MINING LAND USE/LAND COVER INFORMATION AND CHANGING LANDSCAPE PATTERN ANALYSIS USING REMOTE SENSING AIDED MACHINE LEARNING TECHNIQUES

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By

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CHAPTER 8

CONCLUSIONS AND FUTURE RESEARCH

8.1 CONCLUSIONS

The work presented in this thesis explored the usefulness of integrating textural information into spectral or radiometric images in improving LULC classification accuracy using multi-sensor and multi-resolution remote sensing data. A robust classification approach was developed to enhance LULC classification accuracy using ancillary information in a heterogeneous landscape of Varanasi district of Uttar Pradesh, India. This work also demonstrated the effectiveness of multi-temporal earth observation datasets in the analysis and quantification of changes in LULC. The simulation and prediction of future landscape scenario was performed by applying an integrated approach of remote sensing, geographic information system and land change models. Considering the objectives of this research work, the specific conclusions can be drawn as follows:

- The efficiency of textural information in improving LULC classification accuracy was revealed by comparing different GLCM based texture measures using multi-sensor and multi-resolution remote sensing data.
- The textural information is more useful in reducing inherent heterogeneity and speckles within the same LULC categories in comparison to the spectral information. The textural images were not found much helpful for discriminating LULC categories than spectral images, particularly for medium spatial resolution images. But it becomes more valuable with increasing spatial resolution.

- It was also observed that the incorporation of textural information into SAR sensor data is particularly valuable in improving the LULC classification accuracy as compared to optical sensor data.
- The SVM classifier provided highest and reliable classification accuracy followed by RF, ANN and MLC. The Z-test shows that the classification accuracies achieved by SVM and RF were statistically insignificant.
- The composite (ratio and difference) images of HH and HV polarizations significantly enhance the backscatter separability between rice and other land cover features. A DT classifier based on optimal polarization combination, was found to be an effective approach for rice crop mapping with high accuracy.
- The geographically weighted method in combination with logistic regression addressed the major concerns in the analysis and description of accuracy and errors associated with LULC mapping. The GWLR examined the spatial variation in the accuracy measures of remote sensing classification.
- An integration of satellite remote sensing data, GIS and land change models was recognized as an attractive pathway to understand the spatio-temporal dynamics of LULC and prediction of future scenario in Varanasi district of Uttar Pradesh, India.
- LULC maps of years 2000, 2005, 2009, and 2014 were used to investigate the changes occurred in the study area based on post-classification method. During period of 2000-2014, agricultural land, dense vegetation, and fallow land were decreased while sparse vegetation and built up were found to increase. The paired sample t-test revealed that the observed changes are statistically insignificant.

- LULC information were extracted for years 1988, 2001 and 2015.The performance of three MC-based hybrid land change models namely ST-MC, CA-MC, and MLP-MC were compared using kappa index statistics. Then the best result providing MLP-MC model was used to predict the future LULC scenario for years 2030 and 2050. The analysis of LULCC during the period of 1988-2050 showed that there is a vast increase in built up area while considerable reduction in agricultural land, dense vegetation and sparse vegetation.

8.2 FUTURE RESEARCH

The following topics will be considered in the future to further improve LULC classification for higher accuracy and land change analysis:

- The fusion of optical and SAR data is needed to be performed for improving LULC classification accuracy. It is also needed to develop some new methods to perform automatic selection of optimal combinations of textural features for a specific study purpose.
- The relationship between rice crop growth parameters and polarimetric parameters will be further investigated to develop a method for yield estimation.
- Since the number of classes, the selection and size of training samples, the pre-processing steps etc. play a significant role in the quality and effectiveness of the final classification result. Therefore, all these parameters should be taken into consideration in order to achieve reasonable results. It is also needed to explore more experimental and theoretical studies to decide under what conditions SVM is better than the others.

- In future studies, the use of high resolution remote sensing images and longer time period would be able to provide better insights about the changing landscape pattern and its dynamics.
- Some new land change models based on different machine learning techniques are needed to be developed by incorporating more socio-economic, physical and climatic variables.