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Land-use change detection using characterizing temporal vegetation dynamics in Java Island, Indonesia

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Land-use and land-cover change is recognized as one of major drivers of global environmental change through its interaction with climate, ecosystem processes, biogeochemical cycle, biodiversity and human activities. Improving the understanding of land-use and land-cover change is a major research challenge for the human-environmental sciences and is essential for many aspects of global environmental research.

Monitoring land surfaces in both space and time, at appropriate seasonal and inter-annual scales, allows characterization of temporal vegetation dynamics, and it leads to a broader view of land-use and land-cover change. In tropical regions, e.g. Java Island, agricultural lands might undergo a sequence of covers through the year, where the sequence is repeated year after year following the seasons. They are eventually describing the characteristic of the lands which could be reflected by variation of the vegetation attributes, either the vegetation index (VI) or leaf area index (LAI). In that example, attributes of the land surface are: vegetated, bareland, and inundated, which is defined as land-cover. On the other hand, land-use type in which describes the purpose of land is the paddy-rice field.

The study explored the use of multi temporal MODIS product, MOD13Q1, 16-day composite data from 2001 to 2007. Even if, an issue about the availability of sufficient quality of data sets had been arising out of the time-series analysis of MODIS data, but wavelet function application was successful to decompose and de-noise the vegetation index profiles, so that the planting, heading and harvesting dates of some land covers can be obtained.

The characterizing land surface in this study based on available imagery which was not necessarily coincident with temporarily land-cover when employ a single date image. Temporal vegetation dynamics would provide sufficient information of the use of land; meanwhile the single date image interpretation is not sufficient to identify the actual land-use change type because of insufficient change event documentation.

We identified many significant changed patterns during 7 years, and then discriminated into several types. Hereafter, those significant patterns are defined as a land-use change. The temporal pattern analysis was able to detect the actual timing of change event, either by conversion of land-use or vegetation growth; however, such outstanding capability of the method in this research was limited due to mixtures of land covers in MODIS data of which spatial dimension are 250m by 250m.

The results showed the need to evaluate effectiveness of the method in several sites where changed pattern were detected, but actually land uses have not changed, e.g. the changed pattern in paddy-rice fields. In that case, the cropping system changed, from triple cropping system to double cropping system, and delaying of seedling stage have caused the change of the temporal patterns and identified as a land-use change.

The land-use change in Java was successfully detected by temporal pattern analysis; nevertheless, the results were still included the temporary changes of phenology phenomena, particularly as an impact of the long-term dry season. However, the calculation of land-use change excluded the trajectories of phenology could increase the accuracy of results. The result showed the rate of the land-use change in Java about 3467.11 ha per year. The next stage of research, we will perform a field survey with more attention to the kind of social-economic aspects and the mechanism of those changes.

The understanding of the important transition rules of land-use change will assist further research in understanding the dominant process of land-use change allocation and to take it into consideration when land-use change models are made.

Keywords: land-use change, temporal vegetation dynamics, MODIS, wavelet transform, Java Island, Indonesia