

**THE POTENTIAL IMPACTS OF TROPICAL PEATLAND  
FORESTS CONVERSION TO AGRICULTURE PRACTICES ON  
LOWLAND AREAS**

Case study: Siak River Basin, Riau, Sumatra Forest

NURHAMIDAH

1731611006

Promoter

- : 1. Prof. Dr. Ir. Bujang Rusman, MS.  
2. Prof. Dr. Ir. Bambang Istijono, ME.  
3. Prof. Dr. Abdul Hakam, MT.

Dissertation

As one of the requirements to obtain a doctoral degree in Agricultural Science  
postgraduate program at University of Andalas

**FACULTY OF AGRICULTURE  
UNIVERSITY OF ANDALAS**

2019

## SUMMARY

Change in lowland areas has more significant impacts when a combination of several issues such as; land conversion, land subsidence, lowland reclamation, and sea level rise threaten at the same time. The hazard will be exacerbated when the development of lowland areas and reclamation are doing without considering the impacts on the hydrological system and the environment. As a consequence, the life of habitats in lowlands are threatened. Other consequence, deforestation tends to change the character of the watershed. Swamp areas cannot be functioned as natural storage since the forests have been reclaimed to the less controlled process of agriculture, plantation and other land use.

In Indonesia, nowadays less than 3% of the remaining forest is protected; the rest is available for logging and conversion to other land uses. Over 93% of the remaining swamp forests in Sumatra had been profoundly degraded. Initially, Sumatra was covered by tropical rainforests, and approximately 40% of these rainforests grew up at lowland forests. Before reclamations, Middle Sumatra was covered by nearly 80% forest, 50% of which was peat forests and most of them were located in downstream areas. In this area, conversion of forest into agriculture practices and palm plantations have strongly influenced the natural hydrological processes on this lowland. The large area of peat swamp forests has disappeared due to either legally or illegally logging, drainage, forest conversion to the agriculture practices, fire, deforestation or large-scale developments for residential centers and industries. Change the land use to agriculture dramatically changes the characteristics of the peat substrate. Once drained, peat is highly flammable, and the fires can burn for month challenging to extinguish. The peat forest change to agriculture practices and other land use supposed to create short or long term consequences. One of the consequences is surface degradation (land subsidence) due to the oxidation process.

A case of land subsidence is necessarily the integrated surface expression of whatever processes may be active at that site, whether natural or manmade or both. A working hypothesis as to the mechanism or combination of mechanisms

operative at the specific site is requisite for designing control measures. The complexity of subsidence mechanisms and their interaction requires a cooperative effort among different disciplines, both in collecting physical evidence and in developing the rationale for the processes involved. The hydrologic sciences have been and will continue to be, significant contributors to land subsidence investigations.

A set of field measurements has been conducted using Hobo loggers. The measurement aimed at collecting data about the groundwater level and the soil temperature. The data was gathered within one and half year. The measurements were carried out on two conditions: during dry and wet periods.

The state-of-the-art in land-subsidence analysis progresses unevenly because the degree of understanding of various subsidence mechanisms varies. The most study has been directed to subsidence related to man's engineering activities. This is facilitated by the availability of data on quantities of subsurface material removed (or injected), on rates and duration of extraction operations, and on changes in ground-water levels. Natural processes are not as easily quantified.

There is no such correlation between rainfall and river discharge; the water level moreover increases due to tide propagation. The situation is getting worse in places since the land subsidence is found. It has been analysed higher temperature due to climate change and lowering groundwater table have strongly affected the oxidation process on the peat layer. Thereby in Sumatra lowland, flood occurrences are not only due to combination rainfall and spring tides like in many lowland areas but also due to land subsidence that has been reaching up.

The difference of the model to other approaches into the measurement of land subsidence rate, this model adapts to the characteristics of the soil, the different temperature and the groundwater level over time as three additional factors that strongly affect to the rate of subsidence. The rate of subsidence using field observation and linear reservoir empirical model in Sumatra varies from 2 to 13 cm per year due to the oxidation processes.

As the tertiary impact, Pekanbaru has many points of potential prone to flooding. The potential flood areas are generally located in agriculture areas, densely populated areas, public service areas, and the main road in the city of Pekanbaru. It needs an immediate response to anticipating the more significant risk of flooding in the city of Pekanbaru by the improvement of the urban drainage system. The more accurate prediction takes some additional parameters that affect the occurrence of flooding or surface runoff, such as the effect of tides and drainage, and river flow data. The utilization of green areas of land needs to be done to reduce the occurrence of an increase in runoff coefficient.

An integrated and holistic approach is necessary to find out the solutions for land and water management problems. Based on the analysis, it can be suggested that the minimum requirement for the water level of agriculture practices are not lower than 20 cm. Besides, regional land and water Management plan should be developed, taking into account in an integrated way. The implementation of strategies, or separate measures, should focus on priorities for areas most frequently affected. On the short term, effective and low-cost measures should be implemented, such as law enforcement regarding the conversion of forests. In addition, planning of mid and long-term measures should commence on short notice. On the midterm, the larger scale and sustainable measures should be implemented. Finally, involving stakeholders and the local communities in the affected areas in planning, development, and implementation of strategies and measures is of utmost importance.

