TOWARDS A COMMON TELECOMMUNICATION ANTENNA STRUCTURE FARM NETWORK THROUGH GIS TECHNOLOGY

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Abstract

When establishing towers for telecommunication sector on a location, the most of service providers violate rules and regulations regulated by the government, even though there is a possibility to share towers among 3 facility providers. Therefore it is a common scenery in Sri Lanka that the most of tops of mountains are consisted with two or more telecommunication towers with closer locations. This would influence severely the people living in the close proximity and their properties and also to the natural environment. The study was designed to select suitable locations for antenna structures that satisfy the national policies for the study area (Balangoda DS Division, Ratnapura District). The model for the selecting the suitable locations using different criteria was developed using the Model Builder tool in the ArcGIS Software. Using ArcGIS software and different criteria, it was able to prepare the coverage maps for both existing and newly designed tower networks. The study reveals that it needs only two towers to cover up the full study area, even though there are five towers which are maintained by TSPs separately. Further, it discovered that the present network is not so enough for the future demands. And also it is suggesting that the concept of sharing antenna structures is very important to overcome environmental and social issues.

Keywords: GIS, Telecommunication, Towers

1. Introduction

Telecommunication has become one of the most important parts of human lives at present. It has been developed rapidly from the Alexander Graham Bell's simple wire telephone to complex Satellite Telephones. GSM networks are very popular among people rather than other ways of communication, because of their properties such as less expensive, portability and flexibility to use. Specially, in Sri Lanka, as a developing country, the most of the telecommunication systems are functioning as GSM networks. Currently, five GSM networks are operating in Sri Lanka.

The heart of every GSM network is the tower which distributes signals within the wireless telecommunication networks using microwave signals to transport communication data via air. Therefore, towers are used as an intermediate bridge to connect two positions by microwave signals, coming from one position or many positions. When establishing towers by Telecommunication Service Providers (TSPs), they have to consider locations, signal strengths and their frequencies also construct them according to the rules and regulations which are designed by the Telecommunication Regulatory Commission of Sri Lanka (TRCSL).

These rules and regulations help to enhance the current and future technological needs and maintain an aesthetically pleasing environment for the residents and visitors from outside area by minimizing the visual and physical impact upon the landscape. But the most of policies are violated by the TSPs by giving various reasons for the TRCSL. Even though there are nine policies for antenna structure, but out of nine, seven are directly linked with technical side and environmental issues. But in this research, only two policies were considered. They are;

Policy Statement 1: Sharing of Antenna Structures: Antenna Structures should be used on a sharing basis. Thus the minimum number of Antenna Structures that fulfill the technical requirements will be approved for an identified Antenna Structure Farm location. Antenna Structures should be designed and constructed with provisions for more than one TSP.

Policy Statement 3: Lightning Protection: The Antenna Structure premises should be provided with a comprehensive lightning protection scheme to minimize the lightning related damages and injuries. The lightning protection concerns related to the proximity to neighborhood of Antenna Structures will be in conformity with the National Policy on lightning protection. Installation and maintenance of the lightning protection system shall be as per guide line issued by TRCSL on Antenna Structures.

2. Problem identification

When constructing a tower at a location, always people who are living in the close proximity, become concerned of electromagnetic influence and the lightening effect to their lives and properties. If the TSPs follow the TRSCL criteria, there are no worries for the safety of public. But due to various reasons, these policies are not 100% achieved by them. For an example, TSPs are still using 1:50 000 map sheets which have being produced in 1980s, to identify the terrain attributes (population, land use) for network planning. Further, the selected ground locations for the towers are visited by another group of people and there is not a good coordination between TSPs and them. Therefore, there must be a systematic way to

select suitable locations for antenna structure farm network. The study was designed to select suitable locations for antenna structures that satisfy national policies for the study area (Balangoda DS division, Ratnapura District, Sri Lanka), as it is a highly undulated terrain with urban areas, rural areas and semi urban areas.

3. **Methodology**

To achieve above objectives, technical parameters were fixed using literature review and personal communications using a semi-structural questionnaire that are given to the each TSPs and TRSCL. Further data was gathered by interviewing each TSPs' Radio Network Planning Divisions, Telecommunication Engineers who are responsible for planning the cell site networks. Primary data as collected from 1:10 000 map sheets with Land use, Hydrology, Building, Reserves, Road and Contour shape files produced by the Survey Department of Sri Lanka.

Using the data which have being collected by the semi-structured questionnaire and Analytical Hierarchycal Process (AHP) technique, weight matrix was formed for Land Use, Building (population), Distance from the Road, Elevation (Contour) criteria (Figure 1).

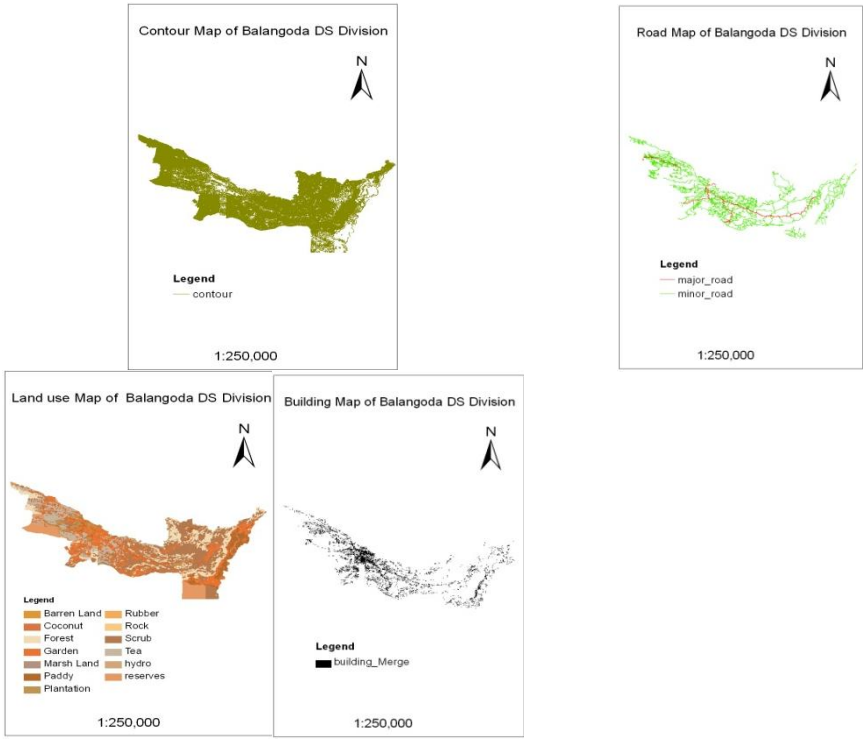
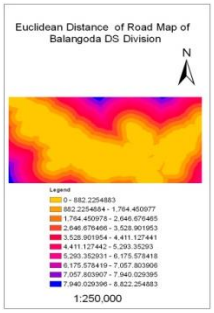


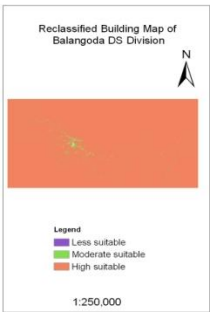
Figure 1:Data used to form the weight matrices

Using AHP technique weight matrix was produced by writing source code for Mathlab programming language. The weights obtained were as 66.82% for Building, 15.9% for Distances from the Roads, 3.84% for Land Use, 13.44% for Elevation (Contour). Spatial analysis process was done using the Model Builder tool of ArcGIS (Version 9.3.2) software. It was able to find the suitable areas for Antenna

Structure Farm that, using the network, the view



Network inside the study area. After designed network and existing tower sheds were created.



Since all shape files converted into raster road raster Each building raster using "Reclassify" and Lighting

were in vector format, data were format. Only for building raster and "Euclidean distance" tool was applied. and road raster was reclassified by tool according to the questionnaire data protection National Policy. Suitable areas were found by using "weighted overlay" tool by using the weights of the shape files of Land Use, Contour, Reclassify Road and Reclassify Building raster files (Figure 2).

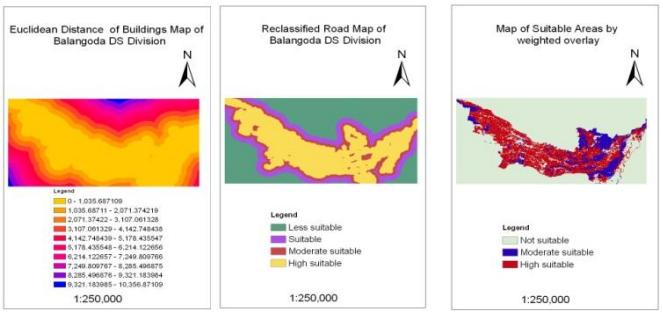


Figure 2: Euclidean distances and reclassify results

Obtained result was filtered using the majority filter technique. Moderate and high suitable areas were considered for cell sites, other areas were neglected. Selected areas were exported into a new shape file (Figure 3).

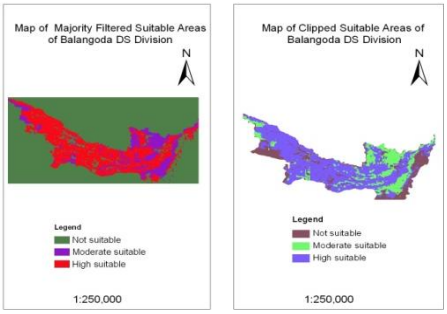


Figure 3: Results after using majority filter technique

According to literature review and personal communications, technical parameters were fixed and obtained 4 km coverage for each the tower as follows: **Antenna Type:** - Directional antenna with three sectorization, **Antenna Mechanical down Tilt:** -10^0 from azimuth direction, **Horizontal Beam Width:** - 65^0, **Vertical Beam Width**: - 9^0, **Height of the Antenna**: - 100m. It was set 1km as the overlapping area between two adjacent cell sites and size of actual coverage hexagons was used as 3 km.

Antenna structure farm locations were created by using network coverage hexagon polygons (Figure 4). AutoCAD 2007 software was used to create reference hexagon polygon with 3 km inscribed radius from its center point. The network of hexagon was created by taking "PETTIGALA MOUNTAIN" Mobitel tower as the reference center point of the first hexagon polygon. Three kilo meters range was used for each hexagon polygon and network of similar hexagon were created covering the study area, reference to the first hexagon polygon where its center at the "PETTIGALA MOUNTAIN" Mobitel tower. Antenna structure farm circle areas were created each hexagon polygon centers with 250 m radius. Antenna structure farm (circle with 250m) network was created by above way. All the processes were done above by. Antenna structure farm network which was created by AutoCAD 2007 software manually was exported to shape file format with polygon feature (Figure 5).

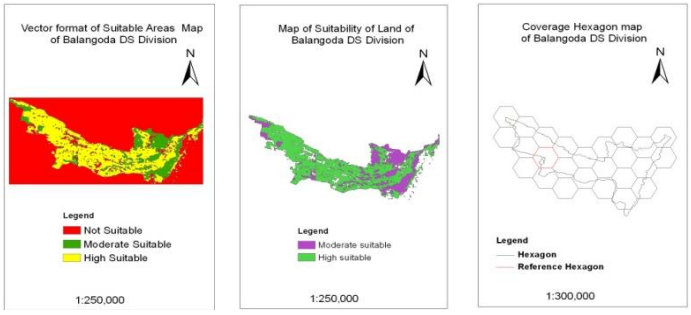


Figure 4: Antenna Structure farm locations

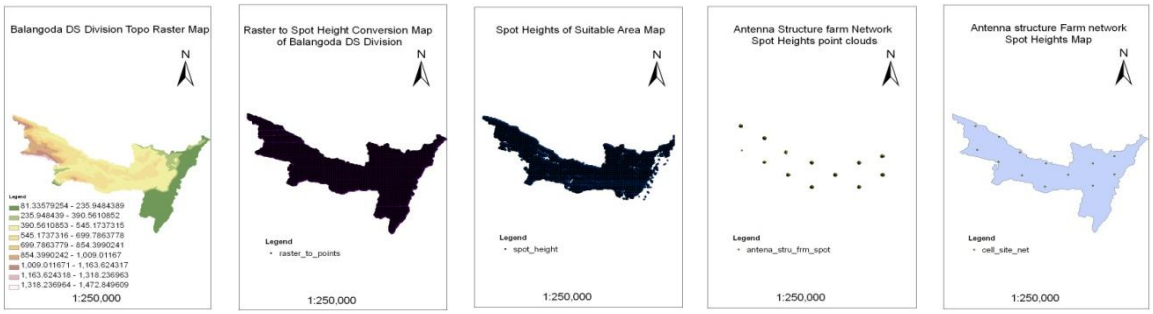


Figure 5: Final locations

Topo_raster of Balangoda DS division was created by using Contour data and Balangoda DS division polygon. To get the spot heights of the Balangoda in the grid arrangement, topo_raster was converted into point features using ArcGIS 9.3 software "raster to points" tool. The result from above step was clipped and it was obtained the suitable area shape file. Spot heights of suitable areas which were obtained from above step were clipped by using antenna structure farm network polygon. Then it was created point clouds that overlapped with antenna structure farm network. Each point cloud (antenna farm network area's spot heights) was exported to different point shape files. In each point clouds, the highest spot height was selected separately by using SQL program code. Separately, selected points were merged together to create a point shape file. TIN was created from the primary data and the inter-visibility of highest points was checked manually. When there was no inter-visibility, the next highest point was selected to get a good inter-visibility. If not the antenna structure farm polygon changed slightly to obtain a good inter-visibility (Figure 6).

Finally the View-shed was produced by using previously obtained results (the collection of highest points of each point cloud) taking as the observation point and topo_raster. Another viewshed raster was created by using topo_raster and as observation points using existing tower locations, which were collected by handheld Global Positioning System (GPS). According to the technical parameters which were defined above, characteristics of viewsheds were controlled.

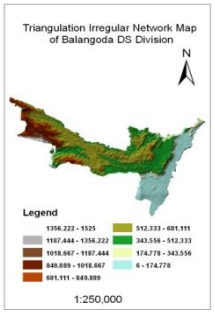


Figure 6: Triangulation irregular network

4. Results and discussion

The study reveals that it needs only two towers to cover up the full study area, even though there are five towers which are maintained by TSPs separately. Further, it is discovered that the present network is not so enough for the future demands. And also it is suggesting that the concept of sharing antenna structures is very important to overcome environmental and social issues (Figure 7).

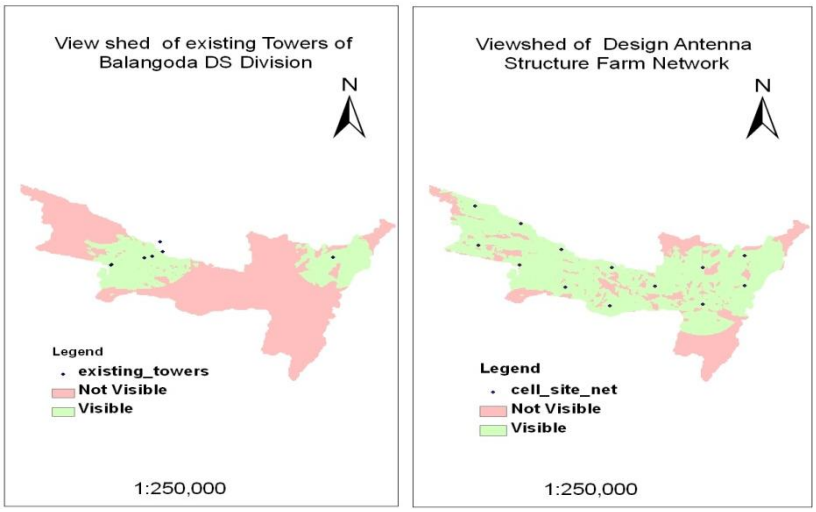


Figure 7: Final view sheds

Normally, TSPs are using special kind of software for designing tower locations by EM field as parameter. It does not concerning about Land Use, Contours, Building and Roads. The software is only employed by purchasing license. Therefore as an alternative solution for designing tower network according to standard, TSPs can be used the research. According to the national policies of the antenna structure maximum of antenna structure (tower) three can be constructed within (250m radius circle) antenna structure farms and each antenna structure should be designed to hang addition two other TSPs antenna (20 m^2 area on the top portion). In Sri Lanka currently have only five TSPs operating as GSM providers. Therefore only two tower enough to hang all TSPs antennas (for one tower three TSPs and other tower two TSPs). Antenna structure farm locations were converted for shape files for further analysis.

5. References

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