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Monitoring land use changes in the Upper Ganga Basin, India by using Remote Sensing and GIS techniques on Landsat 5 TM data

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The Green Revolution represents one of the largest environmental changes in India over the last century. The Upper Ganga basin is experiencing rapid rates of change of land use and irrigation practices. In combination with exploitation of groundwater resources in the northern Indian plains, this causes variations in recharge and fundamentally affects surface and groundwater resources, threatening India's water supplies.
In this study, we have developed a methodology to map and investigate land-use change by applying Remote Sensing and Geographic Information Systems (GIS) techniques on 30m resolution multi-temporal Landsat 5 Thematic Mapper (TM) data for 1984, 1998 and 2010. Firstly, an automated protocol was applied to effectively correct the images for radiometric effects and remove atmospheric interference during the pre-processing analysis of satellite images. Afterwards, maximum likelihood supervised classifications were carried out on Landsat 5 TM colour composites of 1984, 1998 and 2010 with the aid of ground truth data. Post-classification change detection techniques were applied to Landsat images in order to map land cover changes in the Upper Ganga basin. Change vectors of NDVI and Tasseled Cap brightness, greenness and wetness of Landsat Thematic Mapper (TM) images are compared with those values from the initial date of imagery to detect change from no change. Ground truth information and historic images were used to assess the accuracy of the classification results. We find that most of the land-use change is conversion from forest and barren land to agricultural areas. Results indicate that between 1984 and 2010 agricultural areas have increased by more than 150% while forest areas decreased by 28%. The classification accuracy is also examined. Results confirm the importance of field-based accuracy assessment to identify problems in a land-use map and to improve area estimates for each class.
The results quantify the land cover change patterns in the Upper Ganga basin and demonstrate the potential of multi-temporal Landsat data to provide an accurate map and analyse changes in land use over time that can be an important input in regional land-use planning and management strategies.