INTRODUCTION

A systematic assessment of global change research in East Asia is presented in this book. The main aspects studied are monsoon variability, atmospheric composition, land use/land cover change, marine/coastal systems and the driving forces of change.

1. Variability of Monsoon

The East Asian winter and summer monsoons are the dominant atmospheric features determining the hydrologic conditions and natural vegetation cover for East Asia. As such, the system directly influences the climate experienced by about 57% of the world's people. Through our interconnected global economic system, interannual to interdecadal variations in the East Asian monsoons can affect the economies and societal well-being of people in the region and around the world. Consequently, understanding the potential for changes in the monsoons as a result of external factors, such as human-induced global warming, and internal factors, such as changes in land cover or the concentration of atmospheric aerosols, is important.

The nature of the East Asian monsoon, and how it resulted from the presence of the Tibetan Plateau is described in Chapter 1. Studies of climates of the past indicate that the monsoons did not develop until the region's land areas drifted into the current geography, thus creating a suitable land-sea thermal contrast under the seasonal cycle of solar radiation to excite the monsoon, and the Tibetan Plateau became elevated, thus positioning the monsoon over East Asia.

Further information about the variability of the East Asian monsoon over the last several million years is provided in Chapters 2 and 3. Of most importance is that the East Asian monsoon can vary in intensity and pattern, and that some of this variation results because of changes in heating patterns.

Model simulations and their comparisons with paleoenvironmental reconstructions indicate that models are capable of reproducing past variations of monsoon climate. This gives confidence that models will be useful for evaluating future changes of climate under the effects of changing greenhouse gas concentrations in the atmosphere and land use/cover patterns.

Connections between annual variations in the East Asian monsoon and the El Niño/Southern Oscillation are explored in Chapter 5. While these are not well defined, evidence suggests that the East Asian monsoon is affected, and there are indications that variations in the summer monsoon can have effects stretching even to the North Atlantic.

With the East Asian monsoon system being of such importance to the region and to the rest of the world, further research on the system is warranted.

2. Atmospheric Composition

Anthropogenic emissions over East Asia have increased, during the last several decades, in the same way as the global emissions. The surface air temperature over East Asia has increased by about 0.84°C per 100 years for 1900∼1999 which is warmer than the increase in average globe temperature. This is interpreted to mean that human activities are most likely responsible for the warming in East Asia, especially for the last 50 years. Most projections suggest that the annual precipitation over East Asia could increase by about 23∼151 mm for the period 2071∼2100 relative to 1961∼1990 and the East Asian winter monsoon might weaken and summer monsoon might strengthen, and more frequent floods and droughts might appear in some parts of East Asia (Chapter 6). Observed and projected results of the increase of greenhouse gases in recent years on regional aspects of global warming are discussed in Chapter 7.

It has been suggested that the changes in precipitation, and the tendency toward increased floods and droughts in certain regions (Chapter 6) are most likely caused by the large amounts, in the atmosphere, of black carbon particles which have been generated from industrial pollution, traffic, and burning of coal and biomass fuels. Simulations have been conducted to examine the effects of black carbon on the hydrologic cycle over China and the results indicated that black carbon affects regional climate by absorbing sunlight and heating the air, which rises, forming clouds and causes rain to fall in heavily polluted regions (Chapter 8).

Dust particles change optical depth, alter direct climatic forcing by scattering and absorbing solar short-wave radiation and earth's long-wave radiation. Because dust reacts with sulfur dioxide and nitric acid and becomes more hygroscopic, it may play a role in regional cloud formation. Cloud nucleation by dust particles produces indirect climatic effects through the alteration of cloud reflection and radiation by altering cloud microphysics and the production or suppression of rainfall (Chapter 9).

3. Land Use Change

Land cover can affect the impact of solar variation on climate by changing surface characteristics such as albedo, leaf area and surface roughness. Changes in management within land uses lead to changes in terrestrial carbon stocks and fluxes, and contribute to atmospheric carbon dioxide. East Asia has been transformed by land use change, and the environment has been subjected to stresses such as deforestation, desertification, and water and air pollution. The general theme in this section is that these changes have impacted regional climate. Because of the role it may play in future climate change and development, an accurate understanding of past and current land use practices and projections of future land use are provided in Chapter 10.

Land use change impacts the carbon balance of East Asian ecosystems (Chapter 11). Contemporary estimates of carbon exchange in Chinese forests indicate uptake rates of 0.05 to 0.1 Pg C yr^{-1}. Interannual estimates of net carbon exchange across ecosystems varies annually from net sinks to net sources with net carbon exchange typically related to precipitation. None of the inventory-based approaches provide estimates for all ecosystems in China, making it difficult to establish baselines for monitoring the effects of environmental change. Use of different nitrogen sources and increased fertilizer nitrogen to improve food supply, and the effects of changing agricultural systems and food consumption patterns on the nitrogen cycle are discussed in Chapter 12. More marginal land is now being used thereby decreasing nitrogen use efficiency. Environmental problems range from loss of soil nitrogen due to dust storms, to increased nitrate content of rivers.

The impacts of land use change on structure and function of terrestrial ecosystems and biodiversity of East Asia are discussed in Chapter 13. Using vascular plants for biodiversity studies the authors note that plant species information is variable across the region and that updates of species are needed to verify future environmental change. The dramatic recent changes

in land use in Northern China and Mongolia due to increased population growth and political reforms of pastoral systems, and the effect this has had on vulnerable ecosystems in the region is described in Chapter 14.

4. Marine/Coastal Systems

East Asia is adjacent to some of the largest marginal seas in the world including the Yellow and East China Seas. These seas form the linkage between the world's largest continent and largest ocean, ventilate the deep oceans, receive land runoff, exchange with the open oceans, and sustain the life of millions of fishermen. Most of these seas are affected by the East Asian Monsoons as well as land use change.

Deforestation, cultivation, construction of dams, domestic and industrial uses of water, and use of fertilizers have affected water, sediment, and nutrient delivery to coastal zones with detrimental effects. The annual water flow at Lijin on the Yellow River decreased from 514 to 42 $\times$ $10^8\,m^3\,yr^{-1}$ between 1850 and 2002 and the sediment flux decreased from 13 to $0.5 \times 10^8\,t\,yr^{-1}$ during that time. The water flux in the Yangtze River changed little between 1950 and 2002, but the sediment flux decreased by 40% between 1984 and 2000 due to the construction of dams and other practices. The nitrogen flux increased by a factor of two between 1970 and 2000 (Chapter 15).

Dams also affect the environment further downstream. Even the continental shelves could be affected as a result of reduced upwelling due to reduced freshwater outflow and buoyancy. Chapter 16 reports that decreases in all indices of species diversity, benthic community biomass, fish resources and recruitment of living marine resources are consistent with the notion that reduced freshwater outflow reduces the upwelling of nutrient rich subsurface waters from offshore.

Reduction in sediment outflow not only results in less food for the marine biota but it adds to the sea level rise problem. Local sea level rise depends not only on mean sea level rise, but also on sediment transport, land subsidence, waves and current flow patterns. On average, the mean sea level rise 10 to 20 cm during the past 100 years and may very well rise 9 to 88 cm more by the year 2100. These rates suggest that some slow growing reefs might be affected, as most corals do not survive when the water is too deep (Chapter 17).

5. Driving Forces

It is recognized that population trends, economic development, government, energy and environmental policies and technology advancement, will determine future greenhouse gas and sulfur dioxide emissions, which are the basic inputs for determining future change of the climate system with general circulation models. These major driving forces also provide the basis for setting socio-economic scenarios for the assessment of vulnerability, impacts and adaptation strategies, and policies to deal with climate change.

The population driving force, including current population, birth and death rates, factors influencing trends, correlations between economic and population growth rates, and population projection is described in Chapter 18. The importance of aging trends in the region, migration, urbanization, and trends to smaller household size are also discussed.

Application of clean technologies, and new energy and eco-city policies to reduce emissions is described in Chapter 19. For eco-city development, many Chinese cities have set up sustainability goals such as green land per capita, oxygen equivalent per capita, environmental quality, coordinating ability including energy, population, and industry increase elasticity, and impact ability of the city. The authors indicate that technology progress is a win-win option.

A different aspect of climate change, viz. climate-related disaster is presented in Chapter 20. Trends in losses (dollars & people) due to severe weather, institutional arrangements for managing risks, and case studies are presented to illustrate how management policies can be used to reduce risks. An integrated approach of vulnerabilities and adaptation assessment to climate change, along with methods and tools for measuring climate vulnerability are given in Chapter 21. A conceptual research framework which integrates climate change and socio-economic scenarios, vulnerability identification, sustainability indicator specification, adaptation option evaluation, and multi stakeholder participation is presented. A systems approach for designing a research framework to link modeling analysis with policy concerns for climate change is presented in Chapter 22. Implications of driving force changes for greenhouse gas emissions are presented.

The final chapter highlights the facts that East Asia is undergoing tremendous socioeconomic, political, and institutional changes and that the magnitude and rate of development in this region are unprecedented. It is emphasized that the continuous expansion of economies, demographic

dynamics, globalization, policy reforms, and cultural and lifestyle changes will interact and affect the global Earth system. The authors point out that it is critical to understand the underlying human activities and social drivers of change in order to understand and predict changes in ecosystem dynamics, climate, atmospheric composition, and hydrology.