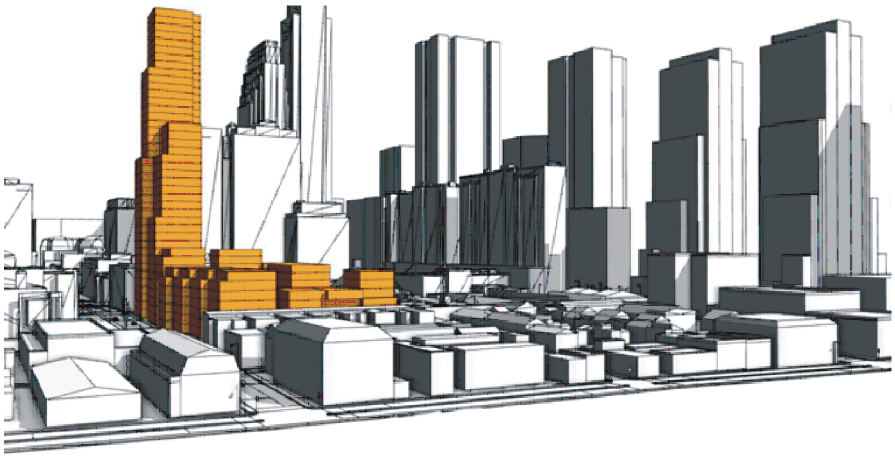
RULE BASED PLANNING AND 3D SIMULATION OF CITY CASE STUDY: RAJPUR ROAD, DEHRADUN



ISSN(Online): 2581-5296

RULE BASED PLANNING AND 3D SIMULATION OF CITY CASE STUDY: RAJPUR ROAD, DEHRADUN

Raghvendra Singh[1], Sadhana Jain[2], Ashutosh Kumar Jha[3]

ABSTRACT

Urban planner faces the challenging task of meeting the aspirations of multifarious interest groups in developing the scarce resource of urban land. In this context, the 3D visualization techniques are very helpful in understanding the spatial problems due to easy interpretation, as well as lend themselves in remedial actions required to be undertaken for future city planning.

After becoming the capital of Uttrakhand, Dehradun has witnessed pressure in planning activities especially along the major arterial road. Rajpur road is one of the major arterial road radiating from the clock tower to Mussorie. This study has been carried out on an area of 150 m buffer up to 2 km stretch along the Rajpur road, Dehradun (starting from Dilaram chowk towards Mussorie). Detailed land use land cover map has been prepared using google imagery and an inventory of vacant plots has been carried out. The existing pattern of space use was analysed and 3D visualisation of existing setup was done using ArcScene ver 10. Distance from the road was found to be the main driver of space use/land use. It was found that most of the commercial property was built along the road side, whereas most of the residential areas were constructed farther away from the road. Size of plot also significantly governs the land use pattern. Larger areas on the road side were utilised for malls/multiplex, whereas larger areas away from the road were found to be suitable for multi-storeyed residential apartment. Average plot size for residential as well as various commercial activities have been derived and rules have been enunciated for each plot on the basis spatial analysis of existing scenario. Space use has increased with vertical extension. This phenomenon forms input for rule based city planning by accommodating the vertical growth pattern in the city. 3D modelling software City Engine has been used to generate the different scenario of city vertical growth by using vacant plots utilisation based on the exiting growth pattern. The case study can be effectively emulated by the urban planner and can also be useful for the policy formulation and implementation. The results of our research showed that the 3D pattern based geo-visualization is one of the most promising techniques for effective and result oriented understanding of future urban scenarios.

Keywords: 3D visualization, urban, geo-visualization, GIS, City Engine.

1. Introduction

The 'rule based planning' is the process of understanding existing site qualities and factors, which will determine the location of a particular activity. The purpose of selecting potential areas for new

1. Junior Cartographic Assistant, Soil and Land Use Survey of India, Ministry of Agriculture & Farmers Welfare, Government of India, C-4, Sector -1 Noida Uttar Pradesh-201301 India Email: rsingh.rkm@gmail.com

2 Scientist "SE" Indian Institute of Remote Sensing (IIRS) Indian Space Research Organisation (ISRO) Dept. of Space, Govt. of India 4-Kalidas Road, Dehradun-248001 India Email: - sadhana@iirs.gov.in

3 Scientist "SD" Indian Institute of Remote Sensing (IIRS) Indian Space Research Organisation (ISRO) Dept. of Space, Govt. of India 4-Kalidas Road, Dehradun-248001 India Email: - akjha@iirs.gov.in

development depends upon the relationship of different factors, like location of available site, extent of the area, accessibility, etc. and site association factors like slope, and others. Incorporating the real world phenomena in the geo-information themes is a big challenge. This trend has changed the way humans relate to land use, and inspired researchers in finding solutions for dealing with 3D property situation. There have been advances in the field of 3D visualisation, especially in navigation and exploration capabilities. A realistic 3D visualization can be a strong tool for decision making and officials are already looking at 3D building by level or even by room in applications related to security and emergency planning (Smith and Friedman, 2004). Zlatanova et al. (2002) summarized the current status of 3D GIS development, where four systems were under detailed consideration.

The definition of 3D GIS is similar as for 2D GIS, with the deviation that the information is associated with three-dimensional spatial phenomena (Rahman et al. 2001). A 3D GIS should be able to provide information about spatial phenomena by performing tasks that 2D GIS are able to provide, such as capturing spatial data to the systems structuring spatial data in a geo-database, manipulate operators, analysis and visualisation of the result (Albrecht 1996; Longley et al. 2001).

This study explores the existing pattern of utilisation of urban space and suggest fresh space use in the identified vacant plots using latest 3D software City Engine. In this project, an attempt has been made to derive the pattern from the existing trend of development and incorporate them in the simulation for the future developments based on the 'rules' and policies laid out by Mussories Dehradun Development Authority (MDDA). Hence the present research aims at finding 3D property solutions toincrease the possibility for sustainable building development in Dehradun along the Rajpur road areas with various scenarios. The study highlights to develop 3D growth of the real world environment and use it to visualize, query and carry out site suitability analysis for different scenarios. The study is mainly focused on potential 3D growth pattern identification and to exploit land use applications which are most relevant in urban studies.

2. Study area

The study area is located in Uttarakhand state of Dehradun along the Rajpur road from Dilaram Chowk (Lat 78°3'46" Long 30°20'8") to National Blind Brail Press (Lat 78°3'46" Long 30°21'7") in India at an altitude of 700 m MSL. An increased pressure on land has led to new development in Dehradun along the Rajpur road. Thus, this areas is getting more complex, a subdivision of land is becoming an important issue for administrator. The two ends of the study area are spaced two kilometres apart. Using the linear length of road space stretching across these two above mentioned end points, a buffer was created for a width of 150 m. on both sides of the road. The physiography of the area is marked by undulations and has strictly governed the physical development. Physiographically, the area is an elongated longitudinal valley extending in north west-south east direction more or less parallel to the strike of the Himalayan and guarded by high hills of the lesser Himalayas in north and gentle Siwalik in south.

October 18, 2001 dated Quick Bird images 120 tiles were downloaded from the google map service and mosaicked. The high resolution Quick bird imagery was rectified to projection set to UTM, Geoid as WGS 84. The RMSE error in registration was 0.03628.

A detailed field inventory work was carried out in Dehradun along the Rajpur road for following built-up class- residential, commercial, public and semi-public, public utilities & facility, building floors, vacant land, road type, others. GIS database was generated in Arc GIS 10.1, which was used to derive the distribution pattern of floor based on the existing trends of development.

3. Existing Land use pattern

The land use pattern along Rajpur road is governed by the residential and commercial activities. There is a dominance of commercial activities till a distance of 50-60 m from Rajpur road. Away from 50 m, there is a dominance of residential activities. The land use distribution is shown in figure 1.

Fig. 1: Landuse map of the study area

3.1 Characteristics of Residential Areas

It was observed that the residential areas were well distributed on both sides of the road. And, the floor size of residential area has displayed significant amount of variation starting from 44.25 sq. m to 16,138.65 sq. m. as given in the table 1.

S. No.	Size [sq. m.]	No. of house	Minimum Area [sq. m.]	Maximum Area [sq. m.]
1	< 139	30	44.25	139.39
2	139-278	96	139.77	278.49
3	279-556	82	281.19	556.72
4	557-787	23	563.91	787.72
5	787-811	26	811.72	1,339.03
6	> 812	18	1,442.98	16,138.65

Table 1: Variance in Residential Type based on area

Residential areas were generally found away from the roadside and lacked orderliness and planning. There was a high degree of overcrowding resulting in lack of amenities like open spaces, parks and playgrounds. Many houses were found to be old and dilapidated requiring demolition. Hygiene and sanitation was of poor quality and open drainages were also found at some places.

Number of floors in the existing residential area was studied with a view to plan for future development. The numbers of floors for each residential area were also varied. The floor wise probability distribution is shown in figure 2. The current development trends showed that irrespective of the type of residence, most of the residential areas had a high probability of Ground+1 storeyed construction.

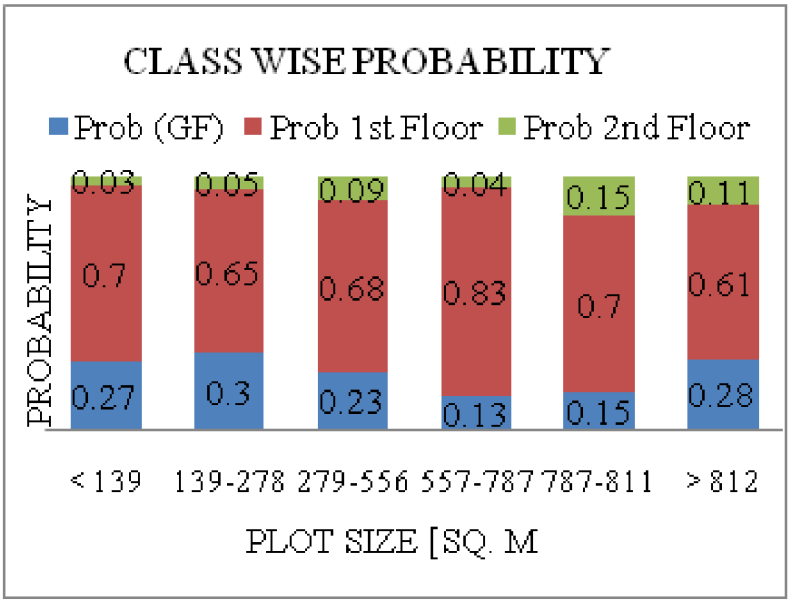


Fig. 2: Floor wise Probability Distribution of Residential Areas

3.2 Characteristics of Commercial Areas

It was observed that the commercial areas were well distributed on both sides of the road. However, the floor size of commercial area varied a lot, starting from 39.38 sq. m to 12,470.69 sq. m (table 2). Again, the number of floors for each commercial area also varied from 1 to 4 storied.

S. No.	Size [sq. m.]	No. of Plots	Minimum Area [sq. m.]	Maximum Area [sq. m.]
1	Hotels	8	822.89	5,104.04
2	Showroom/ malls	10	128.21	1,272.03
3	Shop	16	39.38	258.66
4	Multi Shop Complex	37	258.24	2,834.10
5	Multiplex Cinema	1	12470.68	12470.68

Table 2: Variation in Commercial Type based on area

Commercial area showed great variation and therefore sub divided into five categories based on type of commercial activity and the quantity of area covered. It was observed that the pattern of location was haphazard and displayed a certain amount of randomness and lack of planning. Floor wise distribution of the same is shown in the figure 3.

Number of floors in the existing commercial area was studied with a view to plan for future development. The current development trends showed that hotels and shopping complexes had a high probability (88% and 78% respectively) of Ground+ 2 storeyed constructions whereas local shops were predominantly Ground + first floor based structures.

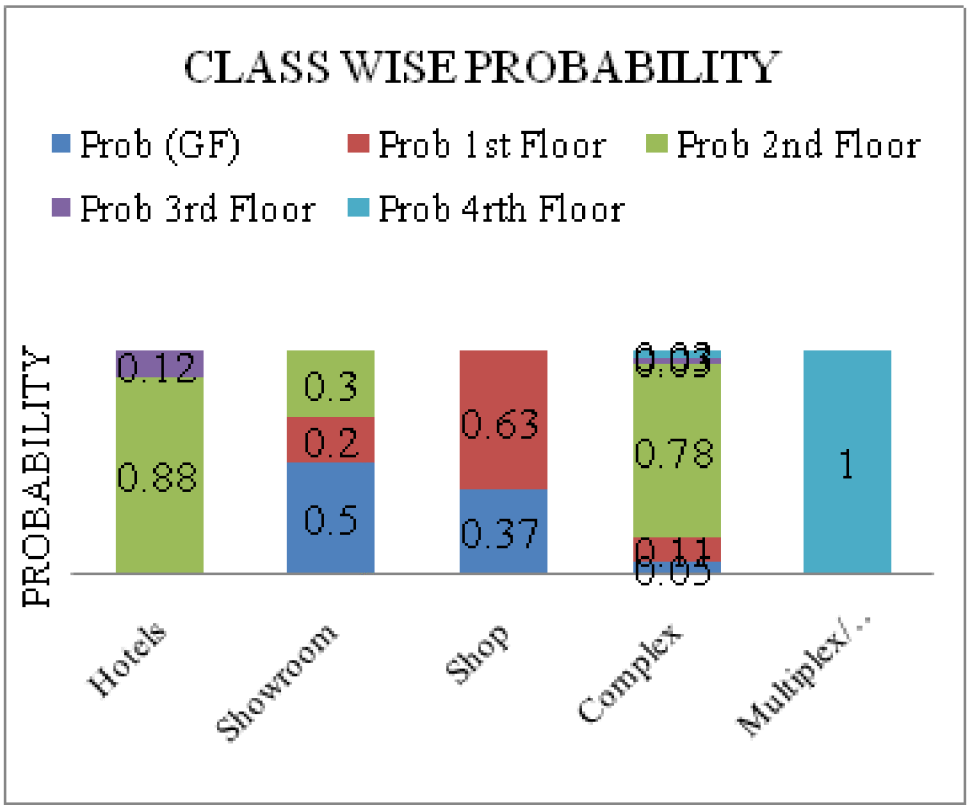


Fig. 3: Floor wise Probability Distribution of Commercial Areas

3.3 Criteria for rule based planning

Rule based planning and its 3D modelling using CITY ENGINE software has been carried out to

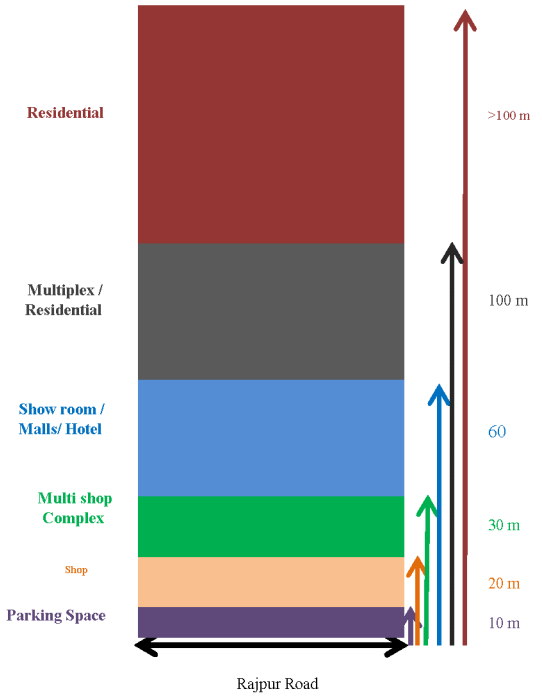


Fig. 4: Land Use Relationship with Distance to Rajpur road

S. No.	Building Type	Area (sq. m.)
1	Shop	25 & less
2	Multi Shop Complex	1500
3	Hotels	2000
4	Show room / malls	2000
5	Multiplex	10,000

Table 4: Size Criterion of subdivision of Commercial Area

The distribution of plot size based on the land use is selected on the basis of table 3 and 4. Planner/ developer can do the sub-plotting of the area based on following criteria

- Area available
- Dimension-plot edge size, subplot edge size
- Shape-Convex or Concave
- Regularity-plot similarity
- Constraint-Corner side of plot & subplot.

4. Discussions

Within a distance of 2 Kms there are five educational institutions including a PG College and a Senior Secondary School. Therefore, it is concluded that no more educational institutes are required. The land development criteria are applied as per the floor wise distribution of land use and criteria discussed in the section 2 and section 3. As an example, let us demonstrate development of the rules for plots no. 456 in the project area is explained below.

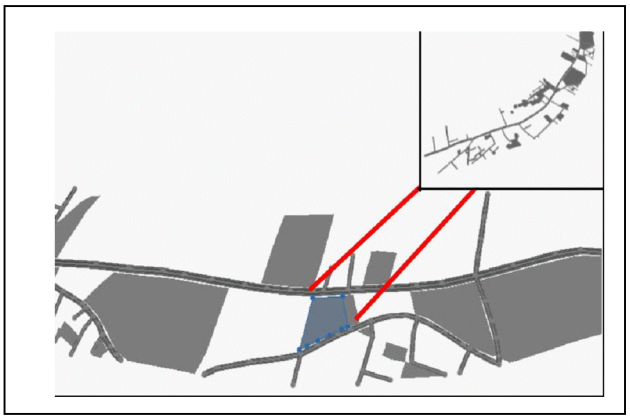


Fig. 6: Location Map of plot 456

- Detail of plot 456 which is divided into 4 subplots.
- Total plot area of 456 is = 4,478.86 sq. m.
- The plots be divided into = 4
- Minimum plotting area = 1000 sq. m.
- Maximum plotting area= 2000 sq. m.

Having broadly decided to have four big plots in the area, that the plots facing the Rajpur road are developed as commercial within a distance of 60 m. Therefore, subplot 1 & 2 are selected for commercial activity. Similarly, the residential building would be developed in the areas beyond 100 meter from roadside. The plot after new development will look like as shown in figure 7. Similarly the rules were applied to all the other vacant. After applying the rules in the Citi Engine software, the developed vacant plots will looks like as shown in figure 8. The land use on the vacant plots were developed based on the keeping the distribution of building type as per the existing distribution pattern as given in the table 5.

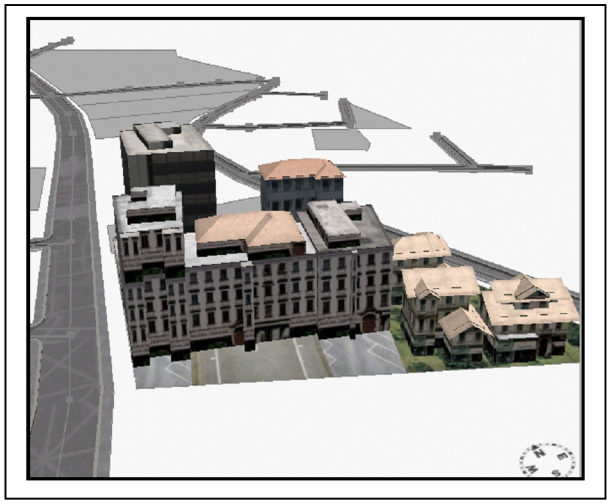


Fig. 7: View of Plot no.456 with all four developed subplots as seen from Rajpur Road

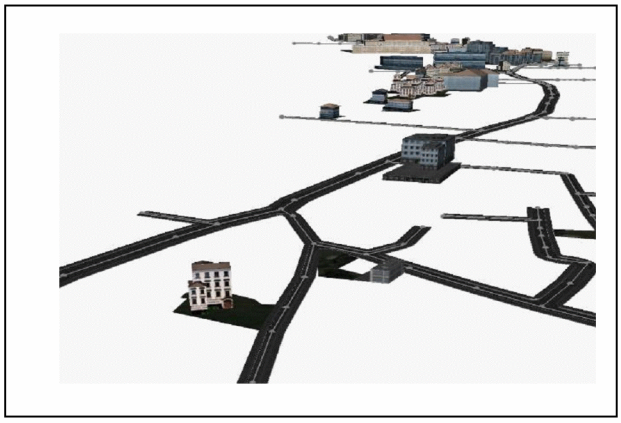


Fig. 8: Visualising development on the vacant plots in Rajpur Road

S. No.	Building Type	Area (sq. m.)
1	Residential area	23
2	Commercial area	13
3	Public and Semi-public land	18
4	Public Utilities & Facilities	14
5	Vacant land	20
6	Road	12

Table 5: Distribution of land use (proposed) on vacant plots

5. Conclusions

A total of Forty one plots were identified as vacant and suitable 3D models of different commercial/ residential type were raised on the same using City Engine software. In this project, an effort was made to identify vacant plots in the heart of urban areas astride Rajpur road which was spatially analysed for land use / space use planning. "Rule Based Planning" has been found to be very useful is for any given urban studies. It was found that City Engine is particularly useful for future planning of an urban area where in plotting, resizing, and managing various type of urban structures are feasible.

Acknowledgement

Authors express gratitude for the support by Urban and Regional Studies Department, Indian Institute of Remote Sensing-ISRO, Dehradun, India to carry out this research work.

References

1. Albrecht, J., (1996). Universal Analytical GIS Operations. A Task-Oriented Systematization of Data Structure-Independent GIS Functionality Leading Towards a Geographic Modeling Language. Dissertation, ISPA Mitteilungen - Heft 23, Vechta, 577-591.
1. Longley, P. A., M. F. Goodchild, D. J. Maguire and D. W. Rhind, (2001). Geographic Information Systems and Science. West Sussex, England, 454.
1. Rahman, A. A., S. Zlatanova, M. Pilouk, (2001). The 3D GIS Software Development: Global Efforts from Researchers and Vendors, Geoinformation Science Journal, 1(2), 13.
1. Smith, G. and J. Friedman, (2004). 3D GIS: A Technology Whose Time Has Come. Earth Observation Magazine. November 2004, 16-19.
1. Zlatanova, S., A. A. Rahman, and M. Pilouk, (2002). Trends in 3D GIS development. Journal of Geospatial Engineering, 4(2), 1-10.

❑ ❑ ❑