International Journal of Engineering Research
Volume No.7, Issue Special 3, pp : 247-251
ISSN:2319-6890 (online),2347-5013(print)
11-12 Jan. 2018

A GIS based application for construction of site in the hilly region of Warasgaon lake catchment Pune Maharashtra State

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Abstract: The information required for planning and design in construction industry are stored in the form of drawing, specifications on paper work and bar charts or pie charts etc. During the Site planning process, planner/architect has to need reorganize understand and interpret the information collected from various resources as said above. GIS nourishes construction planning and design efficiency by integrating locational and thematic information in a single environment. Its capability to store large database is helpful to maintain construction data in digital form that provide a wide range of information having the capacity of attributes and running of query for better results to construction industry with a mechanism for rapid retrieval and manipulation capabilities.

This study inferred the application of geographic information systems (GIS) in modeling the locational and terrain aspects to identify areas of suitability. A GIS-based methodology is used for construction of site in Warasagaon lake catchment in the vicinity of Warasgaon Dam. In the present study various terrain aspects that are crucial for the locating infrastructure facilities were identified

Keywords

GIS, terrain aspects, Construction site selection

Introduction:-

GIS technologies have the potential to solve space related problems of construction involving, integration of information, urban planning, and project site selection, soil studies, Hydrology and environmental studies. Proper use for these tools necessitates training the GIS techniques.
An advanced information system like Geoinformatics plays a vital role and serves as a complete platform in every phase of infrastructure life cycle. Advancement and availability of technology has set new marks for the professionals in the infrastructure development areas. Now more and more professionals are seeking help of these technologically smart and improved information systems like GIS for infrastructure development. Each and every phase of infrastructure life-cycle is greatly affected and enhanced by the enrollment of GIS.
Geographic Information Systems (GIS) is a computer-based method for collecting, managing, analyzing, modeling, and presenting geographic or spatial data. GIS software allows you to overlay maps and datasets and query them in terms of their spatial relationships to each other

Architects and engineers play a major role and contribute significantly to site selection. Their expertize depends upon their depth of knowledge and experience, which results in variations in location-based decisions. Generally, their decisions about site selections are based on an analysis in terms of simple calculations, past experience, or even preference. For ie Site climate, earthquake zone, on and off site activities, hydrology, vegetation, orientation, landslides, land use, water bodies, storm water drains mode of transportation, business hub, importance of an area, future utility prospects, quality of facility developed, landslides, availability of labor, materials, and earthquake zone, Town and Country planning byelaws, soil erosion, existing building line, head load and carriage. For selecting a site n hilly regions, topographical analyses are crucial for identifying the facilities that are located in areas of adverse conditions. It is most crucial issue for architects or engineers. The purpose of site selection is to determine the best possible site for a building within a specific region (Ghobarah, 1987). Site selection significantly influences the success or failure of a project.

Study Area
The study area is located southeast of Pune city at a distance of about 40 km. The area is accessible from Pune by all-weather tar road. Index map of the study area is shown in the study area comprises the Warasgaon Catchment, which is supplying drinking water to Pune city and that is 40-k.m wests to Pune city. The total area is approximately 132.64 sq km. The study area lies between the geocordinates 180 21’ 00” to 180 25’48” North latitude and 730 25’12’’ to 730 37’ 12” East Longitude. This falls in Survey of India Toposheet no. 47 F/7 and 47 F/11.

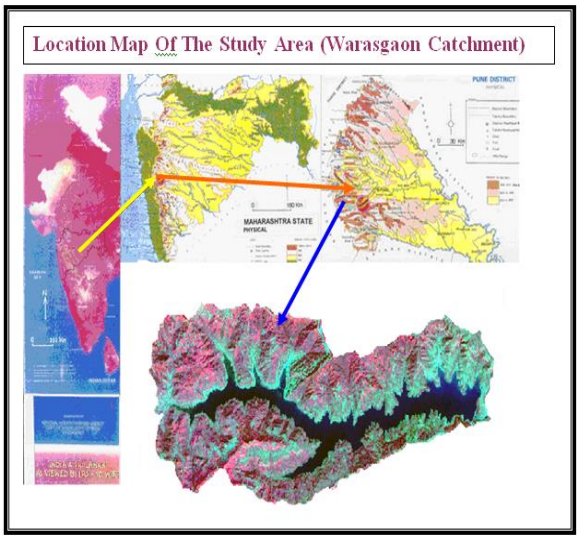

Figure 1: Map showing the study area

3. Data Source and Methodology

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The total research work is done with the help of Primary and Secondary source of data. Main part of the study work is done on the field. The GPS point were collected from the Warasgaon catchment for groundtuthing, which will useful for making different type of maps.Topographical maps are used as a base map47 F/7 and 47 F/11.
Survey of India topographical map on 1:50,000scale are used as base map.
The visual interpretation of IRS LISS III2005 based on eh elements of interpretation.
Base maps has been prepared using toposheet 47 F/7 and 47 F/11.Contour map has been done by capturing the contours and streams through digitization in GIS software.Following ,maps are prepared by superimposing grid 0.5cm*0.5 cm.
Absolute relief map, Relative relief map, Percent slope, Degree slope, Dissection index map, Denudation Map,Landuse map(Using Toposheet and Liss III image) .Aspect map Hillshade map,Slope map Dissection Index,Absolute Relative relief and morphometric analalysis has been calculated by using following formula.

4. Site Selection

In hilly region due to scarcity of workable space layout planning is significant. A GIS-based framework developed facilitates in identifying the suitable positions of various building structure. The number and sizes of construction entities entirely depends on the availability of site space, topography of that region, specifically if the area is high undulating surface or hilly . The concept of considering space in hilly regions provides construction professionals with new perspective in terms of locating various construction sites more effectively. The study sensitizes construction professionals regarding the importance of various critical elements of layout planning. GIS-based framework facilitates in minimizing construction conflicts and improves project efficiency. Study highlights that consideration of slope, DEM(Digital Elevation Model),Denudation prone(Erosion prone area) ,Dissection index, hydrology of a particular area of the chances of errors during construction stage, helps in completing the project with less cost and ensuring safety of various construction resources. Inclusion of safety consideration during layout plan facilitate in reducing the risk of various hazards like landslide, splash flood, mud slide etc.. It highlights that consideration of topography helps in reducing the wastage of building material.
Topography refers to the shape of the physical feature of the land. A topographic map is a representation of the shape, size position & relation of the physical features of an area. Various terrain characteristics are important for construction of site in hilly region.

5. Use of GIS in terrain analysis

Terrain Analysis is the analysis and interpretation of topographic features through geographic information systems. Such features include slope, aspect, viewshed, elevation, contour lines. Terrain data most commonly take the raster format (i.e., DEMs), which records elevation on a cell-by-cell basis for each cell, but irregular sampling points, contour lines, and triangulated irregular networks (TIN) are also common elevation data formats. DEMs may be produced from one or multiple data sources, such as conventional topographic maps, sample points, and remotely sensed imagery, and the production process often requires substantial preprocessing and interpolation of source data. The user should pay special attention to understanding the effect of data lineage when dealing with various elevation data sets.
.Geographic information system (GIS) technology provides the tools for creating, managing, analyzing, and visualizing the data associated with developing and managing in construction line. GIS allows civil engineers to manage and share data and turn it into easily understood reports and visualizations that can be analyzed and communicated to others. This data can be related to both a project and its broader geographic context. It also helps to manipulate all details in attribute form it will help for generating query to develop strategies for sustainable development. Thus, GIS is playing an increasingly important role for construction and civil line supporting all phases of the infrastructure.

Terrain Characteristics

Absolute Relief:
Absolute relief map shows the elevations. That helps to infer about the distribution of peak points over an area. The study area shows that the highest elevation lies away from the water body. And the lowest elevation lies near the waterbody The range variation is from 600m. to 1080m. above mean sea levl.
In general contours are very close spacing indicating higher slopes & hilly terrain

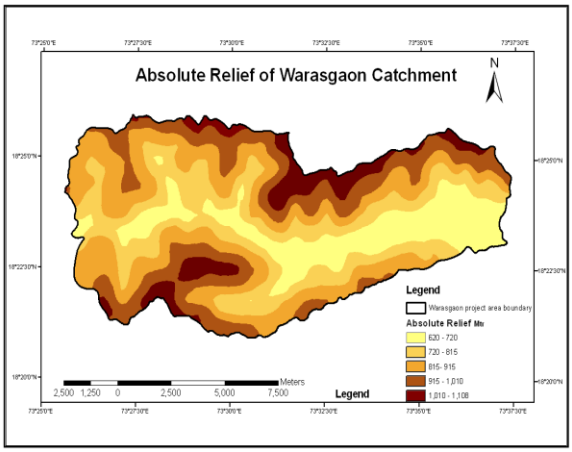

Fig. 2 Absolute relief map of Warasgaon Catchment

Relative Relief:

Relative relief is one of the most significant geomorphic variables. It is used for overall assessment of morphological characteristics of a terrain & for assessing the degree of dissection of a terrain. Relative relief is also termed as relative altitude, topographic relief, and amplitude of available relief, local relief. Lithology, structure, slope, climatic parameters, geomorphic process & vegetal cover etc influence variation in the values of relative relief. It helps in finding out the terrain characteristics & their significance with the controlling factor.

In the present study, the area has been divided into equal girds of 0.25km.sq. to prepare a relative relief map.
The methodology involves the noting of maximum & minimum heights of each & every grid of the study area. Thereafter, the difference between maximum elevations have been found out which in fact, gives the relative relief values for the grid.
The Relative relief in the study area varies from 3 m to 352 m

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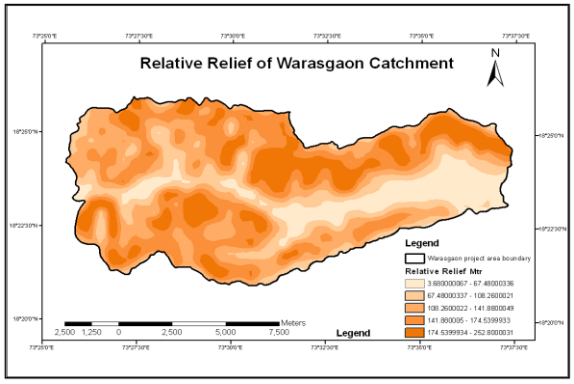

Fig. 3 Relative relief map of Warasgaon Catchment

TIN

The TIN model represents a surface as a set of contiguous, non-overlapping triangles. Within each triangle the surface is represented by a plane. The 3D Analyst extension of Arc Map has a very good algorithm for building TINs. It has plenty of functions to analyze and visualize a TIN surface.

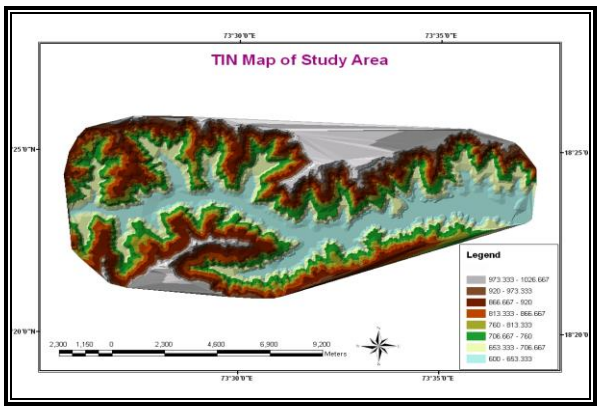

Fig 4 TIN, Warasgaon Catchment

DEM

A DEM is a raster or grid based terrain model. Each cell in the DEM will have a value representing the elevation of the area. The maximum height represent when go away from waterbody. The lower value represent near waterbody. The values are ranges (600-1080`) (fig-)

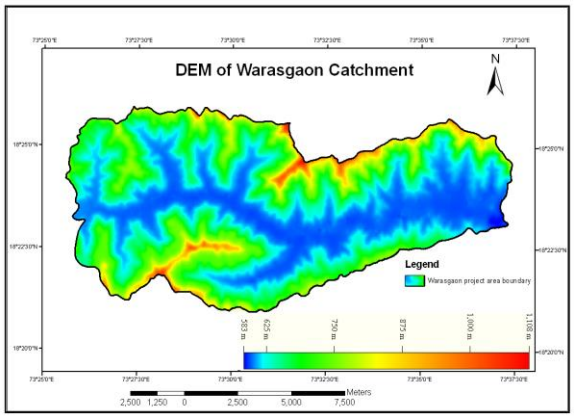

Fig5 Digital Elevation Model, Warasgaon Catchment.

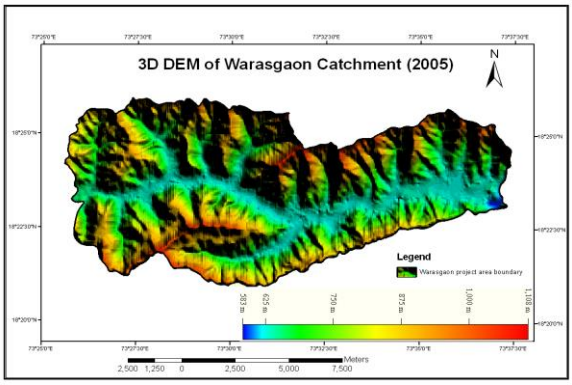

Fig 6 Digital Elevation Model, Warasgaon Catchment.

Slope Map

Slope is an angular inclination of terrain between hill top & valley bottoms. Its Maximum rate of change of Z through the cell.. It is ranging from 00 to 200 degrees. There are five classes for slopes viz its ranges 00to 40, 40 to 80, 08 to 120, 120 to 160, 160 to 200. Slope is a prominent factor for assessing the soil erosion. Normally, the higher the slope, the greater will be the erosion. The values of slopes are decreasing towards to the water body (4.4)

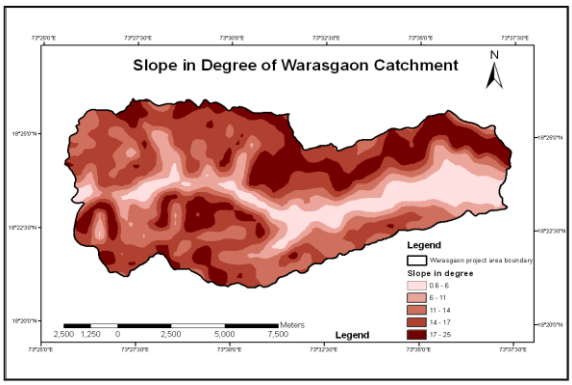

Fig 7Slope Map in Degree

Aspect

Derived aspect from a raster surface. Aspect identifies the downslope directions of the maximum rate of change in value from each cell to its neighbours. Aspect can be thought of as the slope direction the values of output raster will be the compass direction of the aspect. The aspect map of the study area in given in the fig

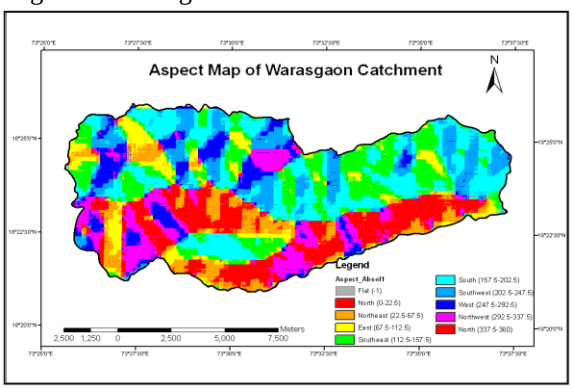

Fig 8Aspect Map of Warasgaon Catchment area.

Hillshade

Computed hillshade values for a raster surface by considering the illumination angles and shadows. Hillshade set suns

ISSN:2319-6890 (online),2347-5013(print)
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position. The Hillshade map of the study area in given in the fig (4.6)

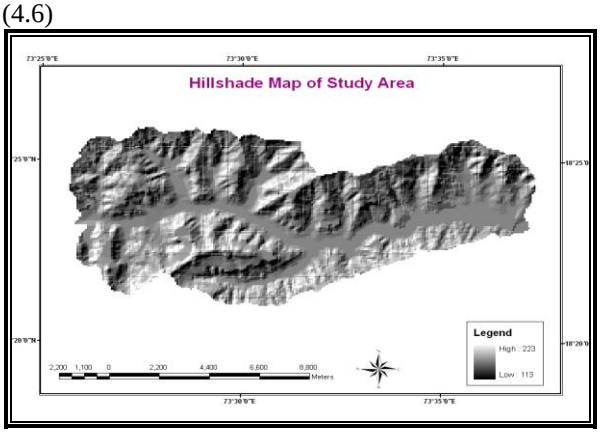

Fig 9 Hillshade Map of Warasgaon Catchment.

Denudation

Denudation is defined as the overall degradation and levelling of continental land masses cf. /Ahnert 1996, Smithson et al. 2008/. Denudation is achieved by different exogenic processes, including weathering, mass wasting and erosion by wind, running water, waves and glaciers. The energy needed for the denudation processes is gained from endogenic and exogenic sources.Denudation cause the wearing away of the earth's surface leading to a reduction in elevation and relief of landforms and landscapes. Weathering exerts the most fundamental control on denudation and is the driver of, or limiting factor, in landscape evolution Turkington et al. 2005. Several authors have shown the significance of differential weathering in landscape evolution. Deep weathering has been considered important in humid tropical regions for long, however, the fundamental role of deep weathering in different environmental settings also outside the tropics has recently been pointed at Migoń and Thomas 2002.

In study area an attempt has been made to prepare the denudation rate. For denudation rate the aster and toposheets data were processed in GIS software and from their differences denudation rate was generated and displayed in (Fig.4.10). The highest denudation rate was observed in higher slope segments like near Lavasa Dasave village which might be caused due to weathering and manmade activity for developing farm houses and new plan hillstation (city).

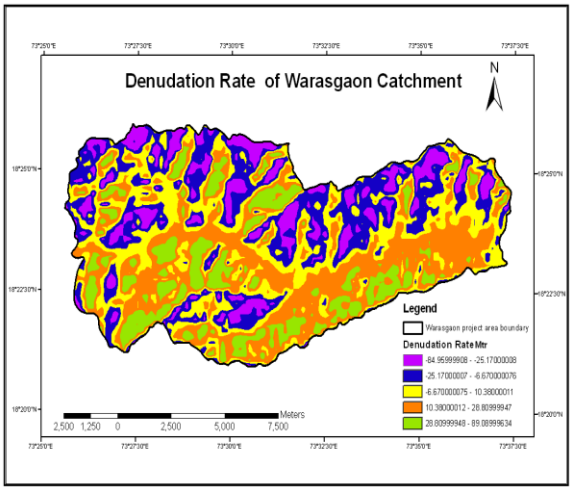

Fig 10 Denudation Map of Warasgaon Catchment.

4.12 Dissection Index

The dissection index, which is the ratio between relative relief & absolute relief, gives a better understanding of the landscape. The sharpness of terrain character of an area cannot be expressed adequately by interpreting the absolute relief and relative relief separately. The dissection index can be obtained by the following formula.

$$\text{Dissection Index: -} \frac{\text{Relative relief (Rr)}}{\text{Absolute relief (Ar)}} *100$$

The values of dissection index vary from 0 (complete absence of dissection) to 1 (vertical cliff at a sea level) Thus, it is the index of the degree to which dissection has advanced other world it express the relation between the vertical distance of relief from the erosion level & relative relief i.e. the dynamic potential of the area. It rages 0.75 to 26 %

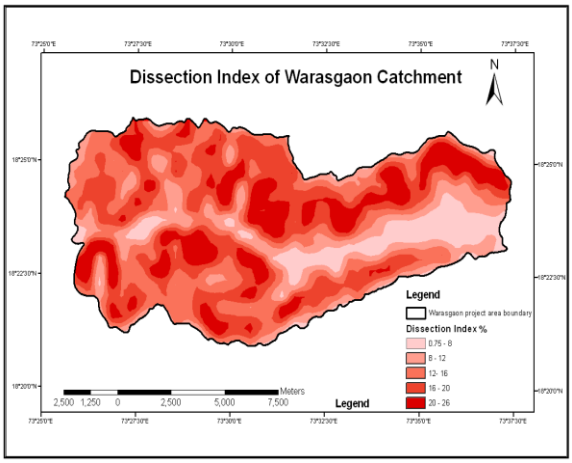

Fig 11 Dissection Index of Warasgaon Catchment.

Result and Discussion

In the present study GIS-based conceptual framework is developed to locate the construction site in study area. The main objective was accomplished through:

•1. Identifying site layout area

•2. Find out the restricted areas,

Identification of suitable sites for construction in hilly area

Effective criteria (factor) used in the identification of suitable sites with their individual importance are:

Slope (Figure): is an important criterion for hilly terrain for finding suitable sites for built-up. Steep slopes are disadvantageous for construction purpose because the slope increases the construction cost.

Land use/cover: Land use/cover map of Warasgaon catchment has been categorized as agricultural, forest scrub because once a building is constructed, it remains there for minimum 50 to 75 years. River bed is also not suitable for built-up area development. Thus barren land/agricultural land is considered to be the highest suitable for development purpose (Figure).

Geomorphology (Figure): The denudational landforms like hills are identified based on stage of denudation, wherein, all the structure gets obliterated. These denudational landforms also can be classified based on dissection. Low dissected structural hills are given higher priority as compared to high dissected structural hills for construction.

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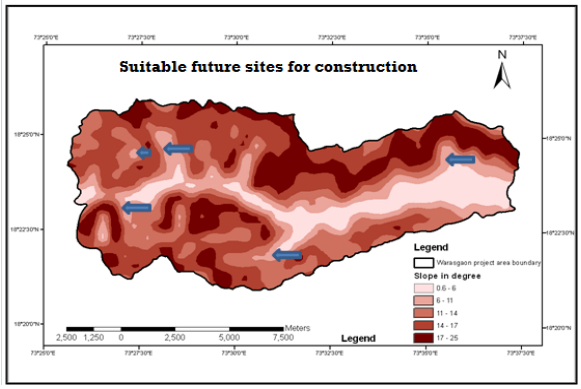

Fig Suitable sites for construction of Warasgaon Catchment

Restrictions areas

Terrain influence was assigned to land use and other datasets. It is variable with the importance given to the topography, existing facilities/utilities, and the choices of the architects and engineers making site selection decisions. A higher percentage of influence for a particular terrain dataset corresponds to its higher effectiveness in site selection.

As per our map the

The re-classed slope dataset indicates that field value 11 to 25 degrees are not suitable for construction site. Area required for the workshop building is not available among the stability because due to high relief the cut and fill costing will increase automatically construction cost also increasing.

The 0-6 degrees area also not suitable for construction site, because this is totally under and near the vicinity of water surface.

All these cells in the slope datasets were restricted except the 6-11 degrees area

Safe site for construction area.

In the present study, the sites with an degrees of slope in between 6-11 were considered potential locations for the workshop building. The sites with depression in ravines and gullies were considered as safe, sites, respectively, because there is less chance to landslide and mudslide, less construction cost like cut and fill analysis, less worker charges, and less time

Therefore, this part was considered a safe site for locating the workshop building.

Fig. shows the identified location for the workshop building

Conclusion

Terrain of a hilly region plays an important role for locating construction site in a hilly region. It affects the development of the region. The various topographical aspects like slope, dissection and denudation rate of a region, Absolute and relative relief, TIN, DEIGITAL ELEVATION MODEL, considered provide a unique and precise solution for assessing exact locations. The consideration of topography reduces the site development cost and ensures the sustainability of a hilly region. The GIS is used in present case study to consider the topography in developing the GIS-based framework for assessing to find out terrain characteristics of study area locations.

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