PREFACE

Land use and land cover (LULC) are assumed to be a fundamental constituent of the terrestrial ecosystem. It is an outcome of various natural processes and anthropogenic activities. Accurate and up-to-date LULC information is vital to scientists, planners, and decision-makers in forming strategies regarding economic, demographic and environmental issues from regional to global level. This information also assists to understand the impacts of natural phenomena better and convene the increasing demands for necessary human requirements and welfare. The changes in LULC termed as the alteration of Earth's terrestrial ecosystem by various human or natural activities. These changes are the comparatively new addition to the core concerns of global environmental changes research including climate change, biodiversity loss, global warming and the pollution of water, soils, and air. Remote sensing technologies, especially space-borne sensors offer a tremendous wellspring of information for concentrate understanding of earth's surface and its dynamics. It has been emerged as a powerful tool in deriving LULC information and its spatio-temporal distribution. However, LULC classification and information extraction from remote sensing images still remains a challenging task because of frequent cloud cover, heterogeneity of landscapes and varied climatic zone in countries like India. In the last few decades, the remote sensing technologies have evolved dramatically to include a series of sensors operating at a wide range of imaging scales with potential attention and significance to researchers. The aim of thesis presented here are: (1) to establish a robust classification process in improving LULC mapping accuracy by using multi-source remote sensing data (i.e. optical data, SAR backscatter) combined with textural information, (2) to investigate the

feasibility of dual-polarimetric SAR data at C-band for rice crop mapping, (3) to estimate the spatial variation in accuracy measures of remote sensing image classification, (4) to assess the changes in LULC using multi-temporal remote sensing images, and (5) to model, simulate and predict the changes in LULC over a period by applying an integrated approach of remote sensing, geographic information system and land change modeling tools.

The LULC classification using remote sensing data has drawn a lot of attention with the launch of Landsat series satellites in the 1970s. Several classification algorithms have been developed and utilized for LULC classification using multi-source remote sensing data. The selection of a classification algorithm is always vital for successful and accurate mapping of land surface features. In spite of many studies in the field of remote sensing image classification, another current research interest is the reasonable selection of suitable input variables, which may have the same importance as the selection of classifier. Textural features as supplementary information can be incorporated into image bands in improving LULC classification accuracy. The quality of thematic maps derived from remotely sensed data also needs to be studied and requires enhanced methods or tools for estimating and describing the spatial distribution of errors in complex landscape mapping. The timely, accurate, and reliable LULC information provided by remote sensing technologies can be applied efficiently to monitor and analyze the past and current trends as well as to predict future LULC scenario. The multi-source remote sensing images namely the Linear Imaging Self-Scanner-IV (LISS-IV), Linear Imaging Self-Scanner-III (LISS-III), Landsat 8-OLI (Operational Land Imager), Advanced Wide Field Sensor (AWiFS), Radar Imaging Satellite (RISAT-1) and Sentinel-1A SAR data were acquired covering Varanasi district of Uttar Pradesh, India. Also, multi-temporal remote sensing images of Landsat 5-Thematic Mapper

(TM), Landsat 7-Enhanced Thematic Mapper Plus, and Landsat 8-OLI (Operational Land Imager) were acquired over a period of 1988-2015 to study LULC changes. The thesis begins with a brief introduction and state of the art explaining current trends on classification and mapping of LULC using multi-source remote sensing images and approach.

In the first phase, the research work focusing on the incorporation of textural features into spectral/radiometric images for LULC classification is presented subsequently, followed by the comparison of different classification algorithms. The research work provides explicitly a comprehensive evaluation of textural features extracted from the multi-source remote sensing data to examine how the varying spatial resolutions of different sensor image affect the selection of the textural component. The results show the efficacy of incorporating textural features into spectral or radiometric images in improving the LULC classification accuracy than individual datasets. The ability of textural features in reducing speckles and inherent heterogeneity within the same LULC type makes it significant for improved LULC information extraction, especially in case of the SAR and high spatial resolution multispectral LISS IV data. The Support Vector Machine (SVM) was found to provide more reliable and realistic results in comparison to the Artificial Neural Network (ANN), Random Forest (RF), and Maximum Likelihood Classifier (MLC) algorithms for LULC classification of remote sensing images. However, the performances of ANN, RF, and MLC were also found useful. A study was also conducted to explore the feasibility of RISAT-1 SAR data at C-band in delineating rice crop fields from other land cover features using Decision Tree (DT) classifier. The performance of DT classifier was found reasonably good for mapping spatial distribution of rice crop area accurately. The results were further compared with

Landsat 8-OLI optical sensor-derived rice crop map and found very good spatial agreement between both the outputs.

In the second phase, a geographically weighted method was used in combination with logistic regression for producing and visualizing the spatial variation of remote sensing image classification accuracy. This work showed how the logistic regression can be applied to create the probabilities of User's Accuracy (UA), Producer's Accuracy (PA), and Overall Accuracy (OA). The geographically weighted extension to logistic regression generates spatial distributions describing the variation of these probabilities. The results demonstrated that the geographically weighted method could offer additional and valuable insights for examining the spatial variation in the measures of classification accuracies varied across geographical space.

In the third phase, an integrated approach of remote sensing images, geospatial analysis, and modeling, along with the assortment of socio-economic factors and environmental variables was employed to study the changes in LULC and predict the future scenario in Varanasi district of Uttar Pradesh, India. In the first part of this research work, the post-classification method was employed to assess the changes in LULC occurred between 2000 and 2014. A paired samples t-test was also performed to test whether the changes are statistically significant or not between study periods. In the second part, three Markov chain-based hybrid models namely Stochastic-Markov chain (ST-MC), Cellular automata-Markov chain (CA-MC) and Multi-layer perceptron-Markov chain (MLP-MC) were evaluated and compared to model the spatio-temporal changes in LULC between 1988 and 2015 and predict the future scenarios for 2030 and 2050. The t-test only states that the changes do not correspond to a significant quantity statistically, even though LULC changes occurred in

study periods. The outcomes of this research exhibited the overall constant increase of built up area and a considerable reduction in agricultural land. The results also show the potentiality of an integrated MLP-MC model for better understanding of spatio-temporal dynamics and predicting future scenario in Varanasi district of Uttar Pradesh, India. Therefore, the findings of this study might support the planners and decision-makers for sustainable management and development of this area.