2. What Are the Expected Products, Scientific Contributions and Current Progress?

2.1 Integrated monitoring network

The integrated network system (Fig. 3) was originally composed of two satellite data receiving stations (at Beijing and Urumqi, China), two data-analysis centers (at IGSNRR and NIES), and five ground-truth monitoring stations (at Yucheng in Shandong Province, Fukang in the Xinjiang Vigor Autonomous Region, Taoyuan in Hunan Province, Haibei in Qinghai Province, and Qianyanzhou in Jiangxi Province, China). The network has now expanded to cover the entire Asia-Pacific Region owing to the formal participation of Singapore and Australia. The data-analysis centers at IGSNRR and NIES store a database that includes satellite data (e.g. MODIS, LANDSAT, ASTER, NOAA, TRMM), Giographic Information System (GIS) data, and measurements from ground-truth ecological stations.

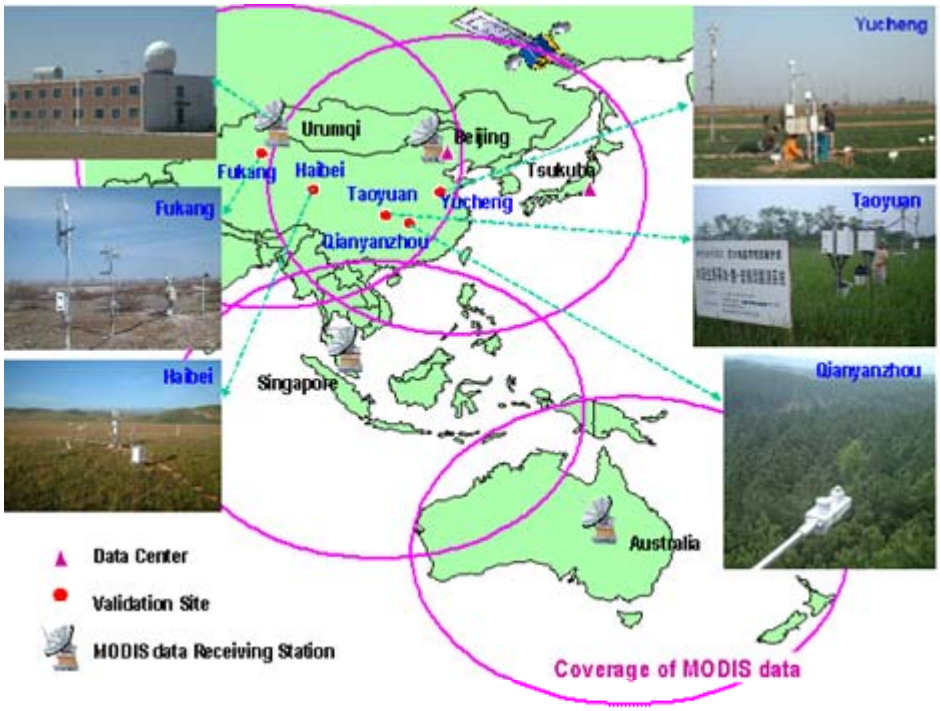

Figure 3 The APEIS integrated monitoring system

2.2 IEM products

IEM can offer the following products:

- MODIS data covering the entire Asia-Pacific region, received by a network of MODIS receiving stations.
- MODIS high-order products developed by a data-processing system at the Data Analysis Center at NIES, Japan; they include data on many important ecological functions, such as land surface reflectance; land

surface temperature; land cover; vegetation indices; thermal anomalies, fires, and biomass burning; and leaf area index and photosynthesis/net primary productivity.

- Ecological indices of environmental vulnerability, such as water deficit index, aridity, index of desertification, and occurrence of dust storms.
- An integrated catchment management model for assessing conditions and changes in ecological goods and services, such as freshwater resources and food production. By using this model and the above information, strategic policy options for sustainable catchment management will be explored.

2.3 Contribution to scientific and technological progress

2.3.1 Monitoring of disasters and environmental degradation

In eastern Asia, serious disasters occur frequently on large regional scales owing to environmental degradation. For example, dust storms now occur on a larger scale, and the damage they cause increases each year. Meanwhile, desertification and grassland degradation are becoming more severe thanks to human-driven factors such as overcultivation, overgrazing, over-exploitation, and misuse of water resources. Satellite observation is a tool that can help us to monitor these phenomena over time (Fig. 4).

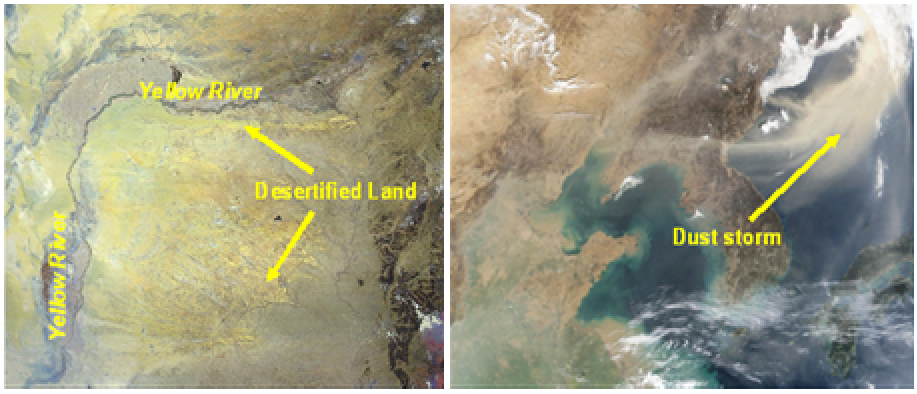

Figure4 Environmental degradation monitoring from MODIS images

Spatially wide and temporally long observations by satellite data enable us not only to monitor a natural disaster, but also to detect the land use and land cover changes that occur as a result of human activities. IEM estimated the surface area and volume of Eastern Dongting Lake in eastern China by using NOAA-AVHRR and MODIS data coupled with a digital elevation model (Fig. 5).

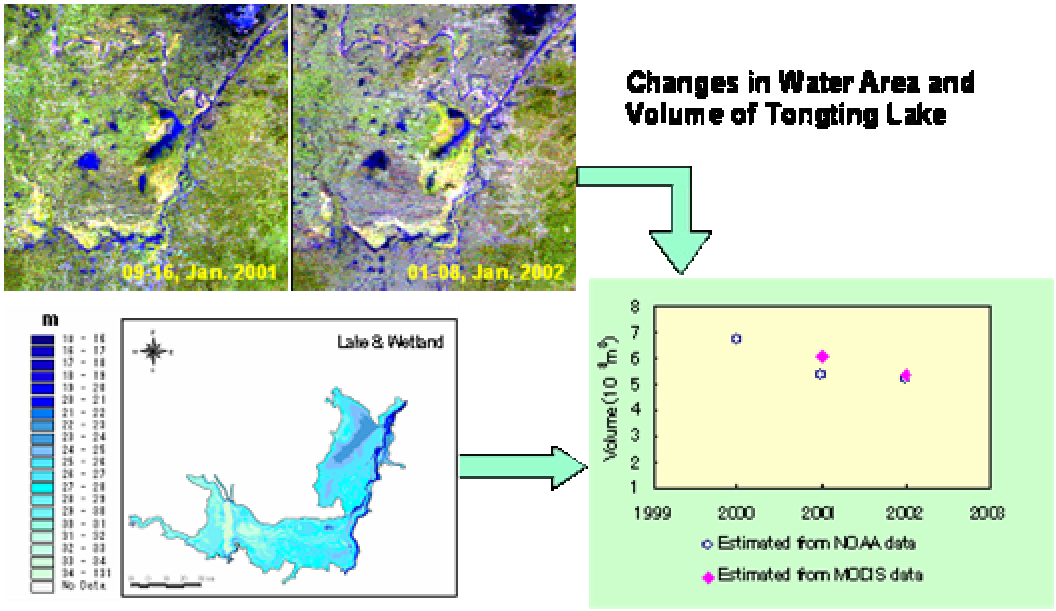

Figure 5 Estimation of surface area and volume of Eastern Dongting Lake in China from satellite data (NOAA–AVHRR and MODIS) and a high-resolution digital elevation model

2.3.2 Integrated modeling of ecological functions and sustainability

There is an emerging need to support policy formulation and decision-making for environmental management on large geographic scales. Typical issues are global change impact assessment and formulation of mitigating measures, water resource allocation in river basins at a sub-continental scale, and environmental impact assessment of agricultural activities in large river basins. To develop a decision-support system, we first need to model the biophysical processes and human interactions. For example, the model should simulate how environmental changes, such as climate change and soil erosion, may influence crop yield, and how changes in cropping pattern, cultivation intensity, and management practices may affect the environment over time. For sound management and decision-making with regard to the Changjiang River catchment in China, catchment-based ecosystem assessment that emphasizes the importance of hydro-biogeochemical processes and ecosystem functions has been accepted as a sub-global project of the Millennium Ecosystem Assessment (MA). Its principal aim is to answer the following questions: 1) what are the main pressures on ecosystem function? 2) What are the main impacts on ecosystem function, goods and services (such as water and food), biodiversity, carbon sequestration, and flood protection? 3) What kind of policy can be implemented to achieve sustainability in the Changjiang River catchment?

To answer the above questions, we need to develop a catchment-based integrated model to estimate the spatial and temporal distributions of the water cycle, carbon cycle, heat fluxes, element and nutrient cycles, sediment transport, and land productivity on both regional and catchment scales. By using the model we can predict future impacts on ecosystem function under various scenarios, such as: 1) decreased crop production because of water cycle change; or 2) increased

soil erosion, desertification, dust storms, and flood events because of land use or land cover changes.

2.4 Current progress in the development of major tools

2.4.1 Establishment and expansion of a network of satellite data receiving stations

MODIS is the key instrument aboard the Terra satellite, which views the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands between 0.405 and 14.385 μm, and at three spatial resolutions, 250 m (Bands 1–2), 500 m (Bands 3–7), and 1000 m (Bands 8–36). MODIS data can be used for up-to-date monitoring of environmental degradation and land use or land cover changes, and for developing integrated models for environmental assessment. The MODIS data-receiving station in Beijing was set up in February 2001, and another station in Urumqi was completed in April 2002. The two stations can receive data twice a day covering a vast area, including Japan, China, Mongolia, Korea, and Western Asia. Data received by both stations are transported to the Data Analysis Centre at IGSNRR in China and at NIES in Japan. After a difficult period of testing and systematic adjustment, data from January 2003 are available. The MODIS network was expanded in 2002 through the formal participation of two other stations in Singapore and Australia and now covers the entire Asia-Pacific region (Fig. 3).

2.4.2 Development of a data-processing system for the derivation of environmental indices

MODIS products are being used by scientists from a variety of disciplines, including oceanography, biology, and atmospheric science. The MODIS Science Team at NASA has already developed high-order products, but most of them have not yet been completely calibrated or validated by ground-truth data in various ecological systems. Developing the next generation of high-quality data sets for the study of regional environmental change and ecological system assessment in the Asia-Pacific Region is our new challenge. At the NIES data center we have already developed a data-analysis system based on NASA's algorithm, and we now produce the following high-order land products of MODIS: MOD 09 – Surface Reflectance; MOD 11 – Land Surface Temperature (LST) and Emissivity; MOD 12 – Land Cover and Land Cover Change; MOD 13 – Vegetation Indices; MOD 14 – Thermal Anomalies, Fires and Biomass Burning; MOD 15 – Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation Absorbed by Vegetation (FPAR); and MOD 17 – Net Photosynthesis (PSN) and Net Primary Productivity (NPP) (Fig. 6).