



Tree cover and forest cover dynamics in the Mekong Basin from 2001 to 2011



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ABSTRACT

The Mekong Basin spanning large parts of continental Southeast Asia is endowed with rich natural resources that are increasingly under pressure as a result of rapid socio-economic development over the last decades. Particularly the forests in the region are threatened by large-scale infrastructure developments, the expansion of agriculture and trading of timber products. In view of these developments, this study provides an updated view of the current state of the forest resources in the region and the change they have undergone throughout the last decade. Annual maps of percent tree cover, herbaceous cover, and barren land for the years 2001–2011 were derived from 500 m MODIS data, and formed the basis for a tree cover specific identification of changes utilising long-term statistics on inter-annual prediction variability. Furthermore, the temporal patterns shown in the tree cover history of each pixel for the observation period, allowed a differentiation to be made between permanent forest cover conversions and temporary forest losses, as well as between areas of abrupt and more gradual forest dynamics. Average gross forest loss for the Lower Mekong Basin was estimated at a rate of 0.4% per year. When considering permanent forest losses only, the highest annual loss rates were evident for Vietnamese Basin area (1.1%), followed by the respective national areas of Cambodia (0.7%), Laos (0.4%), and Thailand (0.2%). Extensive areas of forests and forest regrowth within Laos and Vietnam have been affected by temporal losses that have been mostly attributed to shifting-cultivation practices and the conversion of natural forests to forest plantations. Furthermore, it could be shown that temporal patterns of change may possibly reveal information about the underlying causes of forest cover reduction. Forest clearance related to large-scale mechanised clear cutting, e.g. by the agroindustry, generally showed very abrupt decreases in canopy cover, while forest losses related to small-scale agricultural clearings or more selective logging where characterised by more gradual decreases.

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1. Introduction

The Mekong Basin spanning large parts of continental Southeast Asia (see Fig. 1) is endowed with rich natural resources and is one of the most biologically diverse areas on earth (Myers, Mittermeyer, Mittermeyer, Da Fonseca, & Kent, 2000; Sodhi, Koh, Brook, & Ng, 2004). Rapid socio-economic development over the last decades, however, has led to increased pressure on the region's ecosystems. The continuously growing population, the transition from subsistence farming to more industry-driven economies, and the increase of international and transboundary trade have serious effects on the extent and condition of the basins natural vegetation cover. Furthermore, large-scale infrastructure projects and a series of hydropower projects along the Mekong main stem currently under development will in the long-

term have serious transboundary impacts on water flow, sedimentation, and land use in the area (Kuenzer et al., 2013). Particularly the forests of Southeast Asia, which belong to most valuable and productive tropical forests in the world, are rapidly decreasing and subjected to environmental degradation. In the last ten years, the forests of South and Southeast Asia were estimated to have decreased at an annual rate of 0.2%, whereby Laos and Cambodia together constituting approximately 60% of the lower Mekong Basin, have shown annual loss rates of 0.5% and 1.3% (FAO, 2010). Respectively, these numbers are nearly four and ten times higher than the global average bringing, Cambodia into the world's top 20 nations in terms of deforestation rates.

However, it is particularly in the two less developed riparian countries, Laos and Cambodia that forests support the rural livelihoods of millions of people and provide crucial habitats for flora and fauna. In Laos, for example, over 85% of the population are estimated to be highly dependent on forest products for food, fuel and cash income (MRC, 2003). Furthermore, forests provide a broad range of indirect ecosystem services, such as contributing to watershed protection and soil conservation (Vo, Kuenzer, Vo, Moder, & Oppelt, 2012). Similarly, forests

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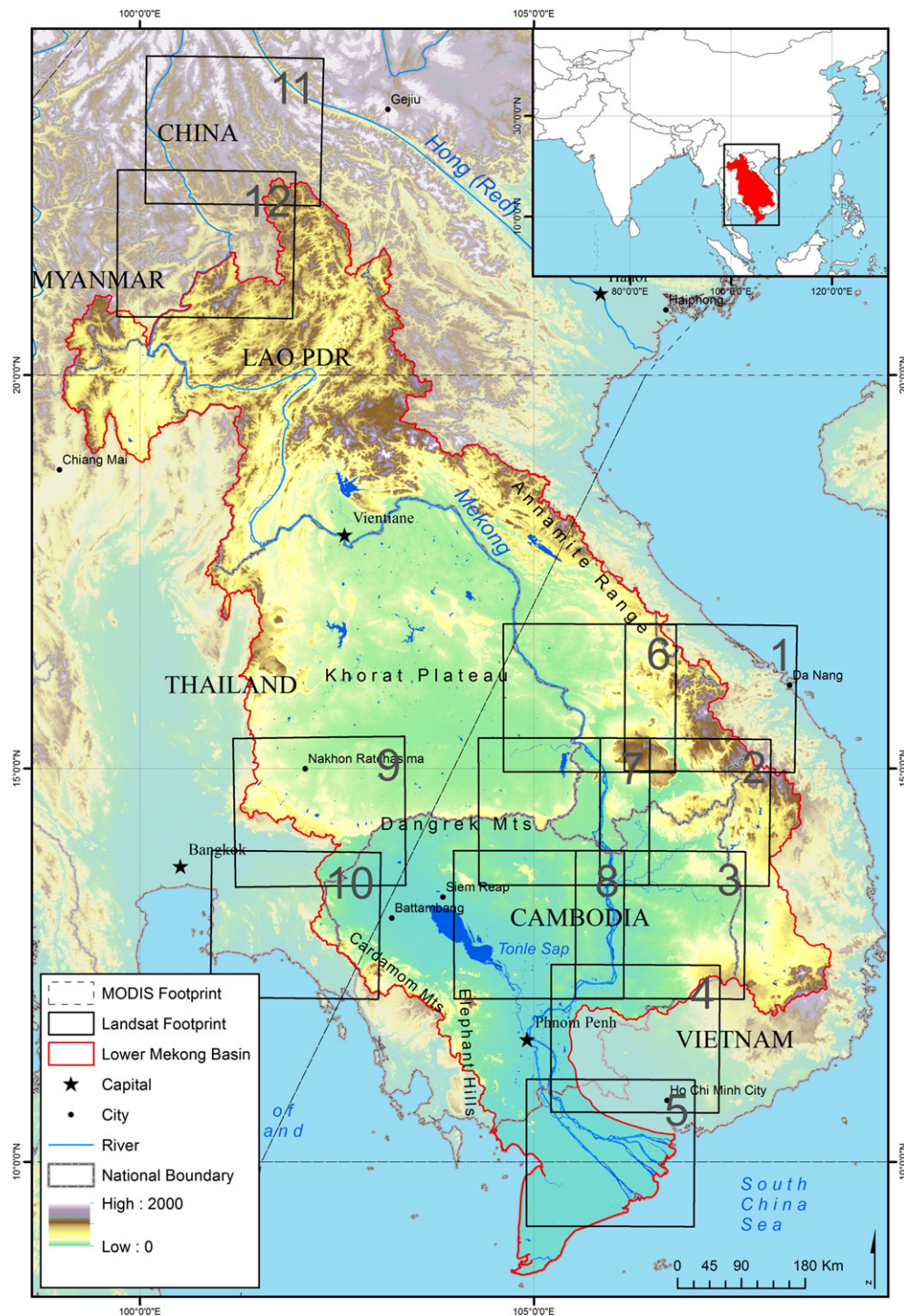


Fig. 1. Study area and data used. For Landsat indices see Table 1.

provide climatic regulating services such as carbon storage, or water and energy exchange with the atmosphere (Achard, Eva, Stibig, Mayaux, Gallego, & Richards, 2002; Hansen & DeFries, 2004). In view of this, regionally consistent and up-to-date information on the spatial distribution of forests and their dynamics is crucial to the understanding and prediction of likely consequences of continuous forest losses for the environment, the climate, and affected livelihoods.

At regional to global scale, the characterisation of the land surface is up to recently provided by remote sensing products derived from moderate to low-resolution sensors (250 m–1 km). Due to the high temporal resolution of these sensors, a spatially continuous, cloud free,

and consistent coverage can be ensured within relatively short time spans. This makes them especially favourable for cloud prone areas. On the other hand, however, when using moderate to low-resolution sensors for heterogeneous and complex land cover systems mixed pixels may emerge, where multiple land cover types occur within the extent of the sensor's projected instantaneous field of view. It has been shown that assigning mixed pixels to a specific single type of land cover, results of inferior mapping performance are being obtained (Fernandes et al., 2004; Foody, Lucas, Curran, & Honzak, 1997; Friedl et al., 2000; Leinenkugel, Kuenzer, Oppelt, & Dech, 2013). As a consequence, uncertainty levels of traditional land cover maps with nominal

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