



SUSTAINABILITY OF NATURAL RESOURCES WITH GEOTECHNICAL INVESTIGATIONS AND WEB ENABLED SOIL PROFILES

POOJITH PRAKASH (Author)

Department of Civil Engineering
DSATM
Bangalore, India
prakashpoojith@gmail.com

DR VISHWANATH. K. N. (Author)

Head of Department - Civil Engineering
DSATM
Bangalore, India
vishuknv@yahoo.com

SUMANTH. V. BHARDWAJ (Author)

Department of Civil Engineering
DSATM
Bangalore, India
sumanthsupreeth@gmail.com

SUPRAJA.I (Author)

Asst. Prof - Civil Engineering
DSATM
Bangalore, India
Supraja.gis@gmail.com

Corresponding author: Poojith Prakash
Corresponding Author's Email: prakashpoojith@gmail.com

ABSTRACT

Urbanization and rapid growth of population has increased the demand for land use, and the damage to the natural resources has crossed its permissible limits. The effect of such activities not only destroy the mother earth and its nature, but also becomes a major geo-hazard. This paper discusses about such activities causing the natural hazards, and the remedial measures with geotechnical investigations.

Encroachment of the land without considering its suitability for the construction of residential buildings, laying pavements will lead to serious disasters or creates new risk. In any developing country the increase in average income of citizens leads to setting up of high standard of living targeting international standards. This is demanding the construction industry beyond its capacity of resources available in terms of land, materials required, leading to destroying the natural shape of the nature, laws of the country and causing inflation in economy. Geotechnical investigations reveals the real facts of the land use and suitability, where advanced technologies helps in mapping such zones and the protection of natural resources would be quite easier. Mapping of soil profiles, wet lands and the exact boundaries of natural resources where the protection is essential will create awareness to the public, reducing the exploitation of natural resources. Creating the web portals of the data of each and every risk hazard area with surrounding natural resources helps the public to achieve the sustainability of the natural resources and Manmade structures.

GIS and remote sensing applications are widely used in land use and land cover. Creating profile of geotechnical investigations zone wise and web enabling the data is the best remedial measure in achieving sustainability of the natural resources.

Key words : Sustainability; Natural Hazards; Exploitation of natural resources; GIS and Remote sensing applications; web portals;

1. INTRODUCTION:

The Rapid growth of population in Cities due to globalization is missing many vital factors to be considered in urban development. Suitability of land in urban development is mainly based on the prime location, public requirements and financial parameters. There is an emergency to have prior check of the land



and its history. Many a times the natural resources are exploited, by converting farming lands in to residential and commercial buildings. Inadequate knowledge of preliminary investigation, lack of knowledge about the stability of the structure leads to severe damages to the structures and sometimes causing loss of human lives too.

The best remedial measure is creating awareness of the land suitability, land history with adequate geotechnical investigations, and providing internet based check of particular risk zones will be helpful in protecting natural resources and preventing any natural disasters.

This task can be solved with the basic geotechnical experiments by creating soil profiles, with proper ground check of natural resources and suitability with respect to both the strength parameters of the soil and suitability of soil for various structures. Suitability of land should not consider the factors like increasing pressure of development in the urban areas, which will lead to mismatch between the suitability factors and stability of the structure. The main focus of this study is to understand the suitability factors, preventing encroachment of natural resources and crystal clear profiles of fast growing urban areas by mapping suitability factors and risk factors. Desperate demands for land is a biggest threat to any nation to loose it's natural resources at higher rate and illegal constructions are popping up by transforming agricultural lands , wet lands in to industrialization zones and residential zones.

1.1 GIS and remote sensing in achieving sustainability and suitability of land:

Public awareness about the conditions of the site and government approvals required to carry out the construction can provide a solution in preventing the land degradation and illegal encroachments. GIS (geographic Information Systems) and RS (Remote Sensing) are the emerging technologies in the present scenario to deal with the vast data, analysis and web enabling the analyzed data. GIS is a powerful tool in research and methodologies which helps to analyze the spatial data and produce the maps with distribution of various factor. GIS layers are an advantage to deal with various factors, analysis of the data and developing the digital topographic map of the entire data of several layers. Each layer contains sub layers with attribute table which is an advantage in mapping the minute details also. Soil profiles are the essential factors in achieving the sustainability of structures and suitability of structures. Conducting the laboratory experiments from the basic properties to the bearing capacities of the soils provides the safety factors of any design which can be carried out in that particular area. Classification of zones with respect to risk factors and natural resources with boundaries helps in creating zones for various purposes. These Soil profiles with various factors are useful in displaying the characteristics of the zone wise profiles along with the attribute tables. The point location maps with spatially processed data can be defined in one digital map.

Remote sensing techniques are widely used in analyzing the data from the past to present, and preventing any future disasters. In this particular topic RS works as an excellent tool in defining the encroachment boundaries and natural resources boundaries. The Landsat data with SLC on can be used in defining the boundaries of government land, and natural resources. The classification of the images provides the signature files of land, vegetation, water bodies and other miscellaneous signatures. The focus is on encroachment of natural resources, land degradation and government land boundaries. The classified satellite images provides the past to present statistical data of any area chosen, the boundaries which are defined in the signatures of the satellite image provides the crystal clear data. These signatures combined with the GIS location mapping helps the public to get a clear picture of the land hence web enabling the entire GIS and RS data is essential in reaching the public and Government Authorities to prevent any natural disasters or to avoid any demolitions in future. This Implementation helps in achieving the sustainability of the natural resources, suitability of land and sustainability of urban development without any future disturbances. [3] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN.

II. STUDY AREA:

Bangalore urban area has been chosen as it is going through so many modifications, demolitions and resurvey of the wet lands (lakes). This paper is focusing on the south Bangalore region where the development of the area happened in a wink. Bangalore is the capital city of Karnataka. It has a population of about 8.42 million and a metropolitan population of about 8.52 million, making it the third most populous city and fifth most populous urban agglomeration in India. Located in southern India on the Deccan Plateau, at a height of over 900 m (3,000 ft.) above sea level, Bangalore is known for its pleasant climate throughout the year. Its elevation is the highest among the major large cities of India.



As Bangalore is the hub of IT industry, and education, the growth which happened in a wink of eye had gone through encroachment due to the high demand of land. It did not show the degradation of land only but also the conservation natural resources. Bangalore which had 108 lakes which are manmade tanks existing from 16th century had lost many and finally left with 54 water bodies which of these are also facing major portion of encroachment. The following map shows the location of Bangalore in Karnataka. The recent resurvey of the city and demolition had left both government authorities and the general public devastated due to the dismantling of the infrastructure. This kind of disasters can be avoided by taking precautionary measures of the land suitability and protection of natural resources.

III. METHODOLOGY:

Suitability and sustainability of structures with respect to geotechnical investigation can be achieved by the following steps.

3.1 Soil Investigations:

Soil investigations carried out at shallow and deep foundations should be collected. Soil investigations should be checked for basic properties, index properties and strength parameters. The following list table 1 shows the factors to be analysed for the sustainability and suitability of land.

Table 1: Soil Investigation table

| Sl. No | Location and Name | No | Soil Properties | Safety precautions | Suitability of land and foundation design |
|--------|-------------------|----|--------------------------|--------------------|---|
| 1 | | | Index properties | | |
| 2 | | | Soil strength parameters | | |
| 3 | | | Stability of slopes | | |
| | | | Bearing capacity | | |

Source (compiled by authors)

3.2 Creating Soil profiles Using GIS:

The created tabular data should be attached to the particular point location along with the GPS reading. The distance to be considered from sample to sample of a zone depends on the homogeneity of the soil present in that particular location. Mapping of the point locations with the interpretation of colours can be displayed as shown in the following figure 1 which briefly explains the mapping of soil properties. Topographic maps collected from survey of India are used for the basic digitization and point locations are established layer by layer with soil properties. Arc map and Arc info are used. Area wise zone mapping will be done, the following boundaries are required for the analysis

- (1) District Boundary
- (2) Taluk Boundary
- (3) Hobli Boundary
- (4) Village Boundary
- (5) Settlements.

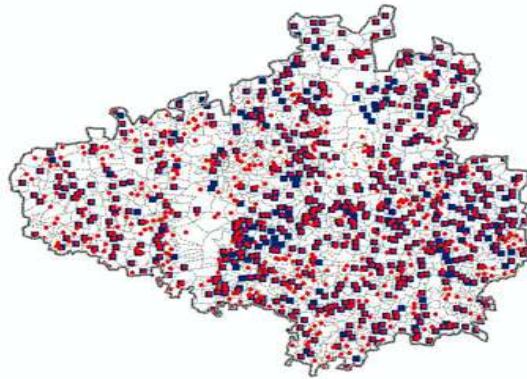


Fig 1: Mapping of the point locations

3.3 Remote sensing data analysis for two decades:

Remote sensing is an evolutionary technology in providing the information, the analysis done by using RS techniques is more precise and accurate. For the study of encroachment and the actual boundaries SAGA GIS an open source software was used, in defining the boundaries of south Bangalore. The two decades data was helpful in finding out the encroachment happened, after the demand increased for the land due to rapid urban development. The statistical data is showing 78% of urban development, where the water boundaries and vegetation degraded to the extreme extent.

The following satellite images and google earth maps are showing the actual boundaries and the encroachment happened in the recent times.

3.4 Integrating the RS and GIS data:

Integration of GIS and RS data provides a module of soil properties with boundaries defined by the signatures created in the classification. The actual boundaries from the topographic map and satellite image should coincide which defines the accuracy rate of the analysis

3.5 Creating Web portal of the soil profiles zone wise:

The data analysed for the sustainability and suitability of the land, natural resources has to be web enabled using the following software.

- ArcGIS Desktop 10.2.
- Spatial Analyst Extension.
- File Geodatabase
- ArcGIS Server 10.0.
- Visual Studio 2010.
- C#
- JQuery.
- Esri JavaScript API 3.2.
- SQL Server 2010.
- Mapservices

ArcGIS Server: ArcGIS for Server software gives you the ability to create, manage, and distribute GIS services over the Web to support desktop, mobile and Web mapping applications. To create GIS services, you use ArcGIS for Desktop to author geographic content, such as maps and GIS tools, and then publish that content using ArcGIS for Server so that it can be used anywhere in your enterprise and on the Web. Web enabling the data, needs the huge data to be structured which is used in coding the project.



Fig 2: ArcGIS Server

Web Enabled data will be displayed by zone wise, like taluk, hobli and name of the zone:

Table 2: Zone wise data collection

| S.No | Filed Name | Data Type | Description |
|------|---------------------|-----------|--------------------------|
| 1 | <u>StateCode</u> | Integer | State Code |
| 2 | State | String | Name of the State |
| 3 | <u>DistirctCode</u> | Integer | District Code |
| 4 | District | String | Name of the District |
| 5 | <u>TalukCode</u> | Integer | <u>Taluk</u> Code |
| 6 | <u>Taluk</u> | String | Name of the <u>Taluk</u> |

Source (compiled by authors)

Table 3: Main tool bar for the search of the data analysed:

| | | | |
|--|-----------------|------|--|
| | Switch maps | Base | Allows users to toggle between Street, Topographic, Satellite and a Wiki press Background. |
| | Search Tools | | Allows the users to search by Taluk, Hobli, Village, Parameters. |
| | Select Graphics | by | Allows the users to search by Graphics (Rectangle, Freehand line and Freehand Polygon) and Clear Graphics. |

Source (compiled by authors)



Switch Base maps: The Base map layer can be switched between Aerial, Topographic, Roads and the White background. Click on Switch Basemap icon from Main tool bar on top left corner.

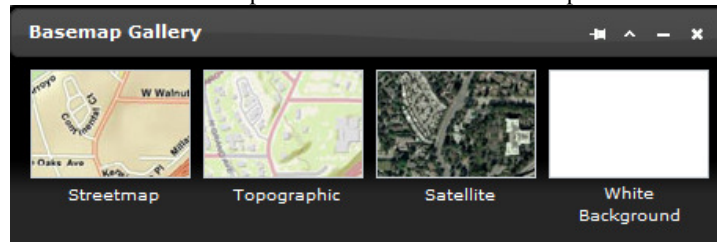


Fig 3: Aerial, Topographic, Roads and the White background view

Navigation Tools: The following tools helps in checking out the web enabled data with different types of options.



Fig 4: Navigation tools

| | | |
|--|---------------------|--|
| | Pan | ✓ Select the Pan Tool from toolbar, hold mouse left key and drag the mouse. |
| | Zoom to Full Extent | ✓ Click on Zoom to Full Extent Tool from Toolbar to get the full extent of the map. |
| | Zoom to Previous | ✓ Click on Zoom to Previous Extent Tool from Toolbar to go to the previous extent. |
| | Zoom to Next | ✓ Click on Zoom to Next Extent Tool from Toolbar to go to the next extent. |
| | Attribute Info | ✓ Click on Attribute Info Tool from toolbar. ✓ You will get the attribute info of the last viewed Info in the grid, unless you haven't cleared the graphics. |
| | Identify | ✓ Click on Identify Tool from toolbar. ✓ Click on village to view Ground Water parameters. |

Fig 5: Navigation tools

IV. CONCLUSIONS:

GIS analysis and RS techniques together helps in achieving the sustainability and suitability of land. It also prevents from violating the rules and regulations of encroachment laws by creating the web portal of the soil profile. User friendly web interface provides an easy approach to the complicated data base and also creates awareness about the natural resources, suitability and sustainability of the land. The approvals required for any construction can also be added to this web portal, so that any further disasters can be prevented. Demolitions and rebuilding is an add on expense to the public and government of any country. Hence adopting the new technologies and implementing them in the right manner helps to achieve the sustainability of any natural resource or structure with more accuracy and precision.



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