Session 2: Climate Change and Biodiversity

Impact of Meteorological Anomalies on Forest Productivity in East Asia

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East Asia is a part of the monsoon climate region in the world. The early summer rainy season in East Asia ('Baiu' in Japanese, 'Meiyu' in Chinese, and 'Changma' in Korean) provides a sufficient water supply to terrestrial ecosystems over Japan, Korea, and eastern China and maintains high productivity of the temperate vegetation in the region. The intensity and duration of the early summer rainy season have a large seasonal and year-to-year variability due to the air-sea-land interactions over the Pacific Ocean and Eurasia. This variability is the major focus of research on ecosystem services related to carbon and water cycles in East Asia including disaster prevention, food and timber production, and climate regulation.

Recent studies using flux measurement networks in Asia have shown that the year-to-year changes in annual net ecosystem CO_2 exchanges are controlled by different key factors in different biomes. In humid temperate forests, the key factors are the temperature and solar radiation during the growing season, which vary year-to-year in response to the timing of the early summer rainy seasons (Saigusa *et al*., 2008). In tropical forests in Southeast Asia, the keys are the length and strength of the dry season, and the El Niño/Southern Oscillation (ENSO)-related dry weather and smoke from fires (Hirano *et al*., 2007).

In order to improve future climate change predictions, more synthetic knowledge of how ecosystem functions on carbon and water cycles respond to large-scale meteorological phenomena, such as year-to-year changes in Asian monsoon circulations would be desirable. This is because ongoing global warming has the potential to increase the frequency and magnitude of many extreme climatic events, including floods, droughts, storms, and anomalous temperatures in the global scale as well as in the Asian monsoon region. Another reason is that any of the recent climate prediction models needs to incorporate the biological feedback of terrestrial ecosystems that may play important roles in the global carbon and water cycles. However, we still do not understand the magnitude of the feedback, and the models have enormous uncertainties in the estimation of that feedback.

In recent years, the climate of 2003, particularly that during Northern Hemisphere summer, was exceptionally anomalous throughout the world. The heat wave led to drought, crop shortfalls, and health crises in several countries in southern Europe (Ciais *et al*., 2005). Another climatic extreme event during 2003 was that the rainy season was prolonged in the mid-latitude extending from Japan, China, through South Korea, and brought a cool summer with extremely low insolation over Japan. On the other hand, the weather was extremely hot and dry in southeastern China.

In order to clarify how meteorological anomalies affected the productivity of Asian forests, the spatial distributions of the year-to-year changes in the Photosynthetic Photon

Flux Density (PPFD) and the Gross Primary Production (GPP) during mid-summer were examined during the period from 2001 to 2006. The spatiotemporal variation of the PPFD was obtained by satellite images, and that of the GPP was derived by a regression-type model, which was evaluated by ground observation data. The correlation between year-to-year changes in the PPFD and GPP was positive in the mid and high latitudes since the incoming radiation was an essential controlling factor of the GPP in the regions. On the other hand, the PPFD and GPP were negatively correlated in the lower latitudes under the influence of severe drought stress caused by enhanced incoming radiation.

Since there is a potential that the frequency of anomalous weather conditions increases in the future affecting productivity in the Asian forests, further studies are necessary to gain a more accurate understanding of the response of Asian ecosystems to the meteorological patterns. This study showed some features of the responses of East Asian forest productivity to large-scale meteorological anomalous pattern. Although this is a case study, the results lead to an understanding of the spatial distribution of ecosystem responses to large-scale meteorological phenomena and serve as a verification dataset for the development of forest carbon monitoring, accounting and reporting system.

References

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