Assessing Land Use of Lower Mekong Basin using Multi-temporal MODIS Imagery

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Abstract **:** Among rice producing regions of the world, Lower Mekong Basin (LMB) can be ranked as the most important region due to the huge population it feeds. About 60 million people are engaged in agriculture and freshwater fishing activates in LMB where produce enough food for over 300 million people annually. Food consumption in LMB is also increasing and studies have found it to be doubled by 2050. This socio-economic background has attracted many researchers to work on various aspects of the LMB. To collaborate with these research interests, the present study is designed to assess the land use conditions of the massive LMB, using multitemporal MODIS imagery. The authors have previously produced the land cover map of LMB in 2005 (edited in 2008) using MODIS data at 250m spatial resolution. The present land use assessment will be used the old map and a new map produced in 2014 using the same land cover classification. The investigation on land use conditions is based on the trends on land cover changes, with a focus on food production aspects of the basin, in order to supply a GIS database for food production assessment studies. Annual devastating floods in south and frequent droughts in central regions are also counted in the assessment. The expected results of the study will be GIS data layers of the basin in raster format comprising old and new land cover data, natural disaster hotspots, together with an assessment of the land use.

Keywords **:** Lower Mekong Basin, land cover maps, land use assessment, rice cultivation, food production

1. Introduction

Mekong river basin stretches from central-west China to Vietnam covering 805,604 km² of area. Well over 60 million of predominantly farming population² is living in the Lower Mekong Basin (LMB) (figure 1), which covers about 795,000 km² of land. Regardless to the natural disaster threats, the LMB is renowned for its rice based 6,000 years old agricultural civilization[9]. Today, rice production in LMB makes the region the global leader. Yet, the total rice export compare to the production is only 6.78%, due to the high local consumption[2]. A significant portion of LMB is belongs Thailand and Vietnam, the top exporters of the rice in the world. Rice fields are the key entry point to evaluate land use of LMB, apart from the importance in flood mitigation, soil erosion control, and fisheries. The prolong drought occurred in Australia in 2006 and the increase of world oil prices have shaken the stability of rice prices in recent years. This study uses two land cover maps produced in 2008 and 2014 to assess the trends in land use of the basin, particularly, the heavily population Mekong delta region. Free availability, suitable spatial resolution for large areas, and excellent temporal resolution are some of the advantages in application of MODIS imagery in this study[7].

Figure 1. The Lower Mekong Basin.

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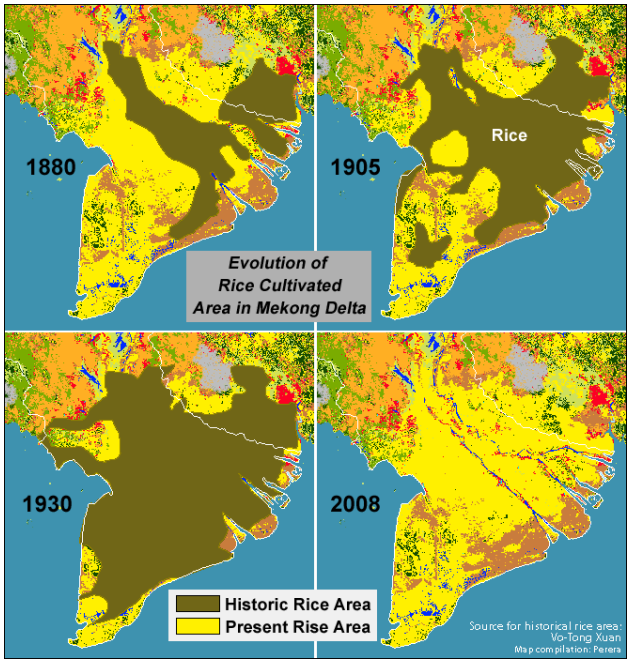

Figure 2. Evolution of Rice Area from 1880 to today.

2. Population, land pressure, and food

Thousands of years old traditional agricultural practices throughout the world have dramatically changed in last 100 years due to the population increase and technological, political, social, economic, and environmental changes. With a massive estimated population between 75 to 90 million by 2025, LMB is facing numerous challenges to maintain its biodiversity while feeding its huge population[3]. The increase of the population of the river basin has expanded the rice growing area dramatically, especially in Thailand and Vietnam Mekong[4]. The figure 2 shows the evolution of the rice area of the Mekong delta from 1880 to present day[9]. Many studies have found a positive relation between the increase of agricultural production and the reduction of poverty in the region. However, about 20% of the population in LMB is still living below the poverty line. The many environmental changes including dam construction, strong chemical and high use of fertilizer for crops, and other profit oriented farming practices have degraded the land resource in LMB in recent years. While environmental changes are threatening to food production security, annual occurrences floods are further hampering the life, environment, and infrastructures. Under this context, alterations in land use are inevitable in LMB.

3. Land cover and land use

As NOAA[6] (2014) documented, *land cover* comprise of a region covered by forests, wetlands, impervious surfaces, agriculture, and other land and water (wetland/open water) types. *Land use* shows how people use the landscape – whether for agriculture, development, conservation, or mixed uses. The different types of land cover can be managed or used quite differently. Satellite images can be used to produce land cover maps, but land use maps need to be based on findings of land cover analysis. Furthermore, land cover maps can be produced specifically to support land use assessments, the objective that this study is also carrying. The LMB land cover map was produced under separate project in previous years and published in international conferences and in a journal[5]. The map at 250m resolution is based on 2005 to 2008 MODIS images and high resolution images for ground truth data (figure 3). The production steps are not discussed in this paper in details. Flood data derived from Dartmouth flood observatory[1] have overlapped on the land cover map to identify potential high risk area in the land use assessment.

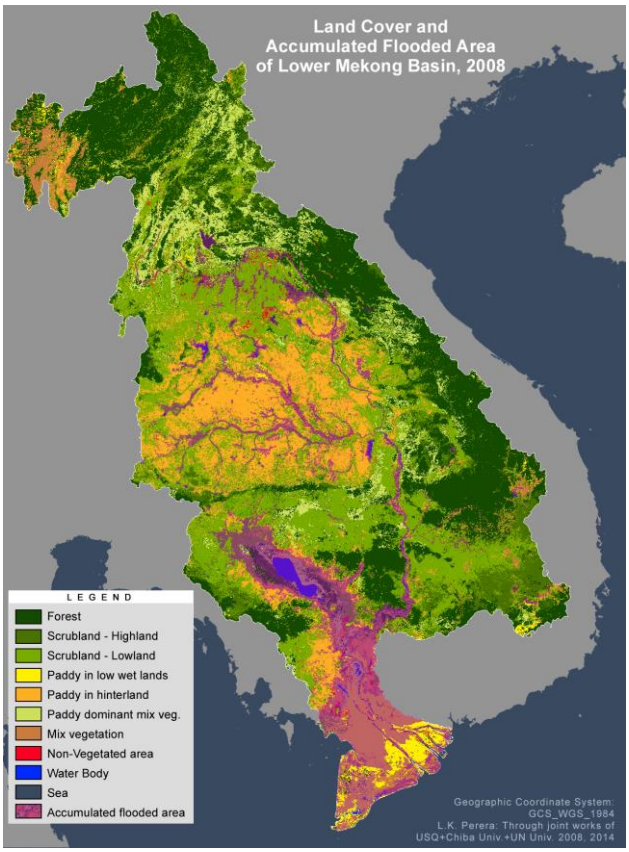

Figure 3. Land cover map of 2008.

4. Land use assessment

The biggest challenge faces in LMB is how to expand agricultural lands to increase the crop production. When the land pressure is severe, people start to shift land use activities. However, any significant land use change at large scale is directly link to the environmental sustainability at local level, and instability in global biodiversity (UNEP, 2014[7]). The construction of 2014 land cover map of LMB is vital to conduct the land use assessment with the consideration of last 6 to 10 years. One crucial challenge to develop map is the near-perennial cloud cover, which partly hampered the data collection process for 2014. Though the full map is not completed, the preliminary classification of Mekong delta region revealed some significant changes in land use. Figure 4 shows the Mekong Delta in 2008 and 2014 together with Google high resolution images showing two dominant land use types. Mekong Delta is predominantly covered by rice farming. Latest lad cover map suggested some of the traditional practices of rice cultivation are shifting to other income activities, due to climatic and market trends. Few prominent spatial changes in land use are marked by C1 (expansion of wet paddy), and C2 (expansion of rice + aquaculture) in figure 4. A significant expansion of wet rice area (C1) and rice + aquaculture dominant by shrimp farming area (C2) is visible. Shrimp farming is one of the leading income sources in the Delta. In last 10 years, shrimp prices have gone up by nearly 200% in world market[8]. The changing market of agricultural products (rice, shrimp, and etc.) as well as climatic impacts is behind the shifting land use practices from one to another. The entire Mekong delta suffers frequent floods (figure 3) as well as droughts in central region. Through the next steps of this study, land use assessment of a larger area from the LMB will be conducted. Investigation will extend to map land use changes and identify reasons behind such changes, especially around the lower region of LMB.

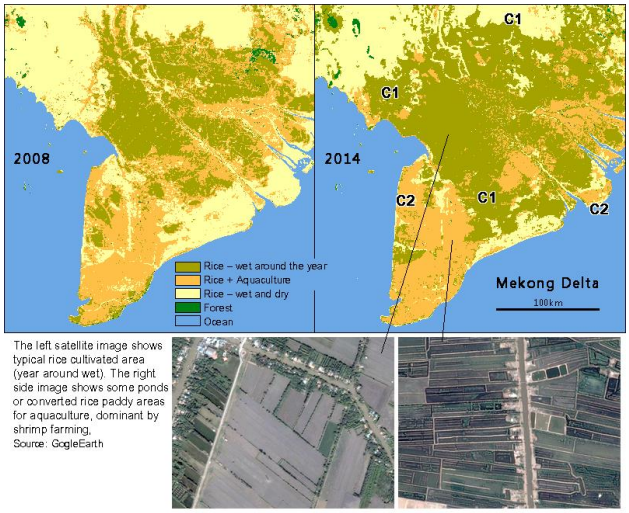

Figure 4. Changes in land use changes in Mekong Delta

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