Information system for rural road network planning - a case study

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ABSTRACT

In a developing country like India where 73 percentage of the population lives in rural areas and only 27 percentage in urban areas, we need a very structured planning procedure should be used for the development activities and infrastructure facilities available in rural area. Rural roads are integral part of rural development and it stimulates overall development by providing access to economic and social infrastructure and facilities. In order to avoid the problems associated with rural road development, it is advisable to prepare a rural road plan by building strong database, which consists of village level information and road inventory details. GIS supports multiple views of data and yet provide integration that would minimize redundancy and maintain data integrity and security. It allows concurrent access to multiple users and processing of user transactions in an efficient manner.

The case study was carried out for a community development block, which is a middle level spatial planning unit. For this purpose Rupauli block, in Purnia District of the Bihar State has been considered. The block maps were digitised and non-spatial data, prepared on MS-Excel, were incorporated to each of the villages. The Geographic Information System (GIS) has been used for planning of a rural road connectivity for a Community Development block and the information system was developed for villages and rural roads. This paper emphasises 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.

INTRODUCTION

In India, rural roads are the part of tertiary road system, which consist of other district roads (ODR) and village roads (VR). Nearly 50% of 6 lakh villages have road access. The Government of India has committed to provide full connectivity under special programme known as Pradhan Mantri Gram Sadak Yojana (PMGSY). Under this programme all the habitations having 500 and above population will be connected by the year 2007. Master Plan for rural roads should be prepared in a scientific manner at district level for implementation of the, PMGSY programme for full connectivity. In order to over come the problems associated with the rural roads such as lack of database and to prepare rural plan it is required to build a strong database preferably in electronic environment.

VILLAGE AND ROAD INFORMATION SYSTEM

Information system plays vital role in planning and development of rural areas. The invention of high-tech in the field of telecommunication, remote sensing and computers would lend a valuable support to spatial planning process. The most advanced computer based information technology tool for spatial planning is the Geographic Information System, which would become indispensable in planning and management of database. GIS can be used as an effective tool for village and road information system, which will help the planners and administrators to identify the problems associated with rural road development activities, location and provision of appropriate facilities, monitoring and maintenance management of the assets created in rural areas. In these cases the information generated from the villages as well as the decision taken at the official level will flow faster to the official involved in development activities. Therefore, there is an urgent need to develop a simple method for collection and collation of data of village and roads, which will help in planning and provision of various facilities.

DEVELOPMENT OF DATABASE

In order to prepare a scientific rural road Master Plan it is necessary to build a strong database, preferably in computer environment. The most important aspect of the database development process is the clear understanding about the micro level data, which should be collected from various organizations at the grass root level and then collated at the block/district level for preparation of the rural road network planning.

GIS Based Approach

The various data items required for the development of a comprehensive rural road planning and development can be broadly categorized under three categories
(1) Village data, (2) Rural road data and (3) Map data.

Village Data

The Village level data will have three main components such as reference data (the name and code number), demographic data (population) and Infrastructure data (socio-economic functions or facilities available in habitation/ settlement).

Rural Road Inventory

It is an integrated system for collection and storage of rural road related data in a format compatible to the requirement of various user groups. A comprehensive inventory of all rural roads including Other District Road and Other Village roads constructed/improved under various rural development programmes such as RLEGP, NREP, MNP, JRY,

PMGSY, sugarcane roads etc have to be prepared. For each road the following types of information have to be collected.

(1) Road reference data
(2) Road geometric details
(3) Road pavement condition
(4) Terrain and soil type

Map Data

The map at block level should be prepared at 1:50,000 scale by referring Survey of India toposheets. If available, the arial photos and satellite imageries etc. can also be used.

The map data should contain the following items.

- Location of habitation/settlements
- Boundaries
- Road Network
- Water bodies (ponds, lakes, etc) Rivers and Irrigation canals
- Other Features, such as places of tourist and historical importance, Quarry Sites, Mining Areas, Location of industries, if any

Figure -1 highlights the various data requirements of Village and Road Information System (V&RIS)

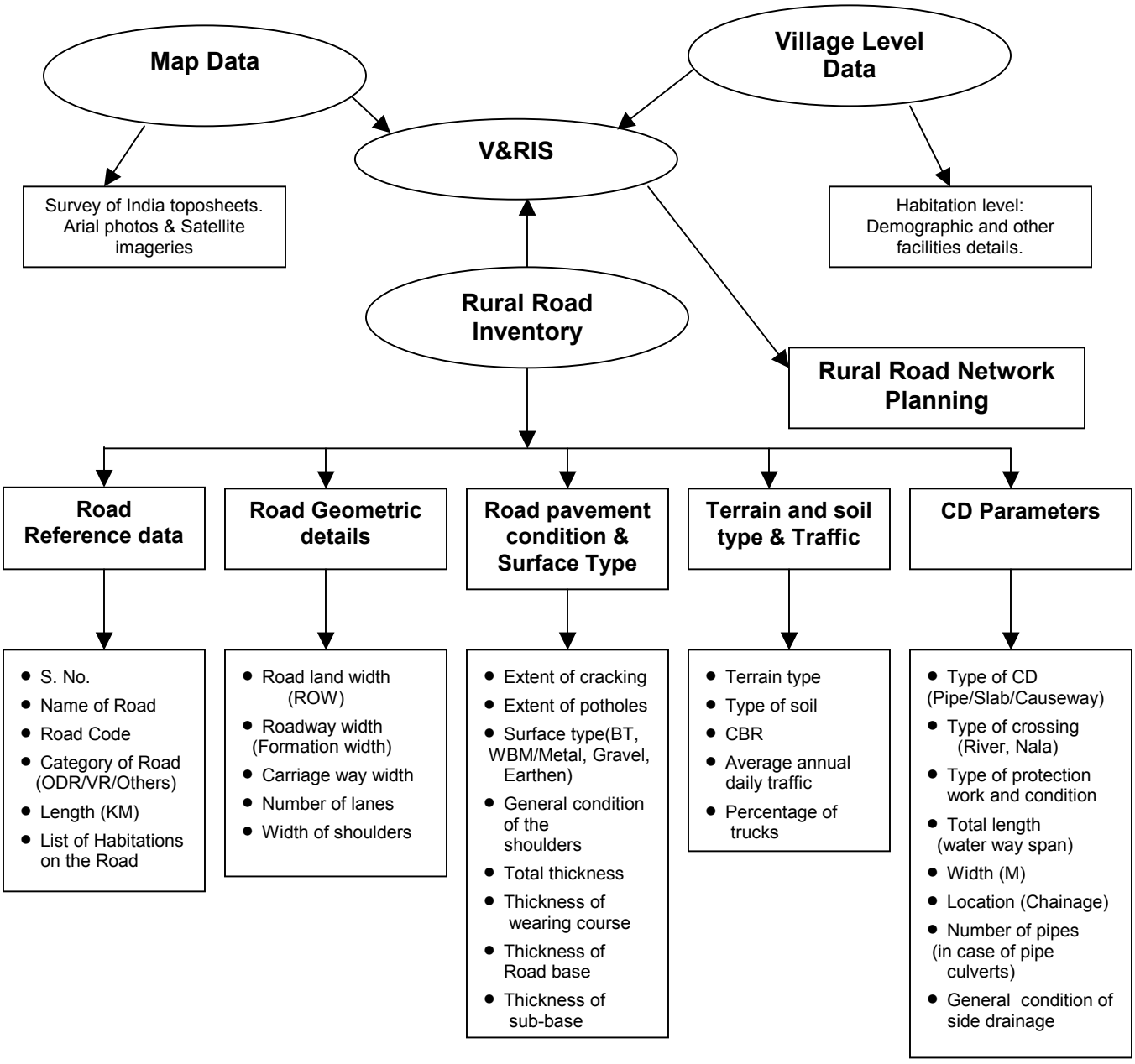

Figure 1. Flow Chart for Village and Road Information System

A CASE STUDY – RUPAULI BLOCK

Database developed above has been applied in the Rupauli Block in Purnia District of Bihar, out of the total population which has a total geographical area of 105.41sqkm Rupauli is the Block headquarters and the only town in the Block. The Block has 51 villages with a total population of 141814 as per 1991 census. Out of this SC/ST

population is 10.6 per cent. The literacy ratio is 23.4 per cent. Out of the total population 37.7 per cent are workers, out of which are 26 per cent agricultural labourers and 11.7 per cent cultivators. The industrial activities are negligible.

VRIS for Rupauli Block

A Village and Road Information System (V&RIS) has been developed for Rupauli block with all the data and information as mentioned above. The development of V&RIS can further be used for development of network as well as for infrastructure development. Once the V&RIS is ready, the physical locations of infrastructure facilities and utilities may be planned and translate all the technological developments on the ground in a systematic manner.

Map preparation and Database

Map forms the fundamental tool for road network planning. A base map with all features has been prepared in the scale of 1:50,000 in GIS environment. A base map with the location of all the village settlements and existing road network has been prepared with the help of toposheets, census maps and PWD road maps. The map has been digitised with number of layers, (i) boundary layer, (ii) village location as point layer, (iii) the existing road network as line layer and (iv) Waterway layer. A base map of Rupauli Block showing the location of village settlements, block boundary, total road network and the rivers, canals etc is presented in figure-2.

Village Level Data

The village level information data available from the census of India (1991) record on village directory and population data has been attached with the point layer as shown in figure-3. The map shows the location of the villages, census code and village level data.

Rural Road Inventory

The road inventory data is essential for planning, management of the road system and planning of rural connectivity. The road inventory data is attached to the road layers. A GIS based map of the existing road network along with road inventory data of selected links is shown in figure-4.

Thematic Mapping

Thematic mapping provides graphical presentation of access characterization. The thematic map generated for education facilities such as primary schools, middle schools, high schools is presented in figure-5. The figure shows that almost all the villages are having primary schools, 20 villages have middle schools along with primary

schools and 4 villages have high schools along with middle and primary schools. This presentation will be useful for spatial distribution of the facilities. But most of the villages do not have good access (road facility) to these middle school and high schools. Through thematic mapping of identification, distribution of potential growth centers spread in the entire area can be viewed at a glance.

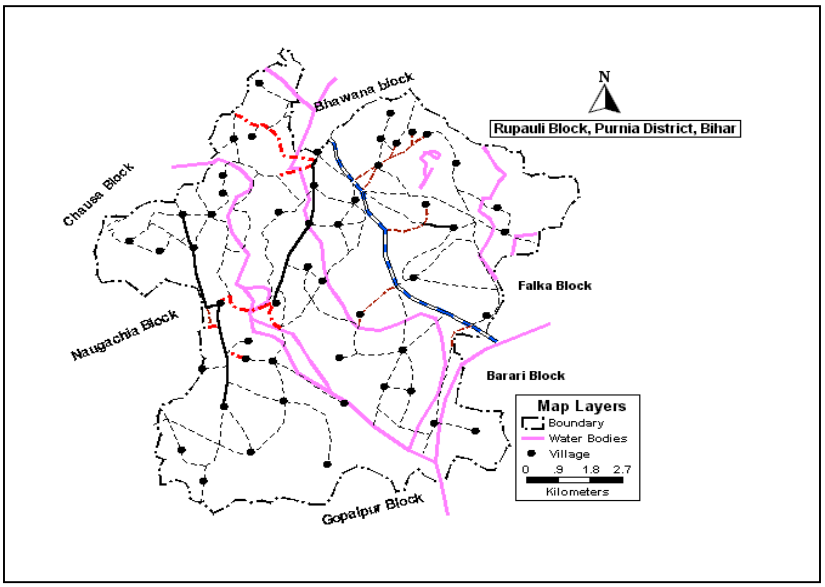

Figure 2. Base Map of Rupauli Block

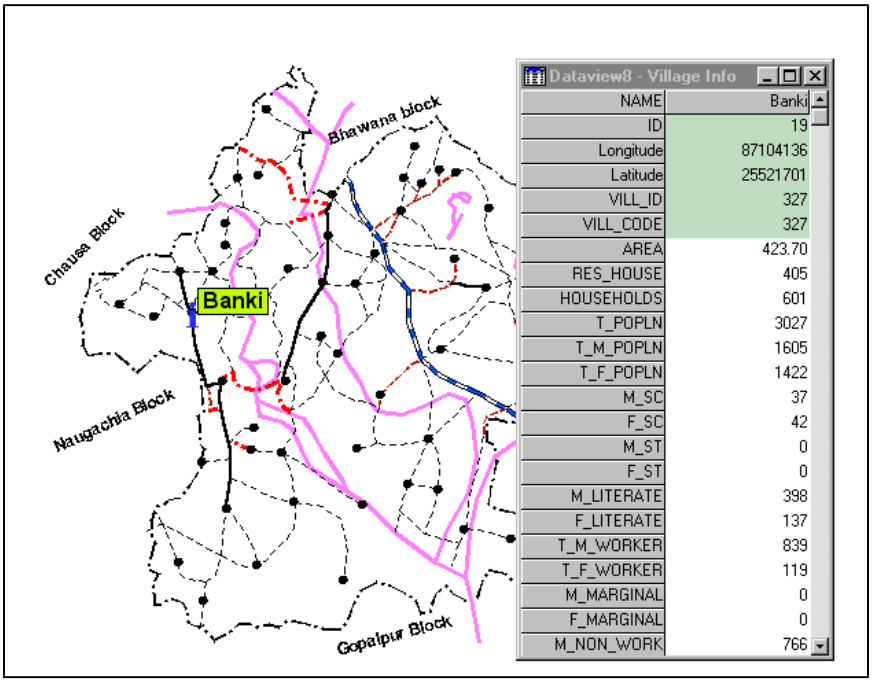

Figure 3. Village level database of Rupauli Block

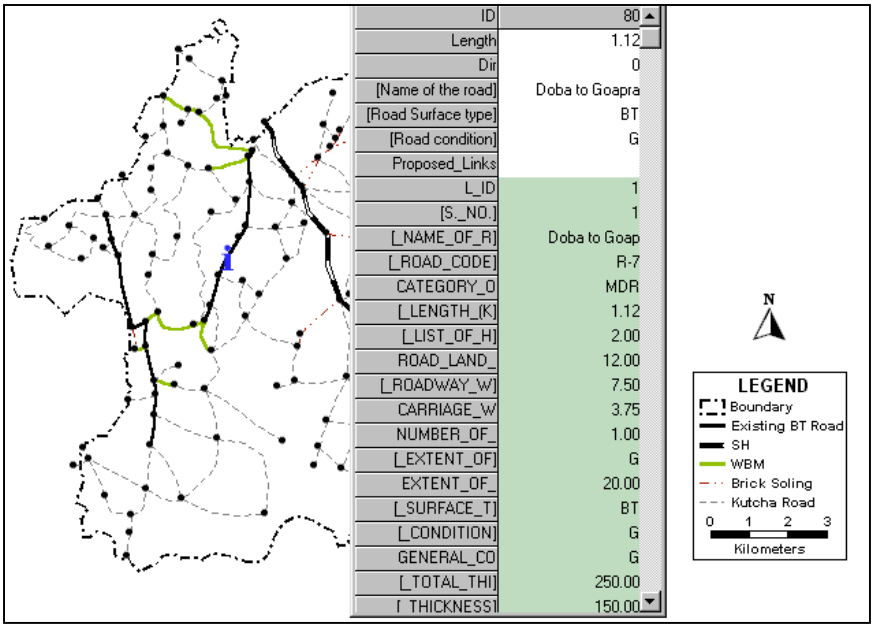

Figure 4. Map showing existing roads and inventory data

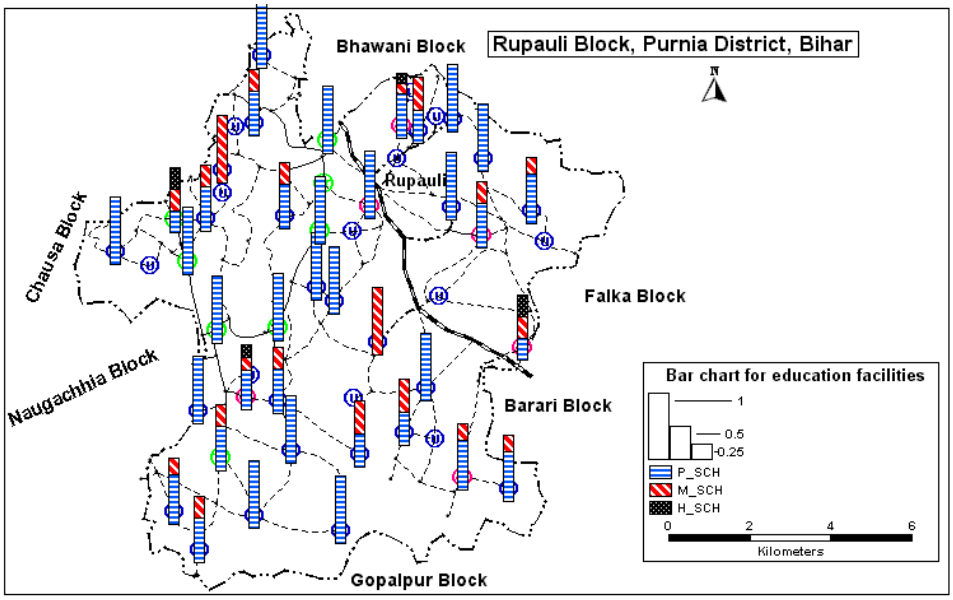

Figure 5. Thematic map of education facilities

Rural Road Network Planning

Optimum network is developed based on the functional accessibility approach for providing a single connectivity in an optimal way by considering the already developed network pattern and also the socio-economic development that taking place in the rural area. This approach has been applied through a case study area by using GIS tool.

Network Link Options

The available options of connectivity for villages shall be guided by certain assumptions as given below in order to develop a road network, which adequately meets the accessibility requirements of the unconnected habitations.

- The population of unconnected habitations shall have to travel to nearby habitations to fulfil their locally unsatisfied needs (utility services).
- The unconnected habitations may be presently connected through fair-weather road links.
- The choice of linkage shall be within the network.

An unconnected habitation is to be provided with all-weather functional connectivity by a new link or by upgradation of existing fair-weather link to the nearest road or connected villages.

OPTIMUM NETWORK

As described in the above methodology, using the GIS software, first the growth centers- (6 nos), connected villages- (8 nos) and unconnected villages- (37 nos) are identified as shown in figure-6. All the villages, located within the population of unconnected village will reach the already connected villages within its influence area having the required utility services (facilities) through a shortest route. From the several possibilities based on available fair-weather roads/ tracks etc. or new alignments, three options based on shortest route access are identified for the final selection.

The shortest route from an unconnected village to the nearest major centre along the existing route is generated using the 'Multiple Shortest Path Method' available in the GIS Software. The best link option shall be based on the highest benefit that it offers. The maximum accessible link has been identified for provision of connectivity. The generated optimum network has been shown in figure-7.

GIS can also generate the analyzed information in tabular and other graphical forms. The information about total length of network classified by surface type and number of links extracted form the road network layer and has been displayed in a tabular format (Table-1). The total road length of existing road network is about 157.72 km. Out of this 68.17 km. of road network is proposed to connect the 37 unconnected villages in the block benefiting 60989 population.

Table-1 Details of Existing and Proposed Roads

Existing road length			Proposed road length			Category of the Village	No. of Villages	Population
Surface Type	*Length (km)*	*No. of Links*		*Length (km)*	*No. of Links*			
BT	20.04	24						
WBM	7.72	10	WBM to BT	7.72	10	GC	6	54103
BS	9.18	14	BS to BT	7.8	12	CV	8	26722
KR and EB	120.78	120	KR to BT	52.65	62	UCV	37	60989
Total	157.72	168	Total	68.17	84			

GC=Growth center, CV=Connected village, UCV= Unconnected village

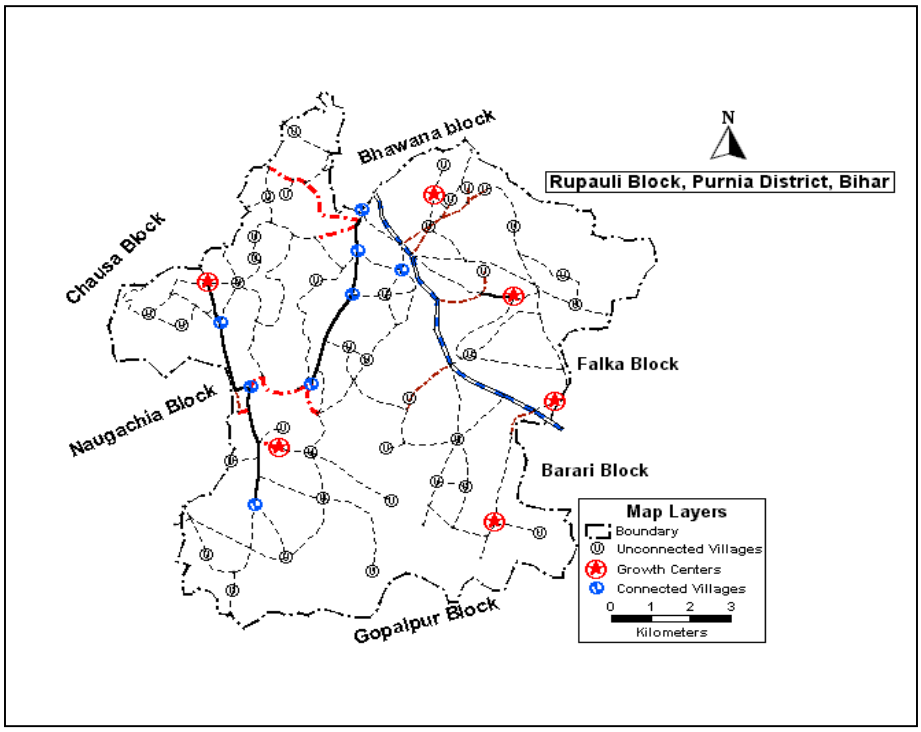

Figure-6 Map showing growth centers, connected and unconnected villages

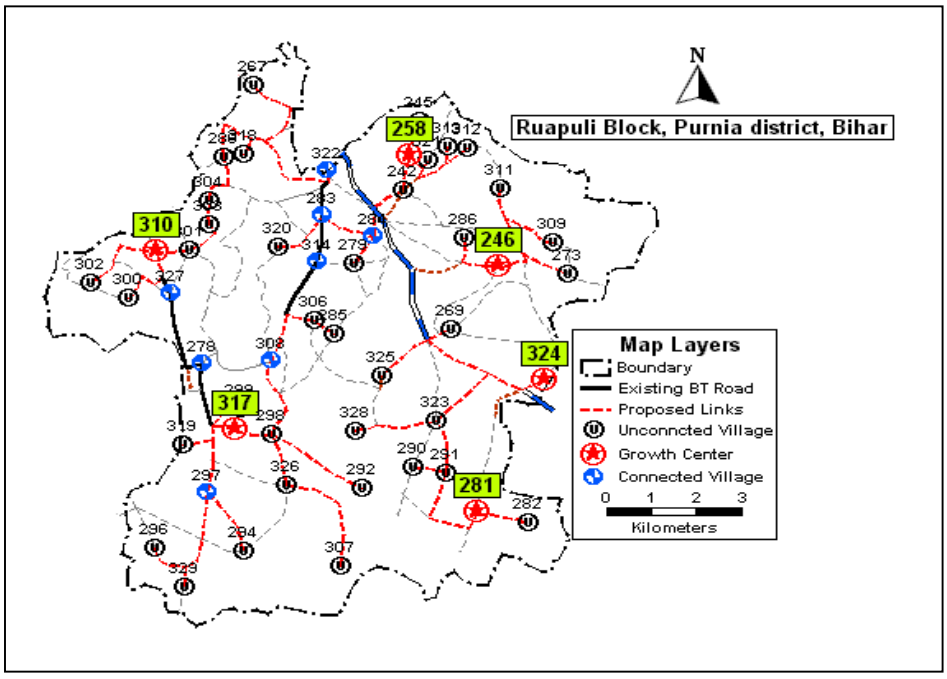

Figure-7 Optimum Network of Rupauli Block

CONCLUSIONS

The Village and Road Information System (V&RIS) developed under GIS environment is very much useful for problem identification, planning, allocation of resources and location of various socio-economic facilities for an integral rural development. It is also useful for creation, maintenance and accessing the GIS database. V&RIS can serve as an efficient tool for decision making with respect to any rural development programme. Further using the information available at the road network layer, it will be easy to estimate the construction cost of selected links. Based on overall information, the budget required for providing all-weather road access to all villages and its priority can also be calculated for phase wise development. Road Maintenance Management System can also be developed using the database, which will sustain the road for a longer time with minimal efforts.

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