

Chapter: VI

CONCLUSION AND RECOMMENDATIONS

In current scenario ‘sustainable development’ is a commonly used terminology among various regional, national and international agencies subsequent to the publication of Brundtland report in 1987. The Agenda 21 of Rio 1992 has endorsed the need for sustainable development. Highlighting the tenets for sustainable development, Reddy (2004) emphasized the need for strategies addressing ‘equity, economic efficiency, environmental soundness, long-term viability, self-reliance and peace’ for regional and the nation’s sustainable So, it is essential for authorities concerned with administration and management of urban areas and urban development to integrate such approaches in regional planning while taking care of stakeholders and managing the resources sustainably. This also requires proper planning along with efficient governance to manage the urban growth and to mitigate the pressures on natural resources and environment. At the same time, taking into account the needs of the economy that sustains these urban areas. It is this belief that maintains balance between both: of economic development and environment, not only for the present but also for the future generations. There will not exist, any one single solution but a combination of multiple solutions and approaches to understand and quantify sprawl. However, the challenges for managing urban sprawl remain as the human population advance and settle in large agglomerations resulting in the expansion of cities.

The research on urban sprawl presented in this thesis, is possibly, a new beginning in understanding and addressing urban sprawl in the Indian context. In a rapidly urbanizing economy with fast technological changes, there is a need for governments to respond rapidly and regularly ‘adapt’ to these changes ensuring that smooth and sustained workflow. As weak governance causes and underline poverty and weaken efforts to reduce it while good governance would have emphases on that developmental schemes reaching all sections of the society and aid in enhancing the quality of life. Therefore, strengthening planning and governance is an

essential ingredient for promoting sustainable development while minimizing resource utilization and eradicating poverty. With this background in mind the present research is carried out.

The important discussions can be concluded as follows:

Cities tend to be open and non geometrical complex system. Thus, to quantify the cities, becomes a major task as the parameter and applications varies spatially and are discipline specific. As cities tend to have horizontal expansion and the availability of the remote sensing images give us the capacity as visualization inventory of the growth of the city. The study attempts the mapping of the urban region in the VUDA boundary with the LANDSAT image at the descent resolution of 30 mtr. The regional study focuses on the mapping of the urban sprawling in last 32 years is included as the study of the historical evolution of the present day city.

The spatio-temporal mapping of the urban sprawl was carried out using different techniques namely visual classification, the supervised classification, band ratioing techniques and the principal component analysis based image classification so as to obtain the best classification for the processing of the modeling process. All methods have the some bias and limitation in terms of users and software's algorithms, therefore, PCA based classification proved to be promising due to closeness to the reality result.

The visual classification result gave the basic information of the temporal changes suggesting the cyclic trend of conversion of the agricultural to open land and then built-up coverage during the study time. This goes correct in the form of the non agricultural conversion process to be done in the land records. The declining trend of agriculture shows a point of concern as the resource in the region is limited and the built-up exert pressure on this land cover only. Thus to maintain the supplies of the city, improvement of the agriculture is more desired for the sustainability of the city economies.

Supervised classification shows the good accuracy of the classification and the result in the form of the change are analyzed which also suggest the same trend.

The PCA analysis on the 7 spectral bands enabled the reduction of the information and eliminating the redundant data among the spectral band and the principal component stack to form the FCC when subjected to the classification gave the clear mapping without any overlapping information confusion, except the noises seen in the form of the scattered pixel of the categories. The land use obtained was focused on the extraction of the built-up class for the input of the Cellular Automata modeling.

Image ratioing is another technique based on individual land cover identification. As the land cover is not a homogeneous in nature thus the heterogeneity is represented as the mixed pixel characteristics, which prevents to have the 100 % of classification accuracy. Thus the requirement of higher accuracy has been always a matter apprehension for research in this field. Thus, for focused individual land cover class the intensity based mapping were done using band ratioing and normalizations technique. This was found to be efficient method of segregation of classes as well as reflecting the intensity of the feature. For example, it enables differentiating the vegetation types, moisture, dryness etc. this helps the researcher in addressing the problem by delineating the regions of the class. This therefore, requires sound logical threshold value identification, without which interpretation of the product becomes difficult. Also the rigorous field check has to be employed to gather field knowledge to correlate the product. This method will have different result for different time period and different areas. So, critical knowledge is essential for this study.

The existing NDBI algorithms is used to identify built-up regions and there growth in the entire study area. From NDVI study it has been observed that the density of the vegetation growth has decreased. New bands were generated directly from three thematic indexes, NDVI, MNDWI, NDBI and BSI. This considerably reduced data correlations and redundancy between

multispectral bands, significantly avoided the spectral confusion between the land-use classes, and thus largely improved the extraction accuracy. Besides, using NDVI and MNDWI instead of NDVI and NDWI also contribute to the improvement because this can significantly increase the spectral contrast between different land-use classes. Thus, the high accuracy of extraction of urban built-up land features was attained through a simplified band spectral signature analysis.

The present study tried to understand the LST regime of the study area for the month of the October. The study showed that city does represent the thermal contrast between the rural and urban region and peri-urban being at the transition. The dissecting river vishwamitry and the scrubs along the flood banks of the river act as the heat sink resulting into discontinuity of the thermal behaviour of the city. It is noticed that the city is still having the formation of thermal island which is the part of the old city, characterised by small road width dense built-up and lack of open space, green space, vegetation.

The Land surface temperature plays an important role in the planning of the smart and climate resilient city. The land surface temperature characteristic primarily gives the scenario of energy interaction with the material cover of the earth. The meteorological temperature gives us the air temperature, thus when we look both the parameter we are addressing to the biosphere we are in. the era were we are in the dilemma to develop our resources for sustainability with increasing the social wellbeing of the population at large, we are witnessing a new form of the environmental risk. The heat wave which used to be common metrological phenomenon but fatality is increasing in real time. The reason correlated is the formation of the urban heat island; micro urban heat island resulted from the concrete and asphalted cover.

The quantification of the changes pursued by discussed techniques only gives the areal coverage and its variation in terms of the area. This number seldom gives the arrangement and interaction of the classes, an essential component to understand the services operating and

supporting. This act as a fabric of the urban phenomenon landscape ecological concept was brought in study to understand the dynamicity of the region in which scattering, patch development core formation, edge length etc were calculated which showed the growth taking place in terms of sudden spurt of patches developing, growing and expanding.

Second interesting result derived was despite of the minimal area change the interaction length of the classes has shown variation as this may influence the development of resources. The ecological approach finds its application in ecologically suitable planning of the region.

This study quantified the land cover change for Vadodara Urban Area during 1978 to 2011 and studied the effect of varied spatial extents on the estimation of landscape metrics. Some of the landscape metrics were estimated to demonstrate their utility, combined with the spatial analysis to drive the point of considering landscape metrics as potential instruments in the preparation of land-use policy for future urban growth.

The modeling of the future growth is used as a predictor of the existing scenario on the future using the CA model in which transition matrix was calculated using Artificial Neural Network (ANN) ANN having the capability to model non-linear features and capacity to deal with the uncertainties of spatial data. ANN do suffers disadvantages as they are black-box devises and the user's intervention is still decisive for the results quality. Besides CA transition rule and priority sequence rule, land use transition also follows the other two rules: (1) maximum transition probability rule: a land use type is successively allocated into the cells as a descending sequence of transition probability of this land use type in all the cells; and (2) hysteresis rule: if a cell is allocated with a land use type, the cell will be not changed to other land types within the simulation period (Li and He, 2008).

Further, studies are needed to consider the responsiveness of the simulation. As a result are simulated area changes shows decreasing trend of the open land and agricultural land and built-up area will increase towards the west and south west region. The study will help local

authorities for better understanding to address a complex land use system, and develop the improved land use management strategies that can lead to balanced urban expansion and ecological conservation.

As different land use types have different priorities to be transformed, the simulated land use maps can serve as an early warning system for understanding the future effects of land use change. It can be referred as the strategic guides for the urban land use planning and understand “what if” scenarios by allocating different parametric rules in the model.

Also not only the proposed land use change model help us understand the complexity of the components of spatial systems, but also provide theories and reference for land planning and land resource management, thus sustainable city planning and development.

Apart from the intrinsic ability of CA models to mimic macro scale urban environments from innumerable interactions among simple elements, their benefits also include: their easy visualization of modeling results, their simplicity, their flexibility, their dynamic technique, as well as their affinity with the GIS and Remote Sensing (RS) (Torrens & O'Sullivan, 2001).

By being intrinsically spatial, CA stand out as being particularly attractive to geographers and planners and can thus constitute powerful tools for spatial analysis and territorial planning.

The main limitation of the study is in terms of the scale and resolution of the image which were taken as the base for the regional study. The model with spatial resolution of the 30 mtrs could not include the TP schemes constraints as that would have added a dimension of planned

As the main objective of this study is to demonstrate the use of CA-Markov model in land-use change prediction, the results from this study can be implemented in urban planning or policy formulation.

So, identification and inclusion of factors that are likely to affect a transition of a land-use class to another class in to the CA-Markov model would greatly improve the predictive power of the model. Nevertheless, inclusion of spatio-temporal land-use change dynamics in hybrid models such as CA-Markov, proved to be a valuable tool for better land use change prediction.

6.1 Future Prospects of the study

Despite the fair achievement of the research, a number of challenges were encountered in the process. The major constraint of the study is that resolution of the image is coarser to compare the TP scheme.

In end, it can be recommended:

To compile detailed spatial data in order to input into the geo-simulation prototype and then take all agents behavior's into account and obtain better outcomes. In other words, by using fine scale data, it is possible to reach better results.

To use this simulation prototype and develop it by means of finer scale data to be used for land use change modeling and urban expansion issues.

This study can be improved in several ways. Since land use transformation is a dynamic process, improving transition rules by taking more scalable factor would improve the classification accuracy and replicable capacity. Moreover, if the CA simulation is calibrated through the desired factor of changes, then the desired relationship can be incorporated into future growth estimation by simulation for alternative growth scenarios.