

Confronting Global Warming: Enhancing China's Capacity for Carbon Sequestration



University of Toronto
Institute For Environmental Studies/
Faculty of Forestry/
Department of Geography
Toronto, Canada

Natural Resources Canada
Canada Centre for Remote
Sensing
Ottawa, Canada

Environment Canada
Adaptation and Impacts Research
Group (AIRG)
Downsview, Canada

Chinese Academy of Sciences
Institute of Geographical Sciences and
Natural Resources Research
Beijing, People's Republic of China
Institute of Soil Science
Nanjing, People's Republic of China
Cold and Arid Regions Environmental and
Engineering Research Institute
Lanzhou, People's Republic of China

Beijing Normal University
Beijing, People's Republic of China

Nanjing University
Nanjing Agricultural University
Nanjing Forestry University
Nanjing, People's Republic of China

*Confronting Global Warming: Enhancing China's Capacity for
Carbon Sequestration
Project Mid-term Report, October 2004*

“Confronting Global Warming: Enhancing China’s Capacity for Carbon Sequestration” is a special Canada-China Climate Change Development Fund project sponsored by the Canadian International Development Agency (CIDA). The purpose of the project is to build China’s enhanced ability and capacity to increase ecosystem carbon stocks through the development of technical and human resources that will result in more informed and effective land-use, forest management, and more solid scientific base for environmental and land use policy making.

Another important purpose of the project is to build China's capacity in terrestrial carbon cycle monitoring and modeling and to develop technology-based integrated assessment tools and participatory multi-stakeholder methods that inform decision making aimed at increasing carbon sequestration while contributing to sustainable development. This will result in a reduction in China’s contribution of greenhouse gasses that will significantly reduce global warming and protect the world’s population and ecosystems from potentially damaging climatic change.

The expected principle results of the project are: (1) Chinese institutions will have increased capacity to estimate spatially explicit, long-term carbon dynamics for China's forests and forestry related activities; (2) Chinese institutions will have increased capacity to assess forestry management methods to enhance carbon sequestration, and (3) Chinese institutions, local and regional communities, as well as government agencies will have increased capacity to undertake integrated assessments of the economic, environmental and social impacts of land use decisions designed to enhance carbon sequestration.

The expected principle short-term results are: (1) greater ability of Chinese partners to use GIS and remote sensing applications for carbon cycle modeling; (2) enhanced capability of Chinese partners to produce country-wide and local carbon sources and sink maps; (3) greater ability of scientists in Chinese partner institutions to undertake forest assessments and ground truthing to validate carbon sequestration estimates; (4) greater ability of scientists in Chinese institutions to plan for reforestation, afforestation, and other effective land uses that enhance carbon sequestration; (5) increased capacity among Chinese stakeholders (institutions and governments, especially policy makers) to use carbon source and sink maps (country-wide and local level) for guiding the implementation of future Clean Development Mechanism (CDM) projects; and (6) increased awareness in local and national governments of the link between local and regional sustainability planning, and carbon-sensitive land use decisions.

In Canada, the project partners include the following:

- The Institute for Environmental Studies, the Faculty of Forestry and the Department of Geography of the University of Toronto

- Natural Resources Canada - the Canada Centre for Remote Sensing
- Environment Canada - the Adaptation and Impacts Research Group

In China, the project partners include the following:

- The Chinese Academy of Sciences - Institute for Geographical Sciences and Natural Resources Research (Beijing) and the Cold and Arid Regions Environmental and Engineering Research Group (Lanzhou)
- Beijing Normal University
- Nanjing University - Earth System Science Institute
- Nanjing Agricultural University
- Nanjing Institute for Soil Sciences
- Nanjing Forestry University

Professor Jing M. Chen of the University of Toronto and Professor Liu Jiyuan of the Institute of Geographical Sciences & Natural Resources Research of the Chinese Academy of Sciences are the chief scientists and serve as the project co-directors.

Project Components

There are four main components to the project (Figure 1):

1. GIS and remote sensing applications for the carbon cycle modeling framework, derived from Canadian expertise and experience, in order to estimate the potential for carbon sequestration in China;
2. Forest assessment and ground-truthing (verification) activities in pilot ecological zones in Western China and other forested areas in order to verify remote sensing data and examine the potential for the development of a carbon-friendly and balanced afforestation policy regime;
3. Integrated assessment of the economic, social and environmental impacts of land use decisions designed to increase carbon sequestration in China; and
4. Contributing to China's land use policy and strategies by producing a computer-based decision making tool to maximize carbon sequestration without incurring negative social and economic impacts.

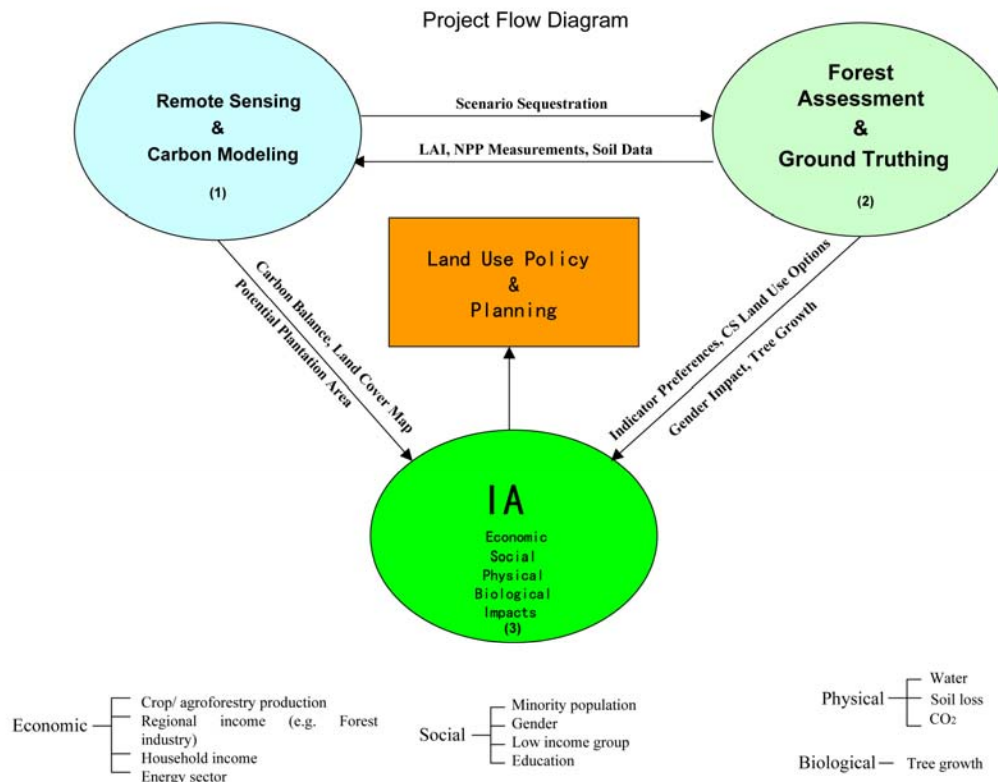


Figure 1. Project structure and components

Project Sites

There are 5 sites chosen as the project's key research area based on the different eco-systems and land scenarios (Figure 2). Changbaishan, Liping and Heihe are core sites, while Xingguo and Baoying are auxiliary sites.

- (1) Changbaishan (Jilin Province, Northeast China): A forested area, mostly natural forests, representative of the northeast forests. A micrometeorological flux tower is being operated by the Chinese Academy of Sciences.
- (2) Liping (Guizhou Province, Southwest China): Demonstration forests, one of 10 largest forested areas in China, mostly natural forests (oak) and plantations (Chinese fir and Mason Pine) of various ages, representative of 60-70% of plantations in southwest China, karst landscape and uniform soils.
- (3) Heihe River basin (Gansu Province, Northwest China): semi-arid region on Yellow Plateau with large pockets on forest plantations and some natural forests. CAREERI has extensive experience in that area. Many international research projects are currently active. Logistics at the site are available. Extensive IA work was previously done.
- (4) Xingguo (Jiangxi Province, Central China): large areas of plantations of Mason pine and slash pine on red soils, representative of large areas in Jiangxi and neighboring provinces. NISS and NAU have previous experience of soil sampling.

- (5) Baoying (Jiangsu Province, Eastcoast): about 4 thousand hectares of poplar forest area. A 9 year-old stand has been intensively studied by NFU. The area is fluvial clay soil.



Figure 2. Locations of project core sites (Liping, Heihe and Changbaishan) and auxiliary sites (Xinguo and Baoying).

In the three core sites, all project components, including remote sensing and carbon modeling, forestry, and soil and IA will be conducted. Two auxiliary sites will augment some components of the project.

Mid-term Project Achievements/Results

Through the above four research components, we will characterize the soil and vegetation carbon dynamics in typical Chinese ecosystems, and evaluate the role of these ecosystems in the global carbon cycle, as well as their feedbacks to the global climate system.

We also attempt to answer the questions related to the carbon sequestration potential of China's forest ecosystems and their effects on the environment. We are examining China's terrestrial ecosystem's carbon flux and pools in order to provide a scientific base for China's greenhouse emission control strategies and policies.

Component 1 – remote sensing and carbon cycle modeling

- 1) Canadian director Dr. Jing Chen introduced the forest structure index measurement instrument TRAC to China and trained 35 Chinese technical personnel, and the instrument is now well used in forest ground truthing which significantly improved the research methodology.
- 2) Dr. Chen and the team also introduced the BEPS (Boreal Ecosystem Productivity Simulator) and InTEC (Integrated Terrestrial Ecosystem Carbon Cycle Model) models to China. BEPS is a remote sensing driven model for short-term carbon cycle simulation at hourly or daily time steps. InTEC is for long-term carbon cycle simulation in monthly or annual time steps. InTEC has the unique ability to consider the effects of forest age and forestry disturbance on the carbon cycle. They are particularly suitable for China's research in forestry management and its effect on carbon sequestration. Figures 3, 4 and 5 show some of the model results.

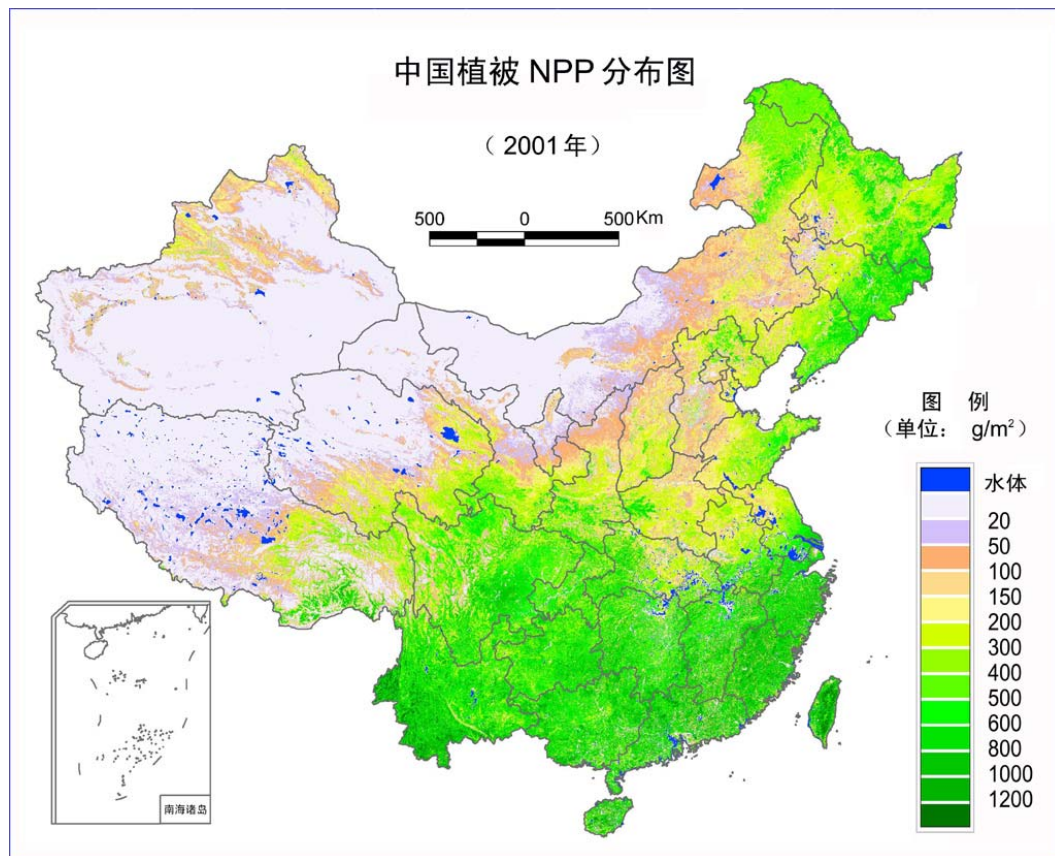


Figure 3. China NPP distribution in 2001 produced using BEPS with remote sensing inputs

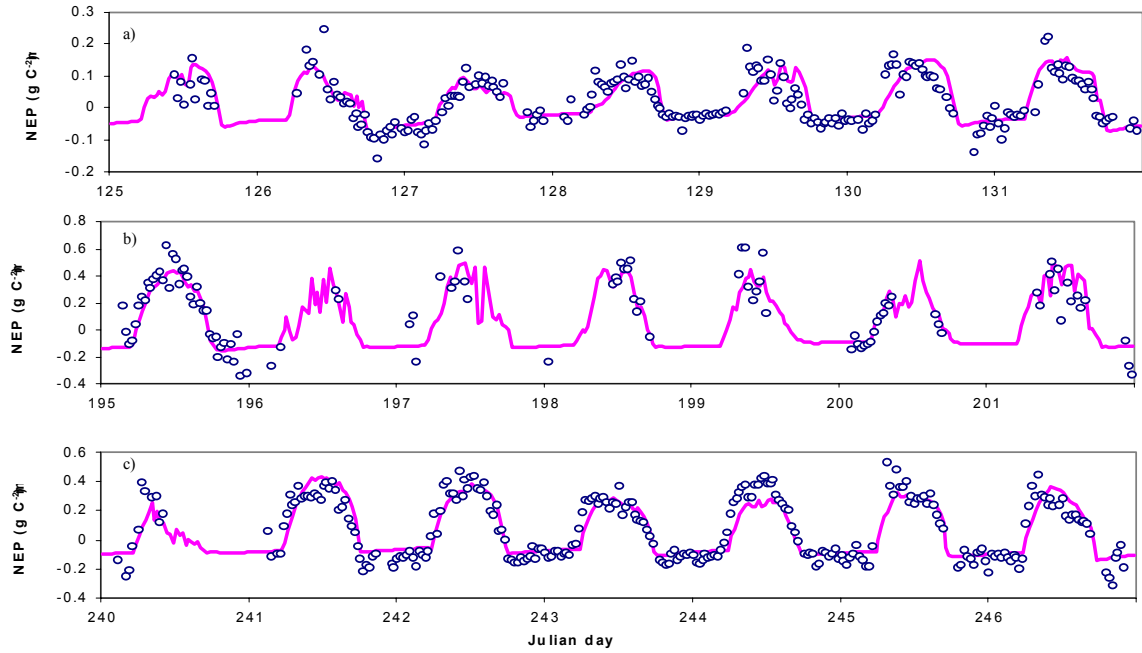


Figure 4. Comparison of modeled net ecosystem productivity (NEP) modeled using hourly BEPS with measured NEP at the Changbaishan flux tower.

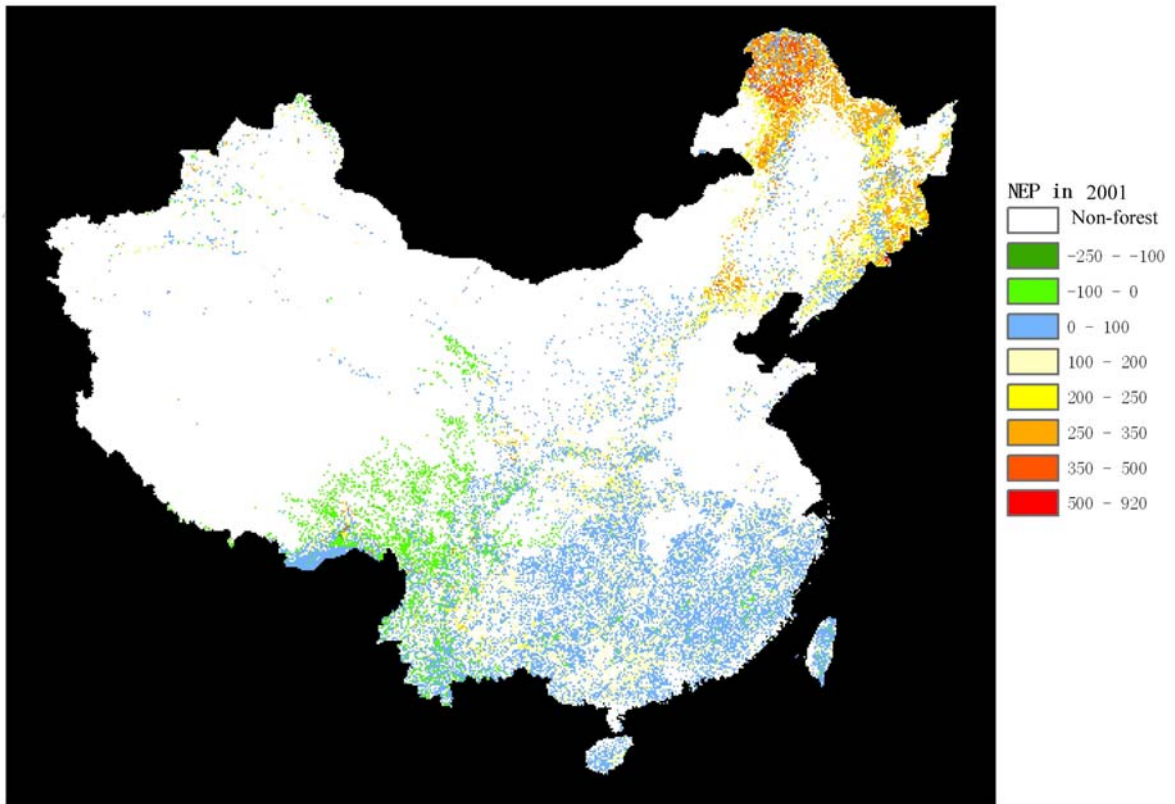


Figure 5. Carbon source and sink distribution (NEP) in China's forested areas in 2001 (Unit: g/m^2) modeled using InTEC

Component 2 – Forestry and soil ground truthing

- 1) In the Forestry & Soil Ground-truthing component, various data including biomass, NPP and soil texture and carbon have been acquired to validate remote sensing and modeling results of major forest types at the core sites. Figure 6 shows a laboratory experiment to separate the total carbon in soil samples into three pools.
- 2) The research team is developing carbon accumulation curves for current and potential plantation species in China, and
- 3) The researchers are also quantifying regeneration requirements for native tree species to expand the range of forestry options for carbon sequestration.



Figure 6. Incubation of soil samples to separate total soil carbon into fast, slow and passive pools for InTEC model parameters adjustments.

Component 3 – Integrated Assessment

In addition to physical and biological factors related to carbon sequestration, integrated assessment will incorporate social and economic factors to ensure the best interests for local communities. The goal of IA is to produce land-use options to maximize carbon sequestration in forested and agricultural eco-systems, while at the same time, minimizing any negative social and economic impacts. Figures 7-10 show integrated assessment (IA) at the township level in the Liping County using various spatially explicit datasets. This GIS-assisted IA will not only produce policy-relevant results, but will also be useful for guiding actions in the “Grain to Green” program, in which some low-productivity farmlands are converted into forests

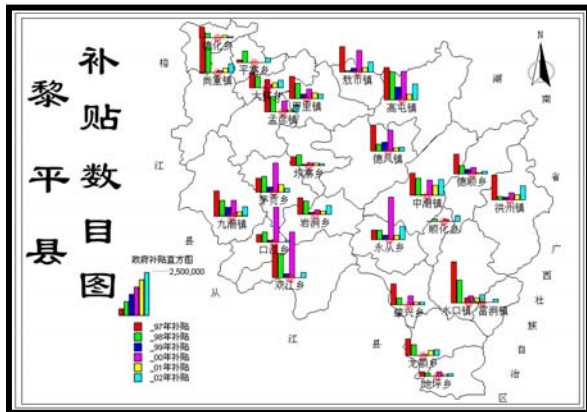


Figure 7. Annual ‘Grain to Green’ areas in Liping Liping County from 1997 to 2002

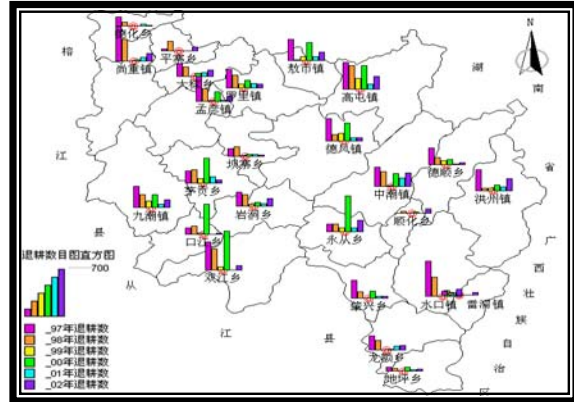


Figure 8. Food and money compensation in Liping County from 1997 to 2002

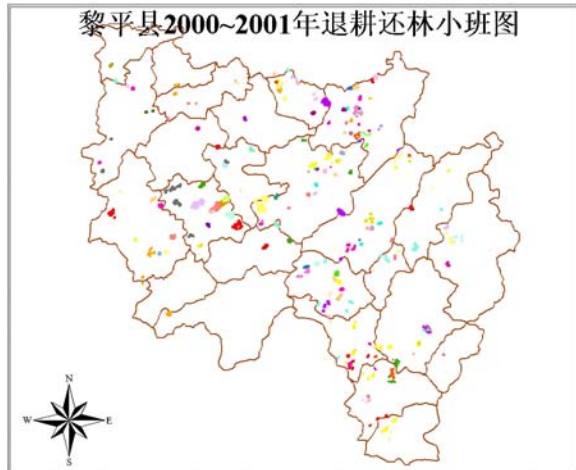


Figure 9. ‘Grain to Green’ areas in Liping County in 2001

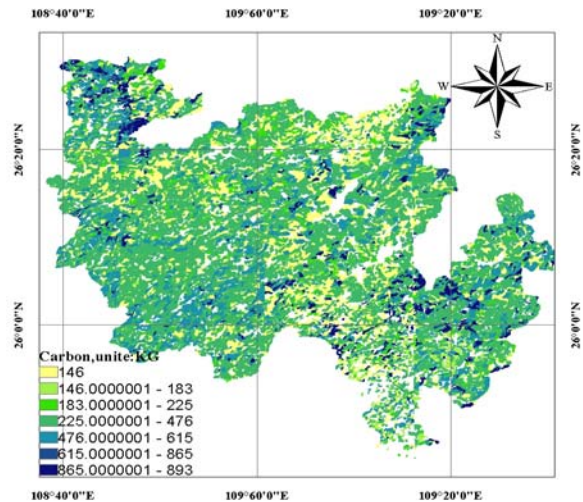


Figure 10. Spatial distribution of average annual carbon sequestration in Liping.

One of the final products of the project will be a computer-based user-friendly decision making tool which allows assessment of the impacts of different land use scenarios on carbon sequestration and on the economic and social status of local communities especially women, minorities and low income groups.

In the year of 2005, two major policy workshops will be held in Canada and China respectively, which will involve decision and policy makers from government to environmental scientific institutions.

Project’s Long-term Impacts on China

This project will culminate at the end of 2005 after three solid years of rewarding collaborative pioneering research efforts of Canadian and Chinese teams. We trust that

the project results will have long-term impacts on China's carbon cycle research and its national strategy on carbon sequestration and land use planning. The long-term goal of the project is to contribute to the global effort of reducing net greenhouse gas emissions by enhancing China's capacity to sequester carbon in natural sinks, thereby supporting environmentally sustainable and clean development in China.

By mapping the spatial and temporal distributions of carbon sinks and sources in China's forest ecosystems, the government policy makers will be in a better position to plan future reforestation/afforestation programs, and they can also make informed decisions regarding to climate change issues.

In addition to the scientific impact of the project, we are also developing a computer-based user-friendly decision making tool which will allow decision makers in China to assess the impacts of different land use scenarios on both carbon sequestration and on the economic and social conditions of local communities.

We are planning to continue this important work by identifying relevant government institutions that will provide a supportive base for future endeavors.



Prof. Jing M Chen □
100 St. George Street. Room 5047
Toronto, ON M5S 3G3
Canada
Tel: (001) 416-978-7085
Fax: (001) 416-946-3886
Email: chenj@geog.utoronto.ca

Prof. Jiyuan Liu □
11A Datun Road
Beijing, Postcode: 100101
P. R. China
Tel: (0086) 10-648-89276
Fax: (0086) 10-648-51844
Email: liujy@igsnrr.ac.cn