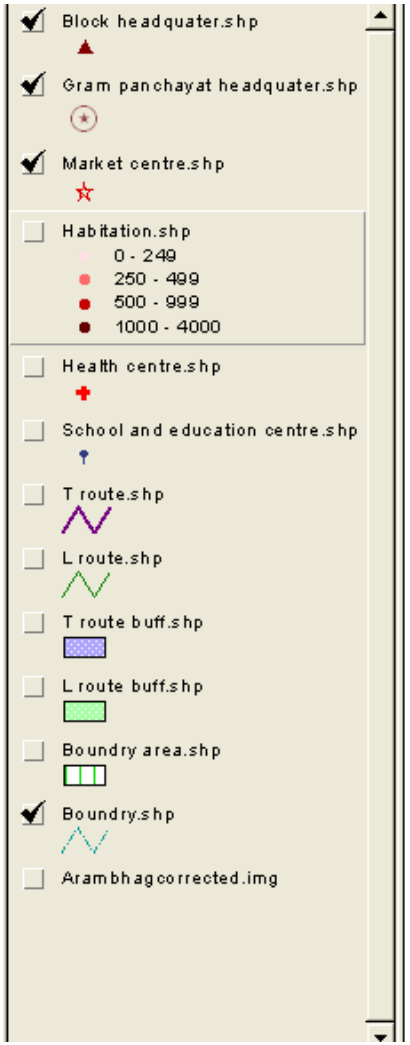


Figure 8 Schools and Health Centre

Point: Market place, Gram panchyat and Block head quarter



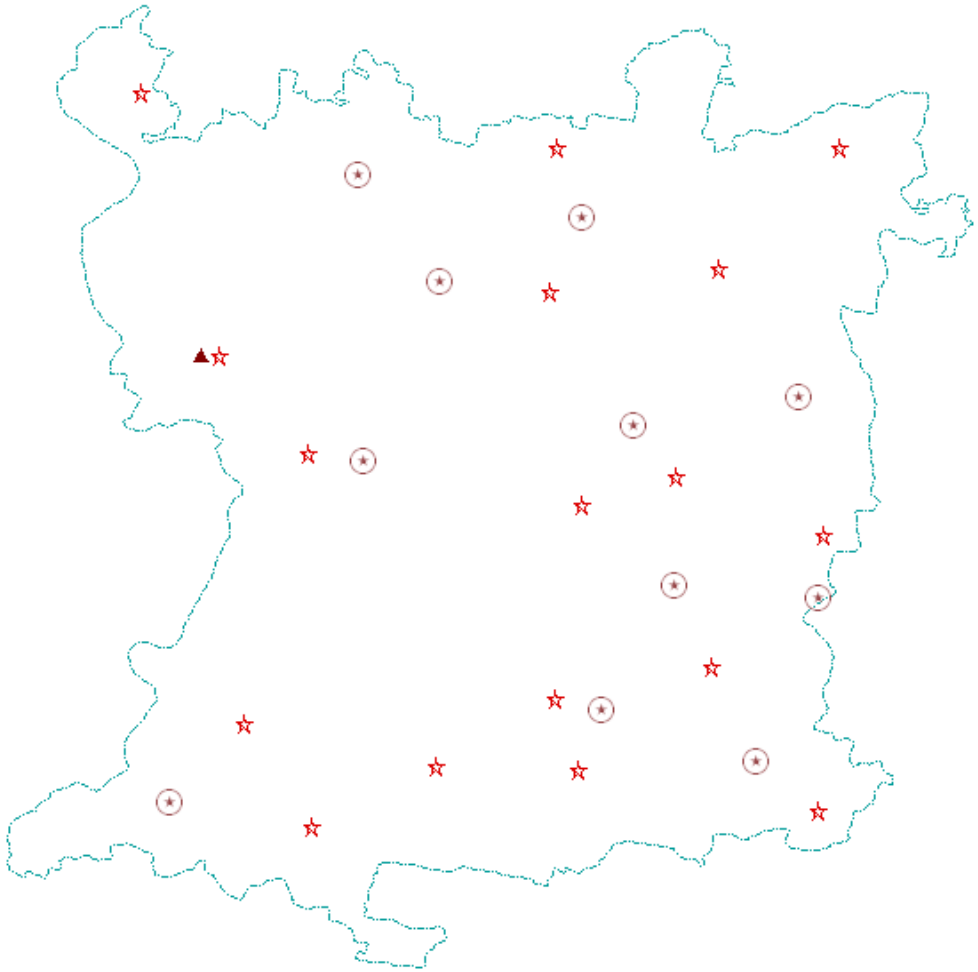
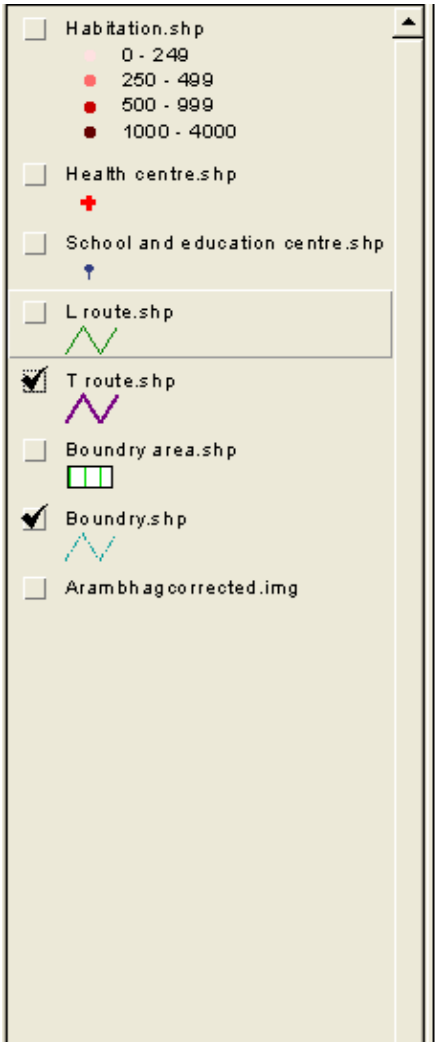


Figure 9 Block Head Quarter, Gram Panchayat and Market Centre

Line: Through route



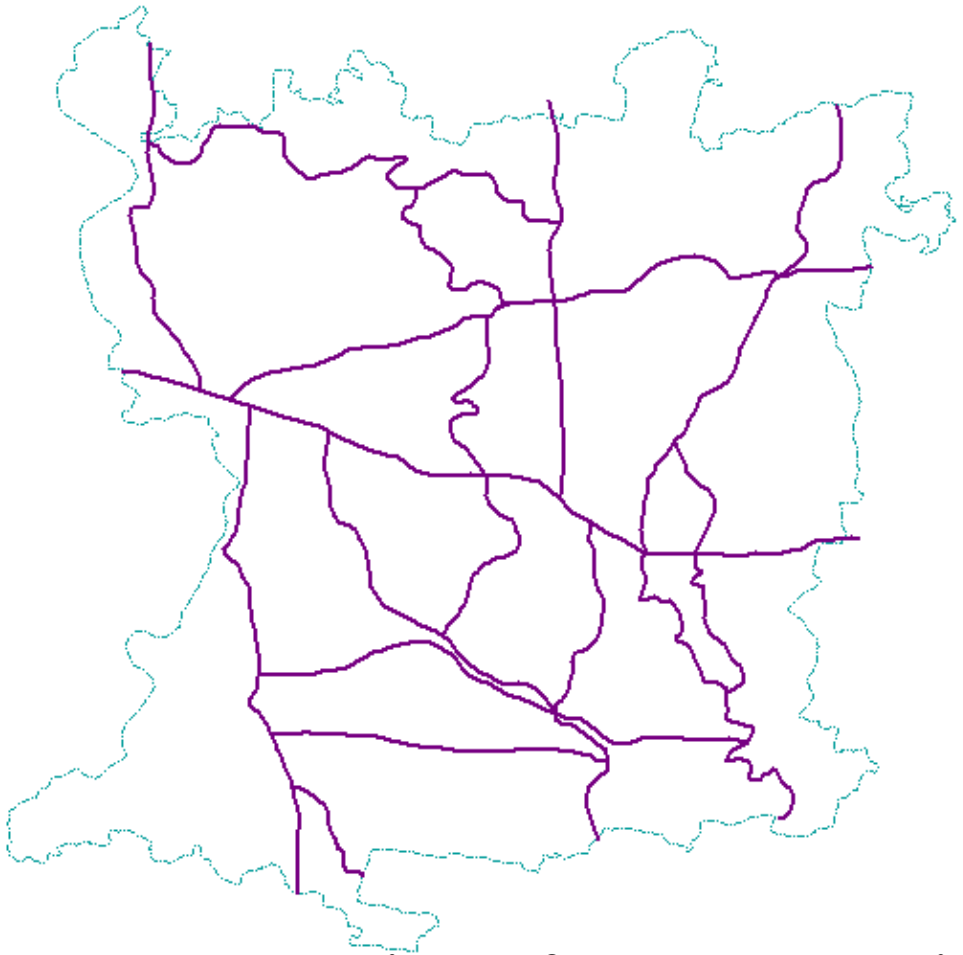


Figure 10 Through routes in the block

Line: Through route data of a selected route

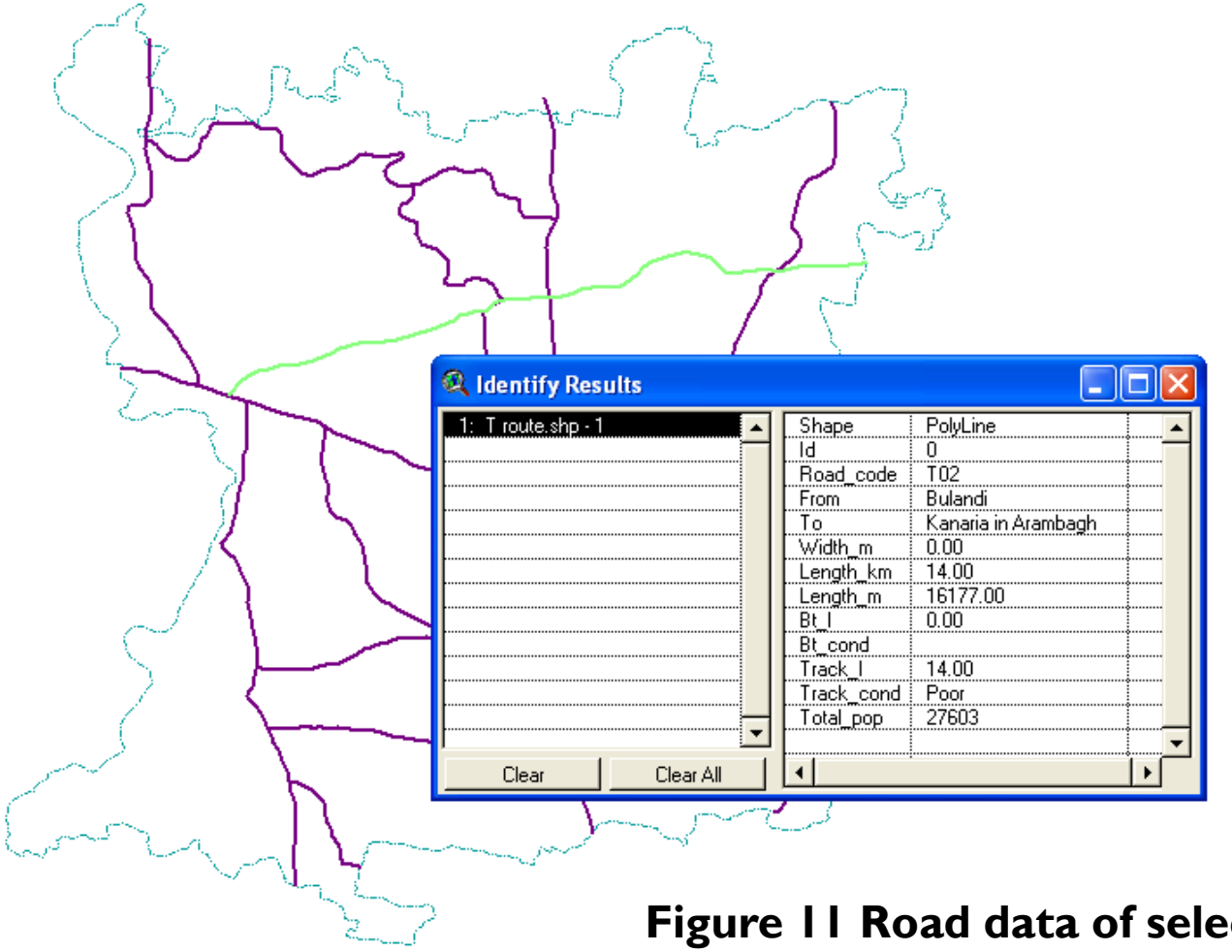


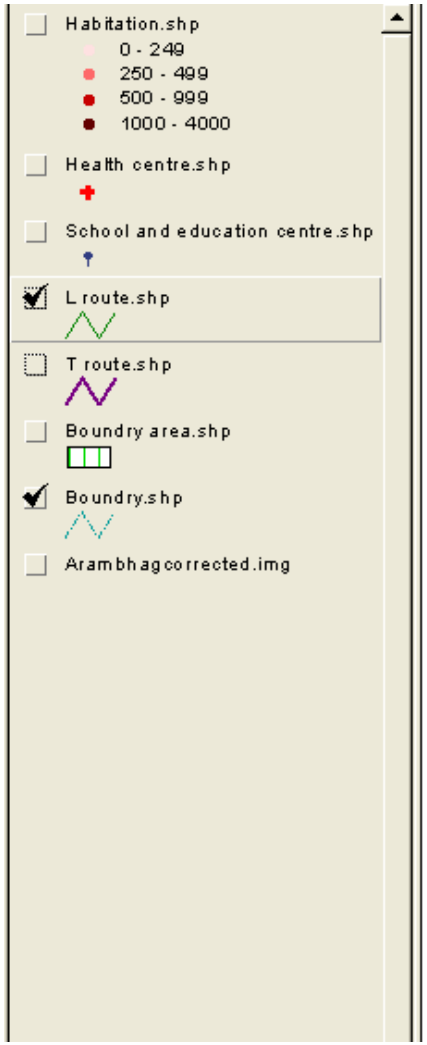
Figure 11 Road data of selected through route (shown in Green)

Line: Through route data

Table 7 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

Line: Link route



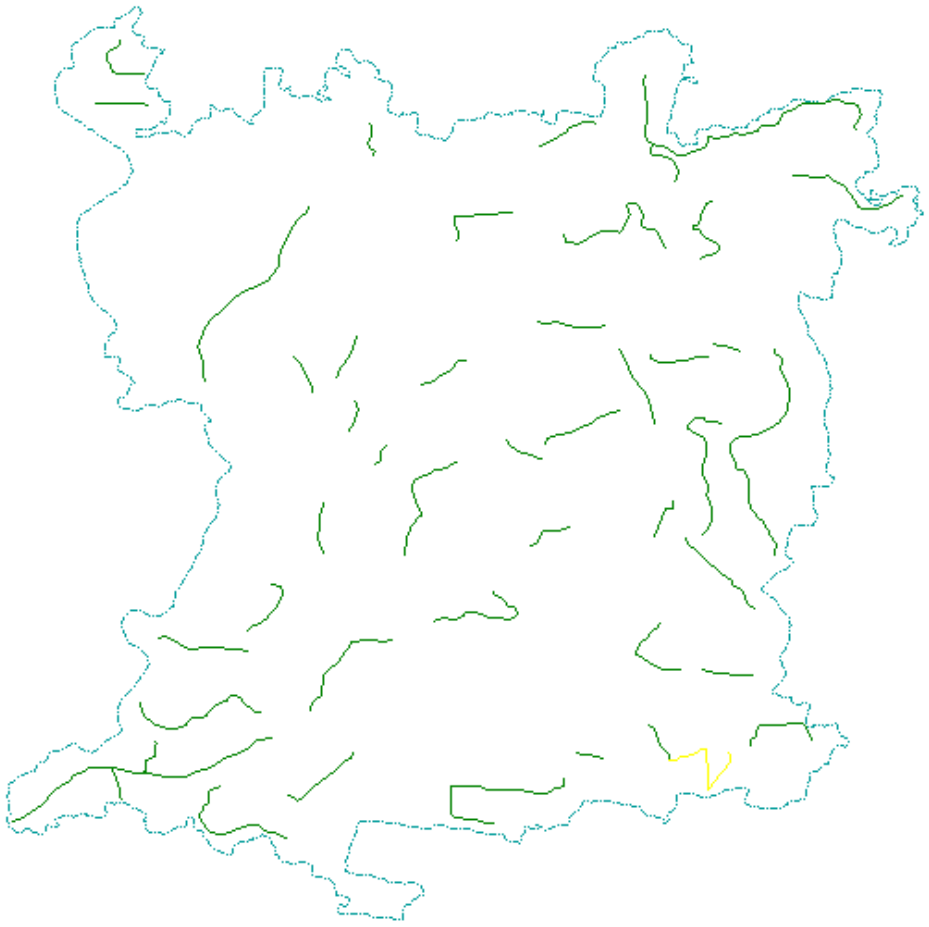


Figure 12 Link routes in the block

Line: Link route data of a selected route

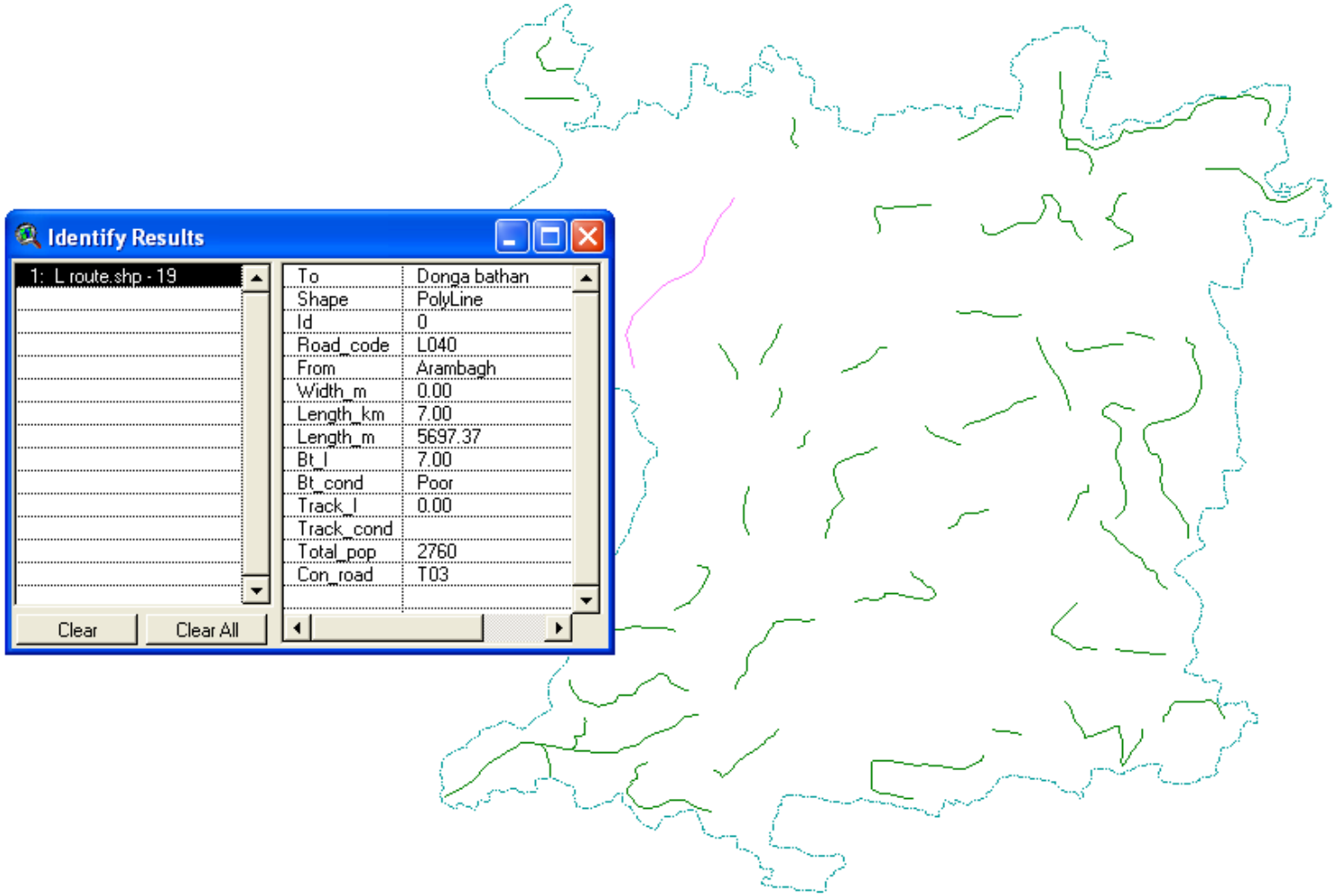


Figure 13 Road data of selected link route (shown in Pink)

Line: Link route data

Table 8 Road data of Link routes

ROAD_CODE	FROM	TO	LENGTH_KM	CAL_LENGTH_M	BT_L	BT_COND	TRACK_L	TRACK_COND	TOTAL_POP	CON_ROAD
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

Analyzing Data

- Identification of unconnected habitation
- Identification of Growth Center

Analyzing Data: Identification of unconnected habitation

- Routes are buffered to 500m range.

- All the habitations that lie between the buffered routes are considered as connected

Analyzing Data: Identification of unconnected habitation

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

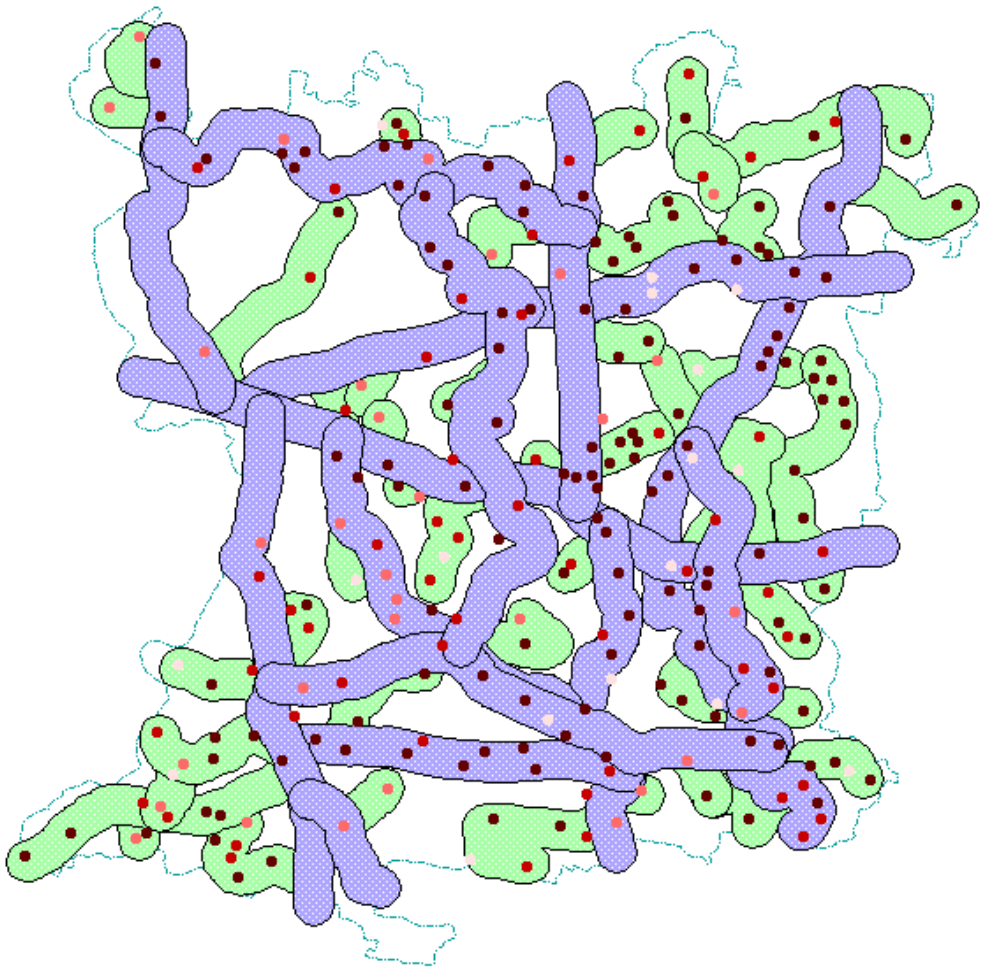


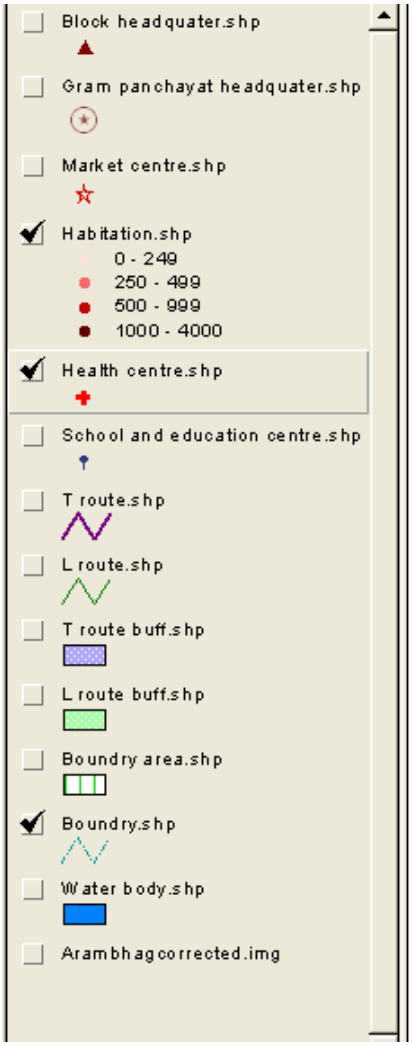
Figure 14 Buffering of all existing routes to a specified width of 500m

Analyzing Data: Identification of Growth Center

Habitation Under:

- 1km buffering of health centre
- 1km buffering of school
- 2km buffering of market centre

Analyzing Data: Identification of Growth Center



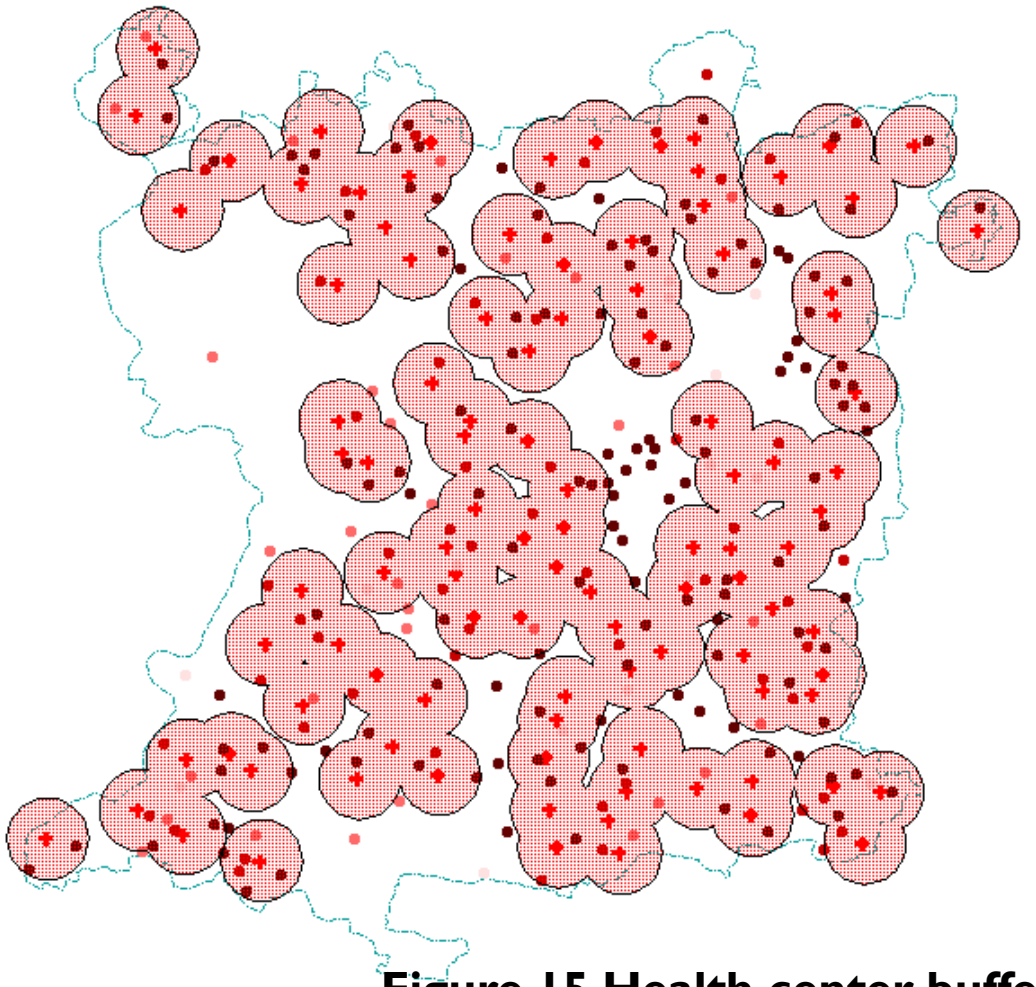
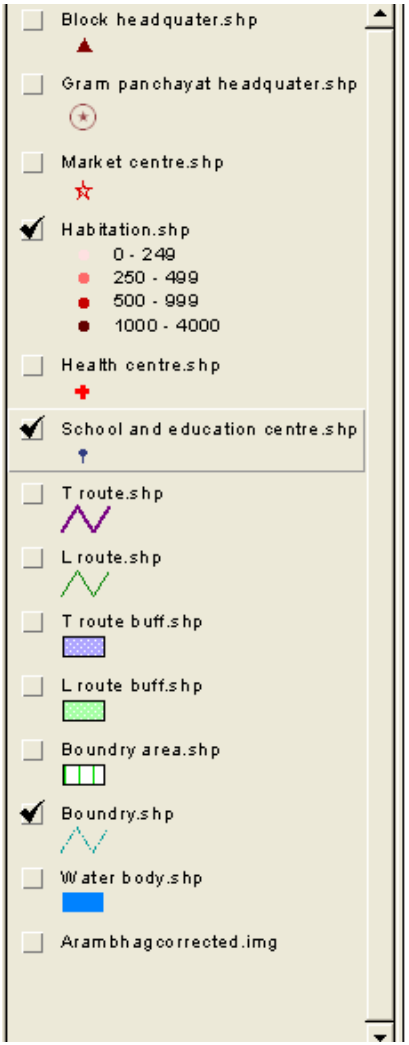


Figure 15 Health center buffered 1 km

Analyzing Data: Identification of Growth Center



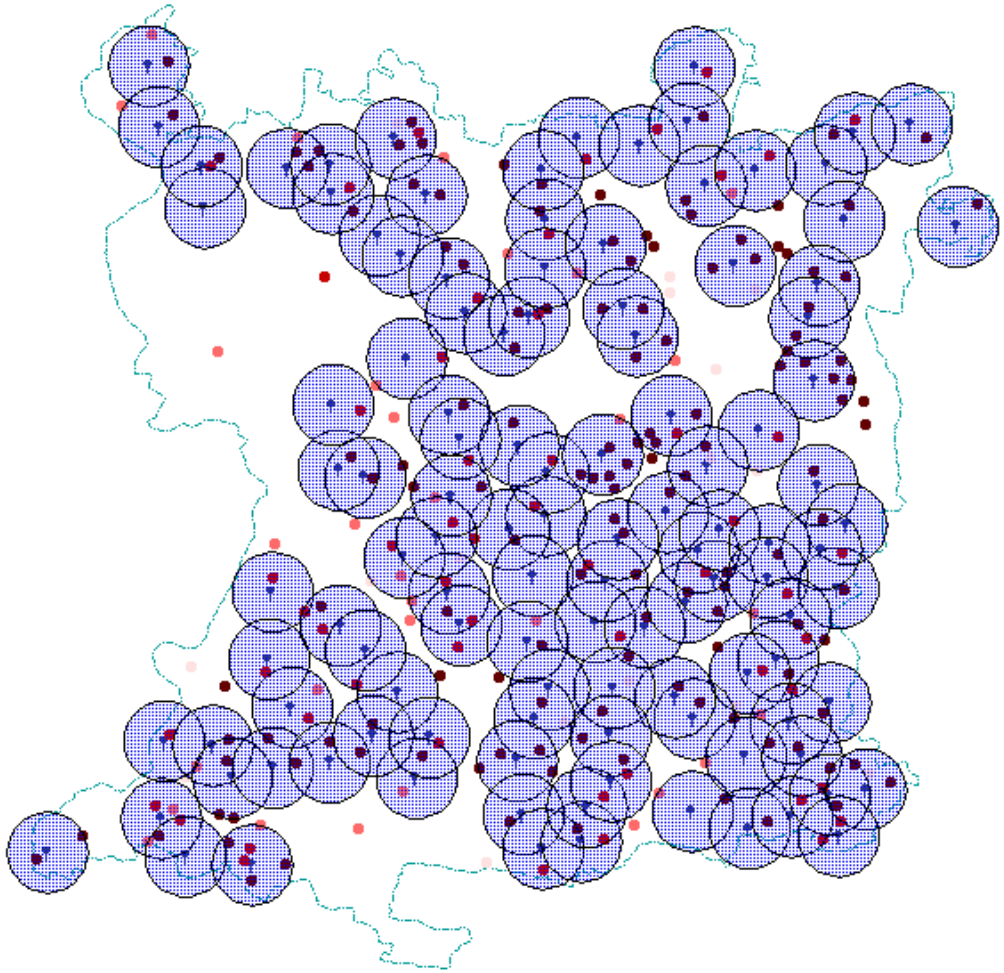
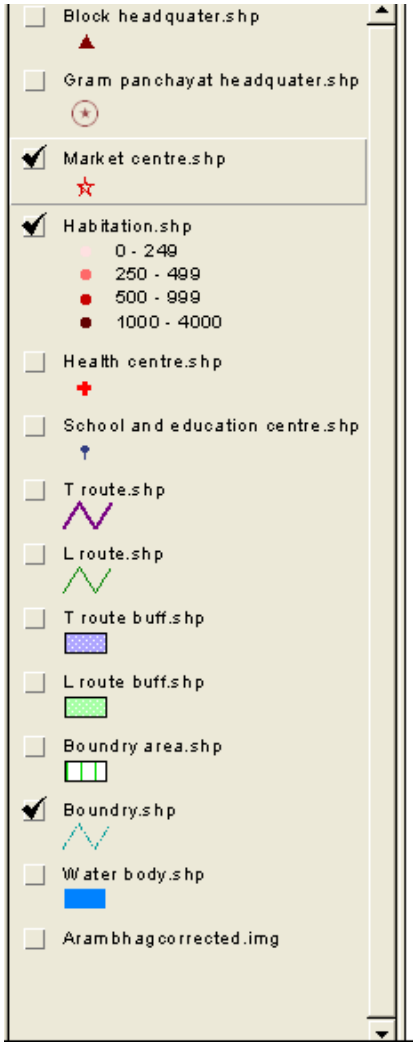


Figure 16 School buffered 1 km

Analyzing Data: Identification of Growth Center



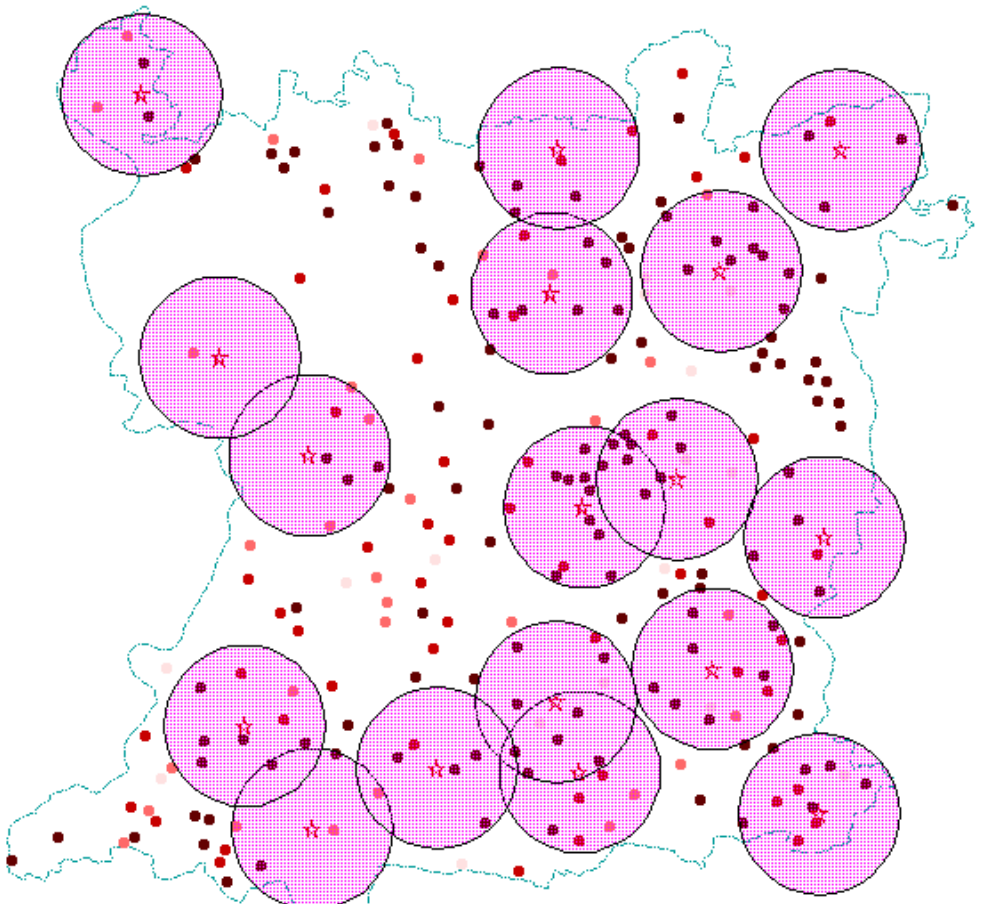


Figure 17 Market centre buffered 2 km

Analyzing Data: Identification of Growth Center

HINDEX

- 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

Analyzing Data: Identification of Growth Center

Calculation of HINDEX

- 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

Analyzing Data: Identification of Growth Center

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 9 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

Analyzing Data: Identification of Growth Center

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

Table 10 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

Analyzing Data: Identification of Growth Center

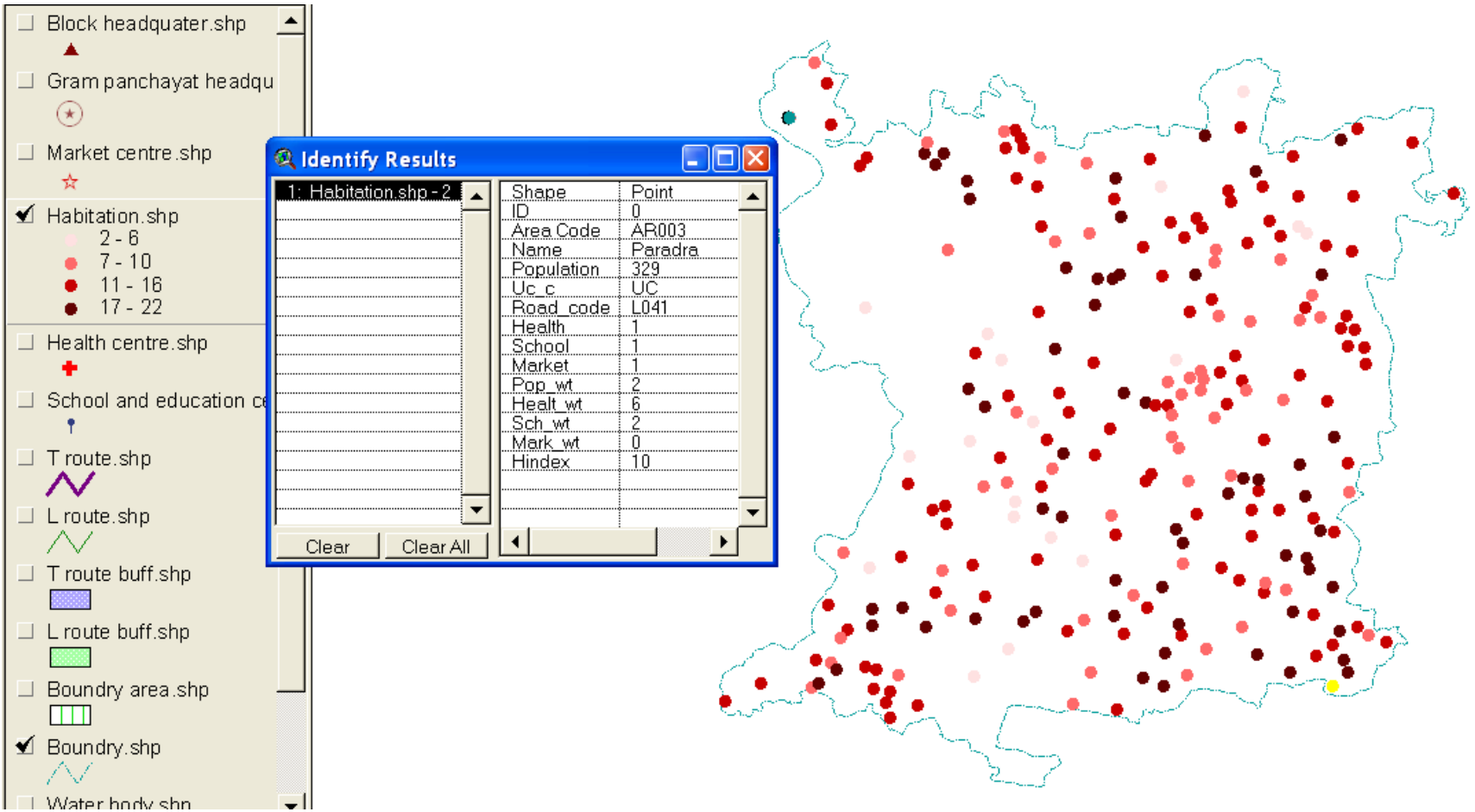


Figure 18 Habitation mapping according to HINDEX value

Analyzing Data: Identification of Growth Center

Table 11 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

Thank you ☺