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Estimating land use change and carbon release from tropical forests conversion using remote sensing technique

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Abstract. One of the main issues in global change is land use change. In the tropics it is usually associated with utilization of forest resources and the development of agricultural lands. Three different satellite images were used to compare their capabilities in identifying the vegetation types. Having different spatial, temporal and spectral resolutions the data obtained from NOAA, LANDSAT-MSS, and LANDSAT-TM, and SPOT images were used to show identifiable vegetation types.

Identification of land use change was based on the digitized False Color Composite derived from LANDSAT-TM 1992 data, which was compared with BIOTROP's vegetation map developed from LANDSAT-MSS and SPOT in 1986. The forest conversions during a 6-year period were identified in terms of new vegetation types and their area. It was indicated that out of 1.2 Mha of primary forests in Jambi Province, Sumatra 69.5% remain unchanged, 8.4% converted into secondary forests, 5.0% into agricultural lands and 0.3% into grassland. However, the remaining percentage was uncertain due to high cloudiness which could not be encompassed by the existing satellite sensors, hence no data were available.

From the global change point of view such conversions were evaluated in terms of carbon from each of new vegetation types. A more sensitive change was shown by lowland primary forest where expansion of agricultural lands is taking place. It was estimated that the region has released as much as 0.03 Gt C/year.

Key words. Forests conversion, satellite imageries, vegetation types, carbon release, Sumatra.

INTRODUCTION

Remote sensing techniques offer the potential of continuously viewing large segments of the earth's surface, thus documenting the changes that are occurring. There are various types of remote sensing products available, such as aerial photographs, multi-spectral satellite imageries and radar imageries. Each of these products provides advantages and disadvantages concerning their resolution, which can be applied through multi-stage sampling designs; i.e. using low resolution satellite data (NOAA, LANDSAT-MSS) at the first or global level and high resolution remote sensing data (LANDSAT-TM, SPOT, aerial photograph) at the second or local level. However, the task is not only to document global change but also to understand the significance of these changes to the biosphere.

There is an urgent need to be able to measure the biosphere function, as well as structure, remotely and continuously from satellite imageries. A thorough and quick evaluation must be made in order to keep up with such changes at a rate that a single generation can observe. This need was summarized at a meeting on 'Terrestrial Ecosystem and Atmospheric Interaction' organized by IGBP in Montpellier, France (IUBS, 1986) and then followed by the United States–Australia workshop on 'Remote Sensing of Biosphere Functioning', held in Honolulu, that aimed at reviewing the utilization of remote sensing techniques to assess globally the earth's changing structural and functional properties (Hobbs & Mooney, 1986).

The use of remote sensing techniques to study land use change and the related greenhouse gases emissions is so minimal that this objective means may be explored to scrutinize difficult remote sensing targets such as tropical forests, although the advancement of coupling satellite data with forest ecosystem models has been of great scientific interest in forestry science and ecology (Running, 1986). Rates of deforestation are so rapid and uncertain due to variations in inventory results having different objectives and methods. Therefore, satellite data which give quick assessments of greenleaf biomass or Normalized Difference Vegetation Index (NDVI) (Tucker, 1979), mean