Advancement of East Asia Forest Dynamics Plots Network -Monitoring forest carbon cycling for the development of climate change adaptation- （Abstract of the Final Report）

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Total Budget for FY2009-FY2013 96,770,000Yen
（**FY2013**; 17,107,000Yen)

Key Words Forest Ecosystem, Carbon Dynamics, Boreal Forests, Tropical Forests, Plots Network

1. Introduction

Recent evidence of global warming has raised awareness of the importance of mitigation practices to reduce or avoid the threats of climate change. Curbing deforestation is a highly cost-effective way of reducing greenhouse gas emissions (IPCC 2007). However, our knowledge of forest carbon dynamics and the impact of climate change are still insufficient.

Long-term monitoring of forest dynamics can help us to estimate changes in forest carbon stocks more accurately. Networking of monitoring plots provides opportunities for global comparisons and the synthesis of researches that could not be accomplished with individual plots (Losos and Leigh 2004). In FY2009, Japan's Forestry and Forest Products Research Institute (FFPRI) established a new network of forest dynamics plots, the East Asia Forest Dynamics Plots Network (EA-FDPN), with funding from the Japanese Ministry of the Environment. This first year report outlines the EA-FDPN.

2. Research Objective

The aims of the EA-FDPN are:

- to develop a sustainable, long-term forest monitoring network in East Asia
- to assemble current and recent data on forest structure, biomass, and dynamics of local climatic and soil conditions
- to explore how changes in climate may affect forest biomass and productivity on the broad scale of East Asia.

3. Research Methods

(1) Monitoring plots

In last few decades, FFPRI has set up large-scale and long-term research plots for monitoring forest dynamics in Japan and East Asia in collaboration with many foreign research institutes and universities. In 2009, FFPRI created the EA-FDPN, which covers forests from Siberia to the Equator. The EA-FDPN encompasses four forest types: boreal forest (Tura), tropical dry forest (Mae Klong), tropical rain forests (Semangkok, Pasoh, and Bukit Soeharto), and tropical swamp forests (Lam Se Buy and Ranong) (Fig. 1). Because FFPRI already has a network and database of long-term monitoring plots under temperate forest ecosystems in Japan (the Forest Dynamics Data Base: http://fddb.ffpri-108.affrc.go.jp/en/index.html), the EA-FDPN currently excludes temperate deciduous and evergreen broad-leaved forests.

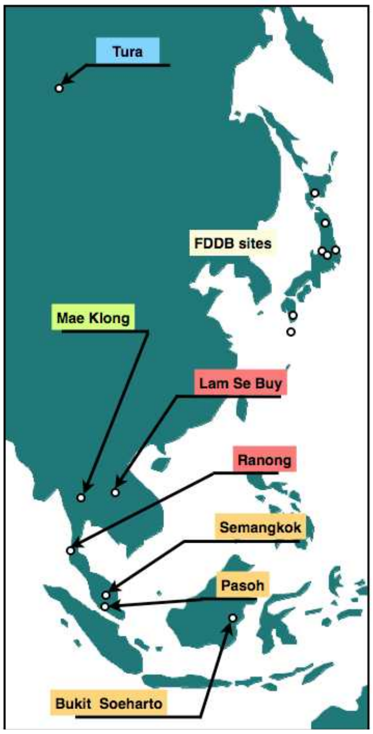

Fig. 1 Map of research sites in EA-FDPN

(2) Monitoring of carbon dynamics

The EA-FDPN data will allow us to estimate carbon pools in East Asian forest ecosystems more precisely. Analysis of data on five carbon pools within a broad range of forest types will give us new insights into both spatial and temporal variations in carbon pools under different climatic and site conditions.

From FY2009 to FY2013, we focus estimation of aboveground biomass (AGB), all five carbon pools and aboveground net primary production (ANPP) with reference to disturbances (i.e. selective logging, forest fire and tsunami impact) in the monitoring plots.

4. Results and Discussion

(1) Monitoring plots

The EA-FDPN comprises seven long-term monitoring plots (Fig. 1), in which continuous tree censuses have been conducted. The Tura plot is the only plot in the boreal zone. It is dominated by *Larix gmelinii* growing on permafrost soil in central Siberia. The Mae Klong plot is a mixed deciduous forest with a dense understory of bamboo. Under its seasonally dry climate, fire is a major disturbance. The Semangkok plot is a typical hill dipterocarp forest dominated by *Shorea curtisii* on the Malay Peninsula. The Pasoh plot is another type of dipterocarp forest, located in a lowland area. During the International Biological Program, part of the Pasoh plot was clear-cut for aboveground biomass estimation. All three plots were established in the early 1990s for continuous monitoring of forest dynamics. In Bukit Soeharto, two big fires were recorded under the effect of strong ENSO events, in 1982–83 and 1997–98. Because disturbance intensities (including fire and logging) vary within the catchment, 9-ha plot was set up in 1997. Long-term monitoring data will help us to understand spatial and temporal variations in carbon pools with fire disturbances. Tropical swamp forest is represented by riparian forest at Lam Se Buy and mangrove forest at Ranong. At Lam Se Buy, wide fluctuations in water level support fish traps within the plot; the plot thus offers a unique opportunity to study the interaction of forests and local people. Because the tsunami created by the 2004 Indian Ocean earthquake struck the research plot, Ranong also offers a unique opportunity to evaluate the recovery of stand structure and productivity after a disturbance.

(2) Comparison in Aboveground biomass (AGB)

AGB varied among the monitoring plots and showed general tendency of decrease in their values toward high latitudes. High AGB values, ranging from 400 to 500 Mg ha^{-1}, were estimated in tropical rain forest ecosystems (e.g. Pasoh and Semangkok). On the other hand, forest ecosystems with periodically dry or water-logging environments showed relatively low AGB values.

In Pasoh, aboveground biomass (AGB) and belowground biomass (BGB) showed similar time trends between 1994 and 2012. AGB increased gradually from 2004, and showed around 435 Mg ha^{-1} in 2012. As compared with Pasoh, Mae Klong, typical dry forest in Thailand, showed relatively small amount of biomass: 126 Mg ha^{-1} for AGB in 2012. During the measurement period (1992-2012), AGB in Mae Klong were rather stable in spite of several fire disturbances.

Disturbance agents (e.g. fire and tunami impact) would play an important role in AGB fluctuations. Bukit Soeharto, one of the tropical rain forest plots in our network, had suffered fire disturbances in 1982-83 and 1998 during severe droughts attributed to strong El Niño Southern Oscillation (ENSO) events. In 1997, selective logging using the conventional method had been operated on a 9-ha plot. Since 2000, we have monitored annual fluctuations in aboveground biomass on that plot to evaluate the effect of disturbance intensity on the recovery process. While the primary species (e.g., *Dipterocarp* spp.) were dominated in lightly-disturbed stands (i.e., a forest not subject to logging operation), pioneer species (e.g. *Macaranga gigantea* and *Euodia alba*) comprised a majority of biomass in a highly-disturbed stands. After 15 years of logging operation, aboveground biomass in the forest subject to high disturbance had only reached 20% of that in the forest subject to low disturbance. Moreover, a number of tree species disappeared during the monitoring period (2000-2010). These results suggest that fire and logging disturbances facilitate many of the changes in stand structure (i.e., number of stems, species composition), and that relatively low biomass conditions would last longer after a severe disturbance.

(3) Cross-site comparison of five carbon pools

Tree biomass (aboveground plus belowground) in each plot was estimated using the latest tree census data. Soil carbon in each plot was cumulative stock in the 0- to 30-cm depth range. The carbon stock values from the five carbon pools varied across the monitoring plots (Fig. 2). High carbon stocks, which were more than 300 Mg-C/ha, were estimated in Semangkok and Pasoh. Both plots were similar in composition in carbon pools: more than 60% of carbon stocks retain within aboveground biomass. In Semangkok, large size class trees of *Shorea curtisii*, dominated especially on the ridge, contributed to high aboveground biomass. In Mae Klong, the soil carbon pool contained about 37% of the total carbon stock. Dead wood stocks showed small values (i.e. 3% of total carbon pools) due to low tree biomass and frequent fire disturbances. On the other hand, the impact of severe fires and subsequent drought caused relatively high dead wood stock and low aboveground biomass in Bukit Soeharto. These data will help us to understand spatial and temporal variations in carbon pools with disturbances.

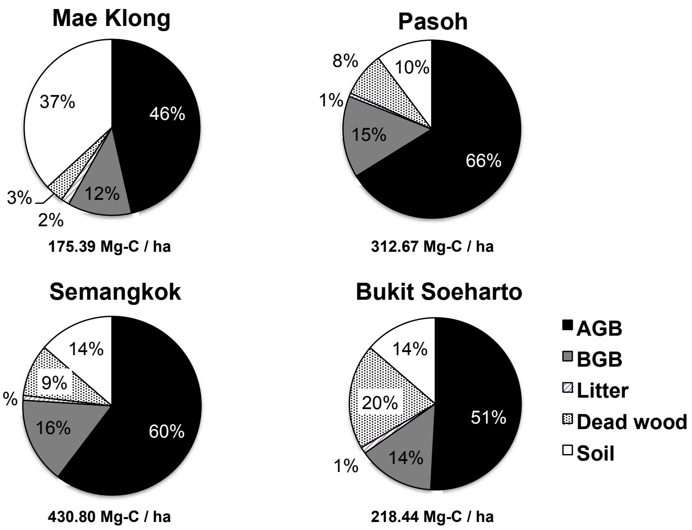

Fig. 2 Cross-site comparison of five carbon pools in tropical forests

(4) Monitoring of carbon dynamics

The ANPP values also varied across the monitoring plots and showed a general tendency of decrease toward high latitudes. High ANPP values, ranging from 7 to 26 Mg-C ha^{-1} year-^{1}, were estimated in tropical rain forests and tropical swamp forests (Fig. 3). Disturbance agents would play an important role in ANPP fluctuations. In Ranong, the impact of the tsunami caused by the 2004 earthquake and subsequent recovery caused large fluctuations in the ANPP.

The data from across the East Asian forests will allow us to comprehensively compare the climate change responses of different forest types. We hope that our findings will help explain forest diversity and productivity in East Asian forest ecosystems in the near future. Further studies and information sharing will provide great opportunities for broad-scale comparisons that could not be accomplished by studying any individual plot.

(5) Data sharing for long-term monitoring data

After reviewing data sharing and their policies on established networks of the world (e.g., SIGEO and RAINFOR), we designed an original homepage for the EA-FDPN. The EA-FDPN homepage has been operating through the FFPRI website since June 2010 (URL: http://www.ffpri.affrc.go.jp/labs/EA-FDPN/). The research plot information and some tree census data sets are available on our project website.

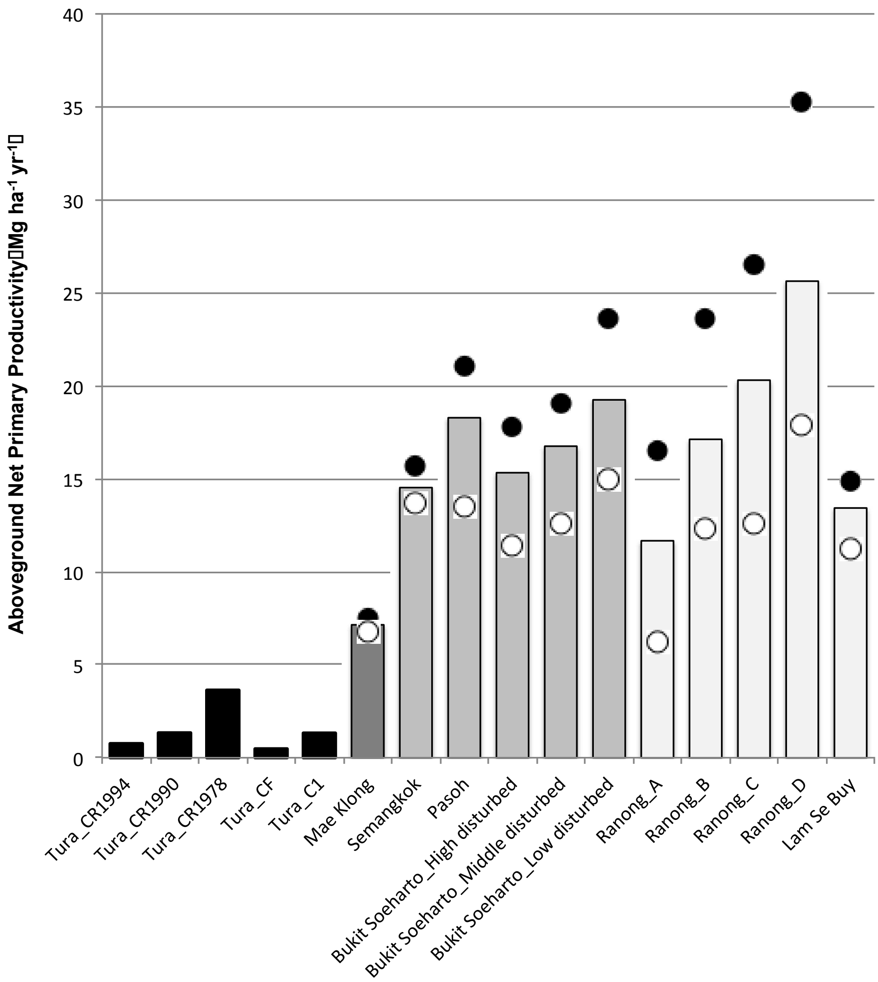

Fig. 3 Comparison of aboveground net primary productivities (ANPP) among the monitoring plots. Closed and open circles represent the maximum and minimum ANPP values in each plot.

Reference

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