

Institutional Design to Prevent Environmental Degradation caused by Biomass Utilization and Hydrological Change

Key words : Peat Land, Greenhouse Gas, Biomass Utilization, Peat Land Fire

1. Research background

In order to prevent environmental destruction related with biomass usage and hydrological changes in the world, an international institutional approach is essential. Water is necessary for all living organisms and access to a good water source is vital to people's lives wherever they live. The tropical forests of Indonesia represent one of the most biologically diverse regions on Earth, as well as a significant terrestrial reservoir for atmospheric carbon. Since 1990, in Indonesia, about 24% of the total forest area and 31% of the primary forest has been cleared, and plantation area increased from 2.2 million to 3.4 million hectares over the past 15 years (Food and Agriculture Organization). The World Wildlife Fund reported that the fastest rate of deforestation in Indonesia is occurring in central Sumatra's Riau Province, where some 4.2 million hectares (65%) of its tropical forests and peat swamps have been cleared for industrial plantations in the past 25 years (WWF 2009). The major causes of deforestation include illegal logging and conversion of primary forest to logging concessions and oil palm plantations. I have continued hydro-meteorological observation in order to contribute to environmental improvement in the target areas since March 2013.

2. Research purpose and aim

I visited the Disaster management research center, University of Riau, at Pekanbaru seven times, and I made research arrangements with Dr. Haris Gunawan of the head of Disaster management research center at the University of Riau to discuss the impact of land use change from natural forest to artificial forest on the surrounding environment. Then, I and Dr. Haris Gunawan moved to the Giam Siak Kecil-Bukit Batu UNESCO-MAB Biosphere Reserve, which is located in the north part of Riau Province and conducted a field survey and observations of greenhouse gas emissions from the peat land. I measured heat and water flux with the Bowen ratio method and CO₂ density using the chamber method to estimate CO₂ emissions. The data gathered in this manner will be used as the basis for a system to reduce CO₂ emissions from peat land. We built an experimental research site by building five rewetting dams in a drained peatland area to clarify the effect of rewetting and reforestation using native tree species.

3. Results and achievements by fieldwork

Peat land is distributed over the Riau province, and its area is 4 million hectares which is equal to approximately 10% of world peat land. The peat land is located around the east side coast of Riau province which is the estuary of two rivers flowing from the mountainous part of this province. Until just approximately 30 years ago, this whole area was covered by peat swamp forest, and the people have mixed occupations based on agriculture, forestry and fishery under the unique hydrological environment. However, acacia plantation is enlarged to the peat swamp forest because the production of wood biomass has high priority now. So much water was drained from peat land, and this area was varied from "water forest" to "land".

After around 2000, wild fires were reported frequently, and illegal oil palm plantation was established by local people. There are two dry and wet seasons in a year in Riau province because this area is located on in the

equatorial zone. The seasonal variation in rainfall in Sumatra can be explained by the intertropical convergence zone (ITCZ), a belt of low pressure that forms in the atmospheric circulation in the region of the equator. Because a lot of wild fires in the peat land occurred in June, 2013, February and June 2014, I analyzed the association with the meteorological condition.

Tanjung Leban village, which is located on the north part of Giam Siak Kecil-Bukit Batu UNESCO-MAB Biosphere Reserve, had experienced the fire once or twice every ten years until 1990s, but the frequency of the fire suddenly increased and the fire to cause damage to farm products occurred almost every year after 2000 when agriculture development progressed. Total 4,500 ha rubber and oil palm plantation were destroyed by fire that occurred in February, 2014.

4. Implications and impact on future research

During my stay in Indonesia, I visited the Disaster management research center, University of Riau and observed the degraded peat land caused by drainage and wild fires in Riau Province. I mainly discussed the issue of scientific collaboration and research including the wetland conservation in Indonesia with local researchers at the Research Center for Limnology - Indonesian Institute of Sciences. In Indonesia, it is not common that researchers participate directly in domestic environment-related issues. The same lack of participation of researchers in national environmental policy exists in Japan. However, I am getting the cooperation from University of Riau about the environmental problem of peat degradation caused by wild fire. In view of this fact, the roles of researchers and Universities are changing in Indonesia.

Large-scale land use and land cover changes could lead to irreversible changes on not only local environment but global climate. In particular, the many islands of Indonesia and their shallow surrounding seas constitute a large-scale environment that is neither purely oceanic nor purely terrestrial. This unique environment has been termed the Maritime Continent. The Maritime Continent lies at the heart of the Indo-Pacific Warm Pool, whose strong convective heating plays a dominant role in driving the atmospheric circulation over the entire tropical Indian and Pacific Oceans and has a significant influence on extratropical circulation. In this complex geospheric system, the state of the terrestrial surface is critical in maintaining the environmental sustainability in the region. I have started multi-disciplinary research including atmospheric, hydrological and carbon cycle



Fig. 1 Simple dam constructed at the experimental site



Fig. 2 Soil moisture monitoring at degraded peat land



Fig.3 Meteorological Observation and Tree Planting at the experimental research site