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Data-Base Creation and Analysis for Rational Planning

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ABSTRACT

With rapid urbanization and shortage of space, various departments have started moving their offices and universities/ colleges to the rural areas. As a result there has been a very rapid change in the land use / land cover pattern of fringes connecting urban and rural areas. However with this rapid change, the concerned authorities are in difficulties to monitor and manage the resources and infrastructure. Hence it is imperative to create a database of all the available information along with proper mapping of the resources to have a proper mechanism and management plan for better developmental planning processes. In view of the above, this study was conducted at a small built up area (about 49 acre of habitat), a fringe to urban area i.e. Doon University, Dehradun, Uttrakhand. The techniques of Remote Sensing (RS), Geographical Information System (GIS) and Global Positioning System (GPS) along with Survey of India topo-sheet 53 J/3 has been used to analyse the data and to create spatial and non-spatial database for Decision Support System (DSS).

The outputs were taken in the form of different thematic layers with aerial estimations, analysis of per capita of drinking water, irrigation water ability and electricity consumption along with rain water harvesting capacity for the different projected years. This paper presents an overview and preliminary results of integrated database and its optimum utilisation for better governance.

Key Words*: Data base creation, rational planning, natural resource management, planning for development*

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1. Introduction

Most of the countries are facing strategic and tactical challenges in the field of e-Administration, e-Services and e- Governance. The gap areas are high which require best practice in e-Governance projects in order to avoid failure and to achieve desired success. Remote Sensing (RS), Geographical Information System (GIS) and Global Positioning System (GPS) are one of the latest techniques helping in these areas. Its effectiveness and high positioning accuracy, the systems have been widely applied in many different fields. The primary goal of a data management system is to provide the best quality data possible within a reasonable scale and providing consistent and acceptable documentation, and supporting the feedback of summary information to administrator for administration, to facilitate data access by resource managers and decision-makers and to provide short-term and long-term security for data through data archiving or collection. All these data sets would be useful for all levels including academia, government sectors, commercial sectors and citizens in general as studied by Goodchild (2000).

The built up site i.e. University has witnessed remarkable expansion, growth and developmental activities such as building, road construction, and many other amenities and their inceptions in 2005.This has therefore resulted in increased land consumption and a modification and alterations in the status of land use land cover over time without any detailed and comprehensive attempt to evaluate the status and changes over time. The data base creation is an attempt to provide possibilities of correction in

future plan for distribution amenities such as drinking water, electricity, and irrigation facilities etc. The design of an effective data management system depends on several fundamental requirements as studied by Bernhardsen (1992) and can be optimized for parameters such as storage space, application convenience, access speed, or ease conversion as studied by Hinde (1998). According to O'Neill et al (1993), data management system must produce the products and services that are needed by University planner or satisfied by decision-makers.

In recent years, many studies have shown the various facets of GIS, its potential application and state of art, Dickinson and Calkins (1988), Hinde (1988), Bonham-Carter (1994) and by Jagannathan et al. (1990) has broadly defines the real strength of GIS and its application is in its capability to depict spatial association and significant application in economic analysis.

An approach to evaluation and monitoring of Government schemes and for decentralized planning using GIS has also been attempted by Naithani (2013), Rawat et al (2008) and Nathawat et al (2005). The remote sensing techniques are extensively used for the study of earth resources at micro - level and identification of spectral signature in India and abroad by Deekshatulu et al. (1991), Dutta et al. (1997), Saxena et al. (1991) and Krishna et al. (1994). Several excellent summaries of the social critique of GIS have appeared studied by Pickles (1999). Xiaomei Y and Rong Qing L.Q.Y in 1999 noted that information about change is necessary for updating land cover maps and the management of natural resources.

Indeed, an attempt has been made to document the growth of University in the past through conventional methods but the dynamics of Land use Land cover and particularly construction and distribution of amenities in the area requires a more powerful and sophisticated system such as GIS and RS data which provides a general wide-ranging synoptic coverage of large areas. The benefit of this study is to use the system in maintaining data base creation and extrapolation for future planning. Hence, in order to use land optimally, it is not only necessary to have the information on existing land use land cover but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape.

2. The Study Area

The study area; Doon University, is in the capital city of Uttarakhand having latitude 30 15'58" N and 78 2'45"E with an area of about 0.199 km^2 the temperature is moderated during summers, 40C is rarity; however, 37-38C temperature from generally May to June. River Respina and a Sal forest lies on the East of the University. The total population of the University is approximately 750, with includes administrative staff, faculty staff, students and workers of the infrastructure development agency i.e. Nirman Nigam.

3. Methodology

3.1 Database Used

The Satellite image form Google earth for year 2005, Nation Geographic Site for 2007 and flash Earth for 2010 along with infrastructural drawing from Nirman Nigam, topo-sheet of survey of India 53 J/3, Rainfall data from India Metrological Department, Water discharge data and electricity data were collected for the study. Different softwares like; Arc GIS 9 & 10, Erdas 9.3.& 10, Microsoft Excel, Microsoft Word and GPS were used for database generation.

The base map preparation, ground truthing and geo-referencing of satellite data its digitization, editing, attribute assignment and finalization of map along with database collection from various internal cells of the University and Nirman Nigam were collected. The meta data was generated. Finally the integration of spatial and non-spatial data process was done to create user interface. The error estimation, change detection and many thematic layers were generated as an output.

4. Result and Discussion

4.1 Land uses Landover Dynamics:

Land use changes coupled with construction development are resulting in conversion of one type land into other form. Therefore, the status of land use land cover of Doon University has been mapped to detecting the land consumption rate and the changes that have taken place and possible changes that might take place coming years as shown in Table No. 1.

For land use land cover category, a comparison is done in the year 2005, 2007 and 2010. The area has been mapped into broad classes like; Barren land, Grassland, Roads, etc. In the year 2005, the major land cover was barren, with an area of 61.31%, tree cover was 27.14% whereas in the year 2010, roads, construction observes an increase due to the increase

at 9.54 % and 12.06 % of the total area in the construction activity. The marginal decrease in the tree land use is also observed due to the construction drive and the grassland cultivation of the total area. In the final stage of the University development, the connectivity of construction is observed the best in the category so far at 24.62 %. The tree and the grassland area also increase due to the plantation drive at 23.62 % and 16.08 % respectively. The area of river bed is observed same at 15.08 % of the total due to construction of boundary wall. The construction in University premises was started in the year 2006 and subsequently changes were recorded. The result of the work shows rapid changes in category between 2005 and 2010 while the periods between 2007 and 2010 witnessed a massive growth in built up area. In the University development, the connectivity of roads is observed the best in the category. The tree and the grassland area also increase due to the plantation drive respectively. The Land use/ Landover map of 2005 and final current status map have shown in Fig. 1 and Fig. 2 respectively.

Through RS the area of University is measured of about 199000 m^2 and the area actualised by the Nirman Nigam is 189071.10 m^2 (Table 2). The map Fig. 3 shows the differential area in red and green colour. The red area is the land loss which is 2146.56 m^2, and the green area in the map shows the extra encroached which is according to the Nirman Nigam maps.

4.2 Drinking Water Analysis:

In University premises, availability of water is one of the several challenges. The only option is to extract the underwater resource from the regime of Respina river bank. With the proposed hike in the intake of the University every year, the water available for per student per day shows a decreasing trend (table No 3). Form the table it is very evident that in the year 2010, 2011, 2012 and 2013, the University has 308.7, 246.96, 185.22 & 168.38 litre/day, which show the water availability is decreasing due to increasing number of students. The day will come when the University offers number of courses, with number of students; no-one has a substantive answer to the problem. This issue appears as a tip of an iceberg. In this analysis, the length of the drinking water supply pipeline is also calculated which is 2291.86 meters and in case of any damage which needs repair and maintenance, can therefore be taken into consideration for futuristic approach.

4.3 Rain Water Harvesting Analysis:

The Rain water harvesting is proposed to function in full swing in the University campus. Out of 24.62 % the constructed area the remaining area is open for the direct exposure of rain water. Rain water harvesting can be a viable option for overcoming water related issues. The annual average rainfall in the Dehradun city is 2051.4 mm and total area (grasslands and trees) available for irrigation in University premises is about 79000 sq. mt (Table 4). The rain water capacity per square meter area is 7.85 ltr. The length of the Water harvesting pipeline is about 6612.15 meter can be utilised for repair, maintenance and for drip irrigation for the proper care of the grasslands and trees in the University.

4.3 Irrigation Water Capacity Analysis:

The Doon University is maintained by 14 hours of water supply. The table no. 5 show in the year 2007, the total irrigated area was 0.032 kilo meter square, and in 2010 the same was 0.027 kilo meter square, and the proposed total irrigated area in the year 2015, when the University will be fully functional is 0.079 kilo meter square. Water available of per square meter area in per minute is 54129.69 litres, 64153.70 litres and 21925.95 in the year 2007, 2010, and final stage respectively. It is important to realise that the availability of water supply is same but the irrigated area is increasing at final stage. This data is vital for the maintenance of campus..

4.4 Electricity Consumption Analysis:

Management and conservation of electricity is the prime need for this newly established University. The University is utilising five types of lamps/ bulbs during night, Metallic Halogen (70 watt), Sodium Light (150 watt), Height Mast Lighting (250 watt), Sonara Bollard Light (18 watt), Ornamental Pole Light (300 watt); the total electricity consumption of these lamps/bulbs was in the year 2009, 2010, 2011, and final stage is 76950, 387450, 624450 894786 watt respectively. During the year 2009 only two kind of Lamps/ Bubs were made use of namely Sodium Light (150 watt), and Height mast lighting (250 watt). The total consumption of electricity during 2009 is 76.95 units at a rate of Rs 3.00, which sums to Rs 6925.50 per month. In the final stage, the total unit consumption of electricity is expected to reach 894.786 units, which will sum to Rs 80,530 per month which is ever increasing. Fig. 4, 5 and 6 depict the light consumption, cost in per month and extension scenario of Pole lights in Doon University.

4.6 Resource Profile:

A Resource Profile is multi-faceted, wide ranging description of resources of any entity. A resource profile is an integrated data base of spatial and non-spatial data through automated and semi-automated processors coupled with RS database, it really represents the actual ground conditions and can be transformed and manipulated interactively in GIS, hence it can serve as a test bed for understanding the environmental process or for anticipating the possible result of planning decision. It can be used efficiently for a development planning process as depicted in Fig. 7.

5. Conclusion

It is observed that the resources are not for misused but to manage wisely in sustainable manner for organised planning and developmental planning processes. This data base helps to planner and administrator to monitor and analysis of the rate of electricity consumption in different time span. The issue of rain water harvesting is crucial, managing the greenery using waste water and roof water should be of prime importance. The University can creatively use the waste water in irrigation, and cleaning and upcoming requirements. The increase of infrastructure development, at the same time the decrease in water availability is a matter of concern. The high recharge potential of adjoining river bed for ground water is an encouraging sign and that can be used for future planning.

On the basis of the database which is being created during this study, similar database can be created for the other existing Universities of the Uttarakhand for better governance the one University can be acted as data base hub connecting all the other University for better planning, governance and for knowledge sharing. This data base helps to planner and administrator to monitor and analysis the database for the future growth of such urban fringe establishment.

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Tables and Figures

Table 1. Land use/ land cover analysis of Doon University in different years

YEAR	2005		2007		2010		FINAL STAGE	
LAND USE /COVER	Area (Km2)	%	Area (Km2)	%	Area (Km2)	%	Area (Km2)	%
BARREN	0.122	61.31	0.119	59.8	0.099	49.75	0	0
RIVER	0.023	11.56	0.023	11.56	0.03	15.08	0.03	15.08
TREE	0.054	27.14	0.032	16.08	0.019	9.54	0.047	23.62
CONSTRUCTION	0	0	0.016	8.04	0.024	12.06	0.049	24.62
GRASSLAND	0	0	0	0	0.008	4.02	0.032	16.08
ROAD	0	0	0.009	4.52	0.019	9.54	0.041	20.6
TOTAL	0.199	100	0.199	100	0.199	100	0.199	100

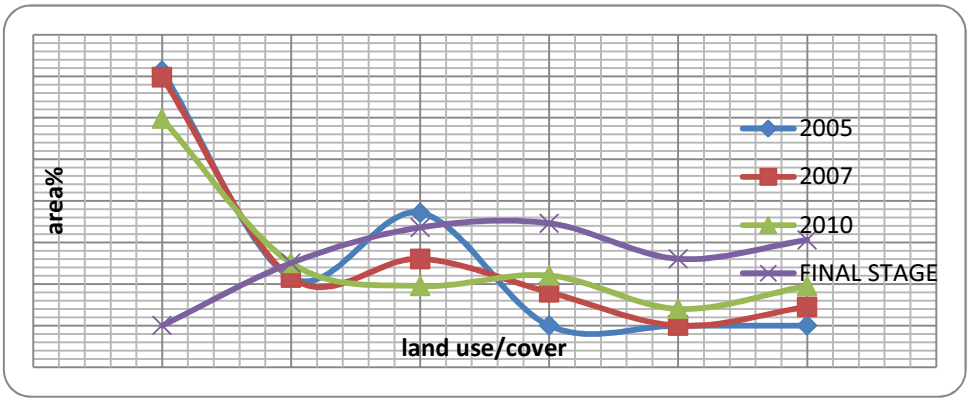

Figure- 1

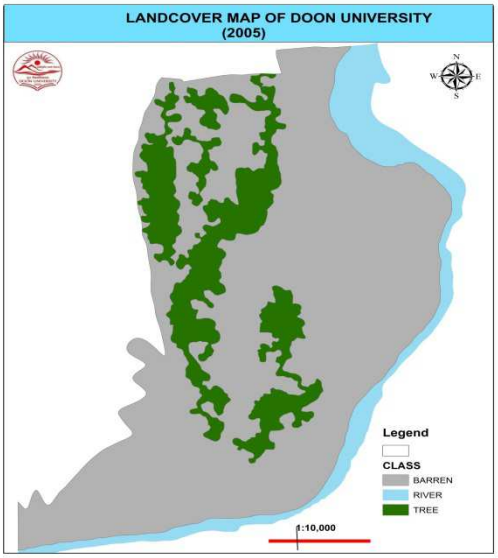

Figure- 2

Table No.2 Discrepancies in Estimations of Nirman Nigam and satellite map

Area according to Nirman Nigam (m^2)	Area according to Satellite image (m^2)	Difference of Area(m^2)	Extra area(Green area) according to Nirman Nigam Map (m^2)	Loss of area (Red area) according to Nirman Nigam Map (m^2)
189071.10	199000	9928.90	4939.39	2146.56

Fig. 3 Difference in Administrative Boundary by Nirman Nigam and Satellite map

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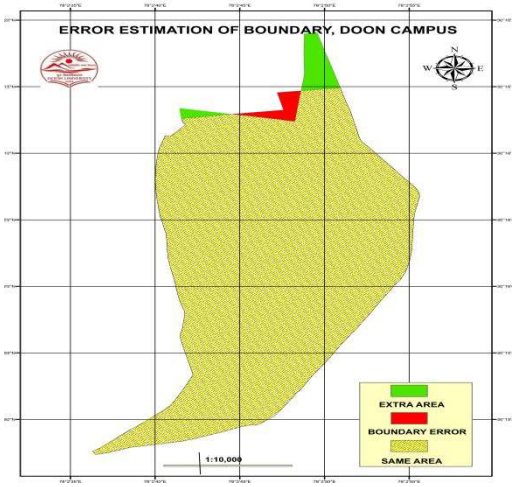

Table 3. Progressive Decline in Drinking Water Availability Per Day per Person

Year	Total Persons	LPCD
2010	600	308.7
2011	750	246.96
2012	1000	185.22
2013	1000	168.38

Table No.4 shows that rain water harvesting capacity of Doon University.

Total Area of Building Roof (m2)	Annual Average of Rain Fall (m)	Total rain water availability (m3)	Total Irrigated Area (m2)	Rain Water Capacity for Per Square Meter Area (lit.)
49000	0.20514	10051.86	79000	7.85

Table 5. Irrigation and Water Capacity Analysis

Year	Total length of pipe line(m)	Discharge (LPM)	Hours of water supply	Total irrigated area(km2)	Water availability in per km2 area
2007	2291.9	123.725	14	0.032	54129.69
2010	2291.9	123.725	14	0.027	64153.70
At final stage	2291.9	123.725	14	0.079	21925.95

Figure- 4: Pole Light Consumption of Doon University

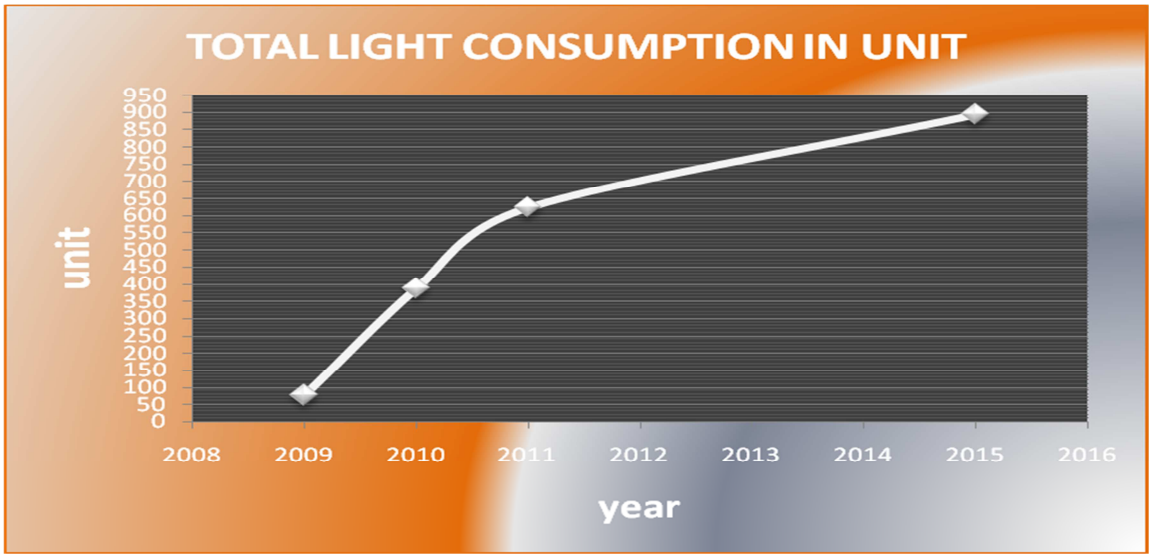

Figure-5 Per month electricity bill of Doon University, Different Years

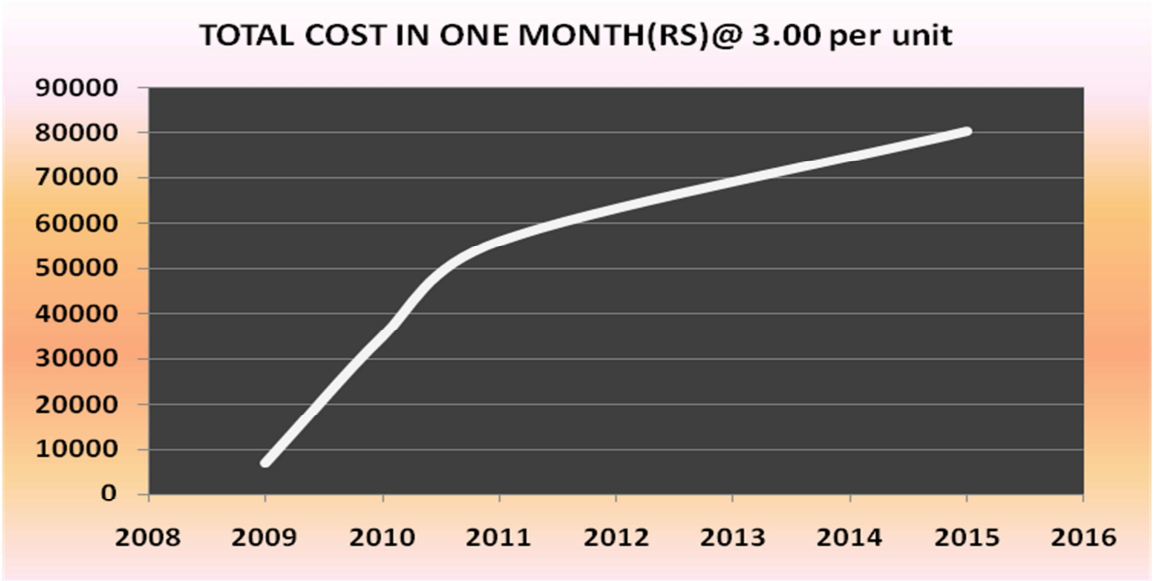

Figure-6 Electricity Pole lights, Doon University

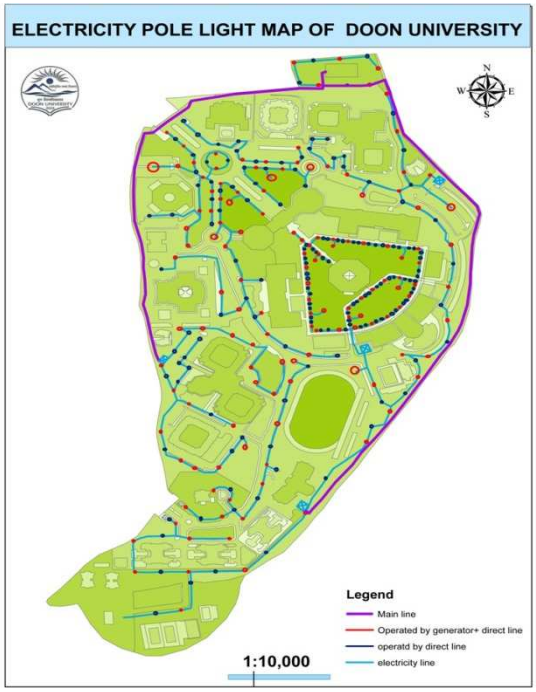

Figure- 7 Device Mechanism, Resource Database Creation, Universities of Uttarakhand