Monitoring and Mapping Land-Cover Change in East Asia

Cheng Shupeng, Professor, Academician of Chinese Academy of Sciences
Cheng Yufeng, Dr.
The State Key Laboratory of Resource and Environment Information System (LREIS)
Institute of Geography, Chinese Academy of Sciences
Beijing, 100101, China
E-mail: chensp@lreis.ac.cn, yufeng.chen@bj.col.com.cn

Abstract:
Some activities related to the land-cover change studies have been going since the early 1980's. Nowadays, the Chinese scientists have been conceiving of the international cooperative research project on land-cover change in East Asia by remote sensing and geo-information system as following: compiling a vegetation/land-cover maps of East Asia at a scale of 1:5M with the historical, current and future periods; estimating the terrestrial and marine biomass and net primary production; and projecting the tendency/variety of vegetation-land-cover change.
Keywords: Land-cover change, maps, remote sensing, geo-information system, East Asia

Global change, especially, land-cover change is the very urgent and important environmental and social issues facing to humanity nowadays. Over the past 3 years, Chinese scientific community has made a lot of progress on land-cover change for the global environmental change studies. It may be as support for the monitoring and mapping land-cover change in East Asia.

Research Progress related to the land-cover change

Some activities organized under the IGBP Committee of China, and the supported by the Institution of Chinese Academy of Sciences have been going since the early 80's, including as following: the studies on impacts of global climate change; macro-scale remote sensed investigation of national land resources and environment; monitoring and evaluation of land-cover change; The eco-physiological studies; the research on the North East China Transect (NECT); the PEP-II profile setting (Arctic-Antarctic-Equator).

Some important results may be introduced as following:

1. Geo-spatial database

A scientific geo-spatial database, named "LREIS data" loaded in a sheet of CD-ROM, has been developed in the State Key Laboratory of Resource and Environment Information System (LREIS), Institute of Geography, CAS. In the "LREIS data", 17 kinds of geo-spatial database at a scale of 1:4M with the formats such as ARC/INFO Coverage, E00, DLG, etc., were included in CD-ROM as following: political boundary with province and country, terrain isolines, soil, vegetation, drainage system, lakes, desert, swamp/marsh and so on.
A world commercial CD-ROM production, named by "ARC-China" including information of political boundary for province, municipality and country, and terrain isolines, drainage network and residential sites, etc. at a scale of 1:1M, has published trough the cooperation between the State Bureau of Surveying and Mapping of China and Environmental System Research Institute

of USA in 1998. In addition, the maps and databases at the scale of 1:1M such as land-use, land resource, grassland, etc. have been published in China.

A new edition of National Atlas of Physiography including more than 200 sheets of thematic maps has been drawing and printing by geographical information system (GIS), whose first edition was published 30 years ago. Moreover, the National Atlas of agriculture, population and economics were published by China Map Press and Oxford Press, which are the most detail and most integrated materials to study the land-cover and landuse so far. Moreover, In addition, more than two dozen of provincial and regional atlases have been published in the past 20 years. These atlases provide detailed historical and current information for studying the global change of China in the physical and human dimensions.

2. Macro-scale Remote Sensed Investigation of National Land Resources and Environment

From 1990 to 1995, the Project "Macro-scale Remote Sensed Investigation of National Land Resources and Environment" has been carried out, which used newly received TM imagery as main information sources and some space images produced by Chinese satellite as supplementary information sources, and produced the land-cover maps covering whole China (1:250 000 scale for the eastern part an d 1:500 000 scale for western part). Another project named "Resources and Environment Database of China" is under way in Chinese Academy of Sciences (CAS) from 1994, which aims to systematically collect and digitize the maps related to land use/land cover previously made in CAS. Since 1996, thematic layers of land cover have been planned to update once every two years and macro-scale change monitoring on land resources will be realized (Liu, 1996).

3. Monitoring and evaluation of land-cover change

Regionalization of land cover change in China using remote sensing data (1983-1992): Based on the NDVI from NOAA AVHRR with 1° and 8km resolution and ten-year time series, two indexes such as Land Cover Index and Sensibility Index of land cover change were put forward, and the maps of land cover index and the maps of sensitivity index of land cover change were made. Then the following conclusions can be drawn from the analysis of these above maps (Ging et al. 1996): (i) the sensitivity is small in the inland of northwest and Xizang plateau, and large in eastern region (so called the southeast and southwest monsoon region). These are a declining trend from southeast to northwest and an obvious strap regularity for the sensitivity; (ii) the land cover in China is deeply affected by monsoon climate and land use patterns at first, then by geomorphologic statement. Therefore, the three different regions such as southeast monsoon region, northwest and Qinghai-Xizang Plateau region, and southwest monsoon region are indicated firstly, which formed the first-class regions of China. It is shown that East-West differentiation of land cover in China is the most important and the South-North difference which means that the vulnerable ecological region (with low land cover index) might not be a sensible region for land cover change.

Seasonal patterns of spatial differentiation of land cover in China: The global 1° by 1° data from NOAA AVHRR visible and near-infrared channels are used to calculate the NDVI to cover China area from July of 1981 to August of 1994, it is revealed through principal component and factor analyses methods that there exist four types of seasonal patterns of spatial differentiation of land cover in China, i.e., November to next March type, June to September type, May or October type and April type (Chen, 1998).

4. Environmental factors monitoring

Land use and land cover change: 1:1M landuse maps and land resources maps over the whole country were published in 1990 and 1992, respectively. Then a more detail mapping work at a scale of 1:250 000 has been launching since 1992 in order to build a digital data bank. Now, the multi-frequency and multi-polarization Global SAR data have been used to study the classification of land use, especially in southern tropic China (Chen S.P. and Chen Y.F., 1998).

Urbanization: Under the support of the Central Government, 100 cities were monitored using TM in 1997 and over 600 cities in China will be monitored in detail this year. In addition, collaborative projects for urban environmental assessment supported by UNDP/ESCAP in Shenyang City of Liaoning Province and Shanghai metropolis have been published in 1998. Moreover, the urban geographical information systems of Shenzhen, Xiamen and so on have been established and the urban land use changes have also been evaluated.

Desertificaton: In this field, a lot of exploration and research, led by Prof. Ci Longjun form the center of desertification under of the Ministry of Terrestrial Resources, with the cooperation of UN and many other countries, have been undergoing. Moreover, along term works, led by Prof. Zhu Zhenda, have been continuing in the Landzhou Institute of Desert, CAS since 1950's.

Qinghai-Xizang Plateau: Qinghai-Xizang Plateau, called as "Roof of the world", is one of the most sensitive areas of the Earth to global change and is one driving area to climate change in Asian monsoon areas. The extensive uplift of the plateau in the past could have strong impacts on itself, the neighboring regions and the global change. Since 1980's, the Chinese research community has developed studies of integrated survey and environmental changes of the Qinghai-Xizang Plateau, and has made a great contribution to global change studies, such as: uplift of Plateau and corresponding environmental change; response of glacier, snow deposit, and permafrost on the Plateau to modern climate change; climate characteristics of the Plateau during the last 2000 years; framework of eco-geographical regions on the plateau (Qin et al., 1998: Section 2.7).

5. The eco-physiological studies

China has founded a national wide network, the Chinese Ecosystem Research Network (CERN), including 29 research stations, 5 sub-centers and 1 integrated center. The 29 ecological stations represent major ecosystem types in China, such as farmlands, forests, grasslands, lakes and marine areas. The five specialized sub-centers are composed of hydrogen, soil, atmosphere, lake and biology, together with 29 stations being financially supported by the integrated center. The main function of CERN is to obverse the ecological process of China's main ecosystem, and their response to environmental changes to investigate the structure, function and dynamics of an ecosystem.

Amongst the 233 species investigated that belong to 37 families and 144 genus, 89 species were C_4 photosynthetic pathways. The habitats for C_4 species were mostly dry and salt alkaline, and much more tolerant to heat and barren and alkaline environment than C_3 species.

By applying the method to fuzzy analysis, and the ecological geographical zonalization in the biodiversity studies, it was suggested that a four class system to determine the main biomes in

China, which are biodomain, subbiodomain, biome and bioregion. Accordingly, China's terrestrial ecosystems have been divided into 5 biodomains, 7 subbiodomains and 18 biomes (Qin et al., 1998: Section 2.5).

6. The research on the NECT and the PEP-II

The Northeast China Transect (NECT) is one of the first IGBP transect set in the world, which was suggested by Professor Zhang Xinshi, the former director of Institute of Botany, CAS in 1993. It is the most remarkable and typical showcase for the climate gradient featured with precipitation as a driving factors in influencing climatic changes in the temperate zone of middle latitudes in East Asia. NECT runs along the line of 43° 30' North latitude and is caught between 112° and 130° 30' East longitude. It is nearly 1600km long, featuring a vegetation transition from a temperate timberland of evergreen coniferous forests and broadleaved deciduous forests to a mild temperate steppe.

The Polar-to-Polar profile (PEP-II) is one of three Pole-to-Pole transects in the PANASH project, which was proposed by Professor Liu Tungsheng, Academician of Institute of Geology, CAS. China plays the important role in this transect.

Through the above studies, the relationship between vegetation and climate, greenhouse effects on the terrestrial ecosystems and the land use at different spatial and temporal scales will be studying systematically and continually.

7. GIS-based climate-vegetation modeling for the study on impacts of global climate change

A new climate-vegetation model supported by GIS has been developed by Dr. Chen Yufeng in LREIS, Institute of Geography, CAS, in which soil taken as a limited factor and elevation as an affected factor. The result shows that the total precision of the model is not only improved from former 40% to present 70%, but the precision of each vegetation type is also amended significantly (Chen, 1999).

Using the new climate-vegetation model coupled with GIS, the changes of distribution of vegetation types in China are studies according to the scenarios for doubled CO_2, with the biggest negative change in no vegetation region and the biggest positive change in the cold prata under the scenario produced by GISS GCM. However, as for the relative change of absolute area after CO_2 concentration is doubled, there are great differences between the increase and decrease in the area of each vegetation type. The area of such types as temperate deciduous broadleaf forest and shrub, subtropical and mountainous coniferous forest, tropical broadleaf forest, cold prata, annually double harvested or biannually tripe harvested crops, annually single (double) harvested cold-demanding rice etc., tend to expand, while the areas of such types as cold temperate and temperate mountainous coniferous forest, subtropical evergreen broadleaf and deciduous broadleaf mixed forest and shrub, mountainous shrub, temperate desert, cold desert, temperate prata, temperate marsh, annually single harvested crop, annually double harvested rice or warm-demanding dry crop accompanied with rice tend to shrink (Chen and Li, 1996).

Perspective and Proposal

The East Asia is one of the special regions in the world, with the strong monsoon, complex terrain relief and geomorphy, huge population, and centuries-old civilization. Therefore, more

and more attentions have been attracting to study the vegetation change and land cover change in this area. The Chinese scientists have conceived of the international cooperative research project on this area.

1) to compile a vegetation/land-cover maps of East Asia with NOAA AVHRR and SeaWIFs satellite data, at the scale of 1:1M, to showing the relationship between the terrestrial ecosystem and ocean ecosystem and their mutual influences.
2) These maps may be with three temporal type such as history-reconstruction, current-distribution and future-variety by the remote sensing/geographical information systems-based modeling with the knowledge of phenology, three-dimension geo-belt-regularity.
3) To estimate the terrestrial biomass and terrestrial and marine net primary production in the range of East Asia based on phenology and biogeochemistry under the supports of remote sensed geo-mechanism, GIS modeling and climatological models.
4) To project the tendency of vegetation/land-cover change in East Asia on the basis of the scenarios of global climate change, population increase and socioeconomic development, thus putting forward the option adaptation on regional sustainable development.

References

Chen S.P. and Chen Y.F. (1998), Remote sensing and geo-information system, In Qin D.H., Chen P.Q., Ge Q.S(eds.), Advances in Global Change Studies of China, China Ocean Press, Beijing.

Chen Y.F. (1998), Seasonal patterns of spatial differentiation of land-cover change in China, *Chinese Science Bulletin*. (forthcoming).

Chen Y.F. (1999), China climate-vegetation model based on soil classification, *Progress in Natural Science*, 9(1):1-7.(in press)

Chen Y.F. and Li K.R. (1996), GIS-based Research on possible impacts of global climate change on China's vegetation (*in Chinese*), *Acta Geographica Sinica*, 51 (special issue): 26-39.

Gong P., Shi P.J., Pu R.L., Guo H.D. (1996), Earth Observation Technology and Earth System Science (*in Chinese*), Science Press, Beijing.

Liu J.Y. ed (1996), Macro-scale Remote Sensed Investigation of National Land Resources and Environmental and Typical Change Study (*in Chinese*), China Science and Technology Press, Beijing.

Qin D.H., Chen P.Q., Ge Q.S(eds.) (1998), Advances in Global Change Studies of China, China Ocean Press, Beijing.