



Sixth framework programme of the  
European Commission

Project no. 044255

**CATSEI**

## **Chinese Agricultural Transition: Trade, Social and Environmental Impacts**

### **Executive Project Summary**

#### **1. Objectives**

The CATSEI-project (acronym for Chinese Agricultural Transition: Trade, Social and Environmental Impacts) is a STREP project within the Sixth Framework Program of the European Commission, executed during the period January 2007 through November 2010, with fifty percent cofunding by the participating institutions. It studies the impacts of China's vigorous agricultural transition, on the country itself, as well on its trading partners, the EU in particular. It follows a quantitative approach, supplemented by qualitative investigations. The quantitative research takes as point of departure the Chinagro I policy simulation model developed in the earlier CHINAGRO project funded under the Fifth Framework Program, also with fifty percent cofunding by the participating institutions.

Regarding methodological improvement, the research on trade extends the Chinagro I model by accounting for the size of China's imports and exports through an explicit representation of the world market, based on the GTAP-model of world trade. The research on social conditions links geo-referenced household surveys to a population map of China and a detailed geographical data set, so as to obtain a complete picture of social household characteristics across the country. Finally, agro-ecological assessment tools are applied to quantify the environmental pressures resulting from intensified livestock industry as well as from intensified crop production.

Findings on the three themes are subsequently integrated to arrive at policy suggestions that account for efficiency, equity and sustainability considerations. Throughout the project, a policy dialogue and dissemination program, conducted in both China and the EU, maintains communication with policy makers.

## **2. Consortium and execution**

The project is executed by a consortium with the Centre for World Food Studies (SOW-VU), The Netherlands, as coordinator, and as other participants the Center for Chinese Agricultural Policies of the Chinese Academy of Sciences (CCAP), China, the International Institute of Applied Systems Analysis (IIASA), Austria, the School of Oriental and African Studies of the University of London (SOAS), Great Britain, the Agricultural Economics Research Institute of the Wageningen University and Research Centre (LEI), The Netherlands, and the International Food Policy Research Institute (IFPRI), USA. Originally foreseen to last for three years, starting January 1<sup>st</sup>, 2007, the project has been extended until November 30<sup>th</sup>, 2011.

The project is organized in seven work packages. Work package 1 defines the starting point by updating the major drivers of the baseline scenario of the Chinagro I model. Work packages 2, 3 and 4 focus, respectively, on foreign trade, especially between China and EU, social conditions in rural areas and environmental pressures. Work package 5 integrates the findings from the work packages 2-4, leading to an improved specification in the form of the Chinagro II model and to a coherent assessment of the issues under study. Work package 6 deals with communication with policy makers and broad dissemination of the results, whereas work package 7 assures proper management and coordination of the project.

## **3. Policy issues**

At the time of formulation of the CATSEI project in 2006, the leading theme concerning foreign agricultural *trade* was the adaptation of China's food security policy to the food demands of an ever richer population. Past policies had focused in particular on wheat and rice, leading to large surpluses when demand for these staple foods reached satiation levels. Government had to reduce the levels of these food inventories while maintaining a stable domestic supply. At the same time it was clear that the rapidly increasing demand for livestock products could not be met without considerable imports of either meat or feedgrains. China's policy makers clearly opted for domestic production of meat, moving agriculture in a more labor-intensive direction, at the expense of larger import volumes of feed.

These adjustments also have important *social* impacts within China, particularly across regions, since it generates a divergence of interests beyond the classical rural-urban income gap, as more intensive livestock farmers close to urban centers would lose from higher feed prices, to the benefit of feed producers in more remote areas. From an *environmental* perspective the transition generates problems of its own, such as environmental pressure from intensive use of fertilizers and pesticides, local concentrations of animal manure, and larger volumes of human excrements and wastes discharged in cities and consequently no longer available for recycling within agriculture.

Those were the challenges as envisaged for the CATSEI study. However, soon after the project kickoff in early 2007 it became apparent that world agricultural markets themselves have entered a phase of transition that has to be accounted for as well. Its overall characteristics are scarcity and price volatility. Regarding scarcity, the fast growing feed and vegetable oil imports of China and other emerging economies make their impact felt on world markets. Furthermore, besides food, feed and fibres, the new demand category of biofuels has been put in place, largely driven by government policies and subsidies. Both types of increased demand are characterized by a rather inelastic response to price changes. Hence, in case of crop failures or other supply fluctuations in major producing regions of the world the shocks must either be absorbed by inventory changes or lead to high price volatility, at the expense of especially the poorer segments of the world population.

The CATSEI project has adjusted to this changed international setting by incorporating the biofuel dilemma's more prominently in its activity program, by giving priority to analyzing the impact of China's agricultural imports and exports on international prices (one of the research topics already foreseen in the project document) and by organizing its mid-term policy dialogue under the umbrella of the worldwide food-feed-fuel tensions. At the same time, recent signs of increasing labor shortages in China's rural areas due to the continued growth of industry and services require special attention in the project.

#### **4. Chinagro I as point of departure**

As mentioned above, the CATSEI project builds upon the results obtained in the earlier EU-funded CHINAGRO project (2002-2005), in particular on the methodological work in developing the Chinagro I welfare model. The Chinagro I model analyzes the price-based interaction between the supply behavior of farmers, the demand behavior of consumers and the determination of trade flows by merchants, thus allowing simulation of the development of China's agricultural economy until 2030.

Apart from maintenance, the CATSEI project aims at further improving the Chinagro I model. Compared to the original Chinagro I version, Chinagro II has its baseyear updated, its county list renewed, and the impact of China's trade on world prices represented. Furthermore, the specification of agricultural yields, area balances and stable constraints is refined. While confirming many of the major conclusions of earlier Chinagro I simulations, there are also significant differences, mainly due to a stronger specification and a more up-to-date and better grounded parametrization and scenario specification. Chinagro II is the largest and most detailed model of Chinese agriculture available.

The project does more than modeling. Part of the work, especially in work packages 1 and 2 can be described as analysis of *historical trends*. In addition, *targeted studies* are conducted for each of the three topics of the project, i.e. foreign trade, social conditions and environmental pressure. Finally, findings from these studies are applied in the update of the Chinagro model, leading to *integrated analysis* of the different aspects of future developments.

## 5. The historical record

China's agriculture has been growing in a healthy manner for the past 30 years. Food production is rising; incomes are rising; yields are rising and the food chain is becoming more efficient. Farm earnings become more diversified, with a shrinking share of the cropping sector following expansion of the livestock sector, while the cropping sector itself diversified out of staple grains into higher value crops. Furthermore, off-farm employment becomes ever more important for farm households, reflecting an effective reduction of redundant farm labor.

At the same time, trade patterns have been changing as well. China is exporting more labour-intensive fruits and vegetables and higher value commodities, while the nation is importing more land-intensive agricultural commodities, such as soybeans, cotton, sugar and dairy. These shifts are obviously in line with China's comparative advantage. Since 2004, the country has turned into a net agricultural importer but this agricultural trade deficit is almost negligible as compared to the immense surplus in non-agricultural trade.

These changes came with improved welfare. Rural incomes have risen steadily during the past 30 years. Poverty rates have fallen dramatically. The National Bureau of Statistics of China reports that more than 300 million people in China escaped poverty. These successes are mainly based on three drivers: institutional change, stronger market orientation and government investments.

Most of the rise in productivity in the early reform years was a result of *institutional innovations*, particularly the household responsibility system (HRS), a policy that gave individual farmers

control and income rights in agriculture. Since the HRS was completed in 1984, technological change has been the primary engine of the agricultural growth. In this period, total factor productivity growth was around 2% annually for staple commodities. For cash crops, horticulture and livestock it was even higher.

Marketing and price policy also had strong influence on growth and structural change in agriculture. Domestic *agricultural markets* have become increasingly integrated, efficient and competitive. There are only few regulations left and entry is easy. In fact, China somewhat surprisingly can now be considered as part of a group of nations, also comprising Australia, New Zealand and Brazil, with the most free agricultural markets in the world. This is remarkable, given the fact that 30 years ago agriculture was completely run as part of the planned economy.

China's external trade environment has also changed considerably. From a country that was insulated from world markets, today China is integrated closely into global food markets. China's Nominal Protection Rates (NPR) on most agricultural commodities have been steadily declining in the past decades. A key event was China's accession to the World Trade Organization in 2001. Moreover, China moved from a regime in which most international trade in food was a state decision to one in which the private sector is responsible for imports and exports.

Furthermore, China's agricultural production has thrived in no small part due to *investment*. Irrigation has played a critical role in establishing the highly productive cropping systems in China. The proportion of cultivated area under irrigation increased from 18 percent in 1952 to about 60 percent in 2009. The investment into agricultural R&D and China's record in pushing agricultural technology from the experiment stations into the field are no less remarkable. These new technological breakthroughs underlie much of the observed rise of production. In particular, no country in the developing world has pushed plant biotechnology as aggressively as China.

Recent concerns about the country's food security and rural incomes have led government to abolish agricultural taxes – that had been in place for 2600 years! – and to install instead a system of subsidies and income supports. By 2009, these supports accounted for not less than 3.6% of agricultural GDP, largely paid as general input subsidies and only to a limited extent coupled to output (grain subsidies).

Past successes aside, there are still many challenges in the future. Demand-side forces such as population, income and urbanization will put tremendous pressure on China's food economy. On the supply side, China will have to meet this rising demand with less land, less water and less labor while trying to address the environmental problems that have emerged in the past several decades. At the same time, urban-to-rural income differences should be contained and,

especially, isolated rural pockets of poverty must be reduced by linking these areas better to the economy as a whole.

To meet these challenges, China is going to have to take dramatic actions. The government will have to continue to push land reform, giving more secure rights to farm households and encouraging cultivated land rental. Together with increased outflow of labor from agriculture, these measures should lead to larger farm sizes for those who remain in agriculture. More investment and institutional innovations are needed to make markets work even better for farmers and address the needs of consumers as well. Finally, huge investments in especially water control, land improvement and agricultural technology are required to take China from today's farming systems to a system of modern, state-of-the-art farming systems that will support high levels of food production for the nation and incomes for those that remain in farming. These concerns will guide the implementation of the rural development policies of the 12<sup>th</sup> Five-Year Plan (2011-2015).

Global challenges will continue to test China's policy makers as well. Trade relations will have to expand. The emergence of biofuels will put additional pressure on global food markets. China's role in world markets as a supplier and as a consumer will make these global issues also China's issues. Trade policy reforms, though slowed by the eternal stalling of the Doha Round, still are on China's agenda. Regarding biofuel, government has already decided to abstain from ambitious plans. The future call on international markets is already large enough.

## **6. Findings by topic: trade**

Concerning foreign trade, the CATSEI project pays specific attention to China's impact on world markets and to China-EU trade relations, in particular China-EU trade in apples and tomatoes.

The *impact of China on world agricultural markets* is explored through an explicit representation of the world market. It is derived from the GTAP-model of world trade and calibrated on the basis of price and net trade data obtained through replacement of the China module in the GTAP-model by a series of shocks in China's trade volumes. The results show that the effects of changes in China's trade volumes can certainly not be neglected. In the base scenario of the Chinagro II model these changes may well account for increases of up to 5 percent in say, world feed prices. Although not immediately causing turmoil, such increases definitely lead to more pressure on world agricultural markets.

The *China-EU agricultural trade* balance is in favor of China. However, the trade levels are relatively modest, with in 2009 a flow from EU to China of about 2 billion US dollar against a flow from China to EU of about 3.5 billion US dollar. For both EU and China other regions in

the world are far more important trade partners in agriculture. Main products exported from EU to China are fish, dairy, wheat products and pork whereas the main products exported from China to EU are fish, vegetables and fruits. There would be scope for expanding the present volumes if the countries could reach agreement on sanitary and phytosanitary standards (SPS) and on protection of intellectual property rights (IPR). In fact, China and EU are more often rivals than partners in agricultural trade since they compete for imports of feed and exports of high-valued products. Regarding these exports to third countries, they might be scope for joint ventures since the respective comparative advantages differ clearly.

To gain insight into the challenges and opportunities in the agricultural trade relations between China and the EU, two *commodity-specific surveys* are conducted, both focusing on the integration of local farmers in export supply chains. In Shandong apple growers and exporters are surveyed, and in Xinjiang tomato growers and the tomato-processing industry. The apple survey shows that small- and medium scale farmers are quite well integrated in the export chain and very innovative in terms of environmental protection, bagging and adopting new varieties. It also reveals clear limitations on the opportunities for exports, since consumers in the European Union are not willing to pay the high premium for top quality bagged apples that rich Chinese consumers pay. The area of the tomato survey in Xinjiang is developing rapidly into the world's largest tomato processing centre, with two giant processing corporations that together dominate the domestic market. Contrary to the Shandong apple farmers, the local tomato farmers express some concern that they see international price rises insufficiently transmitted to them, unlike price falls.

## **7. Findings by topic: social**

Regarding the social aspects of agricultural transition, dedicated research is undertaken that looks into the living standards of households, recording their poverty characteristics, savings and social security, as well as into the conditions prevailing in the village concerned, taking stock of the degree of price transmission, the extent of labor scarcity and the quality of local governance.

Regarding *poverty*, analysis of the 2005 rural household survey of the National Bureau of Statistics of China (NBSC) shows a Gini-coefficient of just above 0.35, which is markedly higher than in the past and, consequently, gives cause to concern. Inequality appears to be rising between urban and rural areas as well as within rural areas. For income distinguished by quintile, there is a clear positive correlation between total income earned by a household and the fraction of working time spent outside agriculture but cultivated land and education are also positively related to household income. There are also large differences among regions. Nonetheless, off-farm income obviously plays a crucial role, even for farm households. Nationwide, the fraction of off-farm income in total income of farm households almost reaches 40 percent in 2005.

Remarkable is also the high *household savings rate* in rural areas. According to NBSC's Statistical Yearbooks this rate shows a definite upward trend and by 2010 reaches about 30 percent, which is high by international standards, but not when compared to the 50 percent national average (including the corporate sector and its retained earnings). Though partly attributable to thriftiness as a national characteristic the rise is also due to weakening of *social security* in the countryside, where traditional healthcare systems have been dismantled while family-based elderly support is under pressure due to outmigration and the one-child policy, a development described in detail in one project report. A further explanation might point to the gender-bias towards males induced by the one-child policy, as traditionally the son is taking charge of his parents when they retire. Indeed, one study conducted under this project finds evidence that this bias leads to competitive savings by families of adult males to mobilize sufficient (negative) dowry to compensate the wife's parents in this respect. This compensation could explain up to half of the recent increases in household saving rates.

The adequate functioning of rural markets also is a topic of investigation. It appears as mentioned above that domestic commodity markets are nowadays well integrated. This is confirmed by an econometric analysis conducted in the project on the *price transmission* from market to farm gate level. Nonetheless, in remote areas the linkages are still relatively weak, which makes it more difficult for farmers to increase their production without seeing their prices drop. A more controversial issue is whether *rural labor markets* witness labor scarcity, due to industrial development and outmigration to urban areas. Analysis of rural wages in a nationally representative sample of 100 villages – to which the project contributed particularly in formulating and funding the environmental component of the latest survey – shows a clear rise since 2004, suggesting that the Lewis turning point has been reached in several regions and that rural labor is indeed getting scarce.

Many of these developments can only be monitored and guided at local level. This places responsibility on local government. The question is, therefore, whether *local governance* is sufficiently strong and representative to meet the challenges. The 100-village study mentioned earlier finds striking differences across villages with respect to the trust in local government. In regions where trust is deficient, self-governing social organizations have mushroomed, sometimes even taking over the provision of public goods from the official leaders.

## 8. Findings by topic: environment

The environmental component of the project contributes to the 100-village survey of 2008, and conducts specific studies on nutrient surpluses, nitrogen management, climate change and ground level ozone.

Regarding the 100-village survey, the project has formulated questions on pollution and recycling. It appears that about 44 percent of the villages reports worsening of environmental quality over the past 10 years, an alarming outcome indeed. The survey also shows that 85 percent of human excreta is currently used as manure, a very high percentage still but nonetheless significantly lower than two decades ago. Economic prosperity, population concentration and easier access to chemical fertilizer negatively affect this utilization rate. This suggests that conservation of the traditional eco-friendly practices of organic recycling will require special supporting measures.

The project also looks into these fertilizer issues on a nationwide scale, both via model simulations and via specific studies. Simulations show steady and significant surpluses for nitrogen and phosphates on cropland, and deficits for potassium, as will be discussed in the next section. A specific study analyzes *nitrogen management* in more detail for crop and livestock farming separately. It appears that nitrogen losses due to leaching and emissions constitute serious health threats in many counties of China. Policy actions should combine improvement of practices in fertilizer application, technical measures to reduce losses and spatial reallocation of production of livestock.

*Climate change* is another major concern for the future of China's agriculture, although its effects are not merely negative. In general, crop production possibilities will shift northwards, with a larger overall potential for e.g. maize but a reduced potential for wheat. Positive temperature effects may be limited by soil moisture deficits and more frequent extreme events. In total, crop water requirements are projected to increase by more than 10 percent in 2050. Given the now already limited water availability in the North, water stress is likely to become a serious issue, and more generally, climate change will require substantial adaptation of China's cropping systems.

In addition, China also has to cope with crop damage due to *ground-level ozone*, which actually also constitutes a threat to human health, and may have a substantial impact on crop output, in particular for wheat and soybeans. Unfortunately, the possibilities for agronomic adaptation seem rather limited. Hence, reduction of emissions of ozone-precursors is the only solution, basically by reducing the use of fossil fuels.

## 9. Findings of Chinagro II simulations

The integrating component of the project takes on board various results from the targeted studies on specific topics, and analyzes the development of China's agricultural economy until 2030 under different scenarios, using the Chinagro II welfare model. A scenario is defined as a coherent set of assumptions about exogenous driving forces (farm land, population, non-agricultural growth, world prices etc.), derived from the literature and own assessments. Under these assumptions, simulations with the Chinagro model analyze the price-based interaction between the supply behavior of farmers, the demand behavior of consumers and the determination of trade flows by merchants.

The outcomes from the scenarios seem reassuring for China in that foreign imports remain moderate relative to the country's size, though quite large as fraction of world trade. It would be possible to feed people as well as animals without excessive imports. There is even a potential for significant export flows of vegetables and fruits. Regarding concerns, the trends in per capita agricultural value added are problematic, because they stay in all regions behind per capita value added outside agriculture, albeit that they are rising steadily. This leads to growing disparity in per capita incomes within and across regions. No solution will be possible without rural-based industrialization. The mounting environmental pressure from nitrogen and phosphate surpluses and potassium deficits on crop land is another cause of concern.

More specifically, regarding import volumes, the conclusion would seem to be that China is likely to become an even greater importer of vegetable oils, carbohydrates and protein feeds than it is today, and probably expand its imports of maize for animal feeds. This will definitely increase pressure on the world markets of these commodities but the effects remain limited since China's agriculture itself adjusts as well. We note, however, that an expansion of the currently modest biofuel targets would aggravate this problem. Regarding imports of livestock products the situation is much less clear. Since livestock products remain a major source of farm income, government may want to continue its policy of producing most of the meat domestically, while focusing its efforts on the reduction of the associated hazards for human health and the environment. For dairy products the options are even more diverse, due to the ample availability of grazing land, albeit not always in the proximity of cities. This finds expression in widely different import levels of dairy under various scenarios.

Concerning farm incomes, the results emphasize that the farm sector needs high growth outside of agriculture, not only because of the high fraction of off-farm income in total farm household income, but also because of the crucial contribution of livestock to the growth of these farm incomes. Other options can by themselves not compensate for high growth outside agriculture, which in itself increases the rural-urban income gap, a basic dilemma which this study could not resolve...

Under high growth, further trade liberalization favors consumers but it also hurts farm incomes on average. This illustrates the difficult choice between economic efficiency and poverty alleviation that agricultural policy makers often face. Also under enhanced irrigation, farmers see their prices drop, a common finding in scenarios that improve technical opportunities without expanding the outlets. A program to increase biofuel output will not help the farm sector either, not even when the additional crop is produced on new marginal lands. This is because such a program will increase the feeding cost, and hence hurt livestock farmers.

Regarding nutrient balances, the outcomes show that nitrogen and phosphate are generally oversupplied, while potassium is increasingly mined from the soil. The surpluses and deficits are large and pose serious environmental challenges. Nitrogen surpluses may result in greenhouse gas emissions, leaching to the groundwater with a potential toxic effect on drinking water and cause eutrophication in surface water. Phosphate surpluses may cause eutrophication of surface waters, leading to growth of algae in lakes and rivers. Sustained potassium deficits eventually result, after several years of soil mining, in reduced crop yields. All these outcomes call for more efficient nutrient application.

## **10. Dissemination**

The project has conducted an active program of policy dialogue and dissemination of results, mainly through a series of meetings with the business community, policy advisors and fellow researchers. Furthermore, several contributions have been published already in scientific journals or are about to be, and a special issue of the China Agricultural Economic Review is under preparation devoted to CATSEI.

In November 2007 a policy workshop was held in Brussels with traders and policy makers, and in April 2008 a similar event was organized in Beijing. At these meetings concerns were expressed about various hurdles currently encountered in the trade between China and the EU, from both sides. European firms argue that China does not comply with SPS agreements by imposing too many unnecessary bureaucratic hurdles such as 100 percent checking and irrelevant physical norms. The grievance was expressed from EU side that: “China prohibits all imports that are not explicitly allowed whereas the EU allows all imports that are not explicitly prohibited”. The Chinese side expressed the complaint that the EU uses SPS and additional safety or quality requirements to restrict China’s exports to EU. In particular, they criticize the current requirement to sign a separate SPS treaty with each member state, while the overall EU policy tends to follow its most stringent member.

At three scientific conferences special sessions were organized to present research findings of the project: in October 2008 in Nanjing at the international conference on “Rural reform and development: meeting new challenges of the 21<sup>st</sup> century”, in June 2009 in Amsterdam at the 17<sup>th</sup> Annual Conference of the European Association of Environmental and Resource Economists (EAERE), and in August 2009 in Beijing at the 27<sup>th</sup> International Conference of Agricultural Economists (IAAE). In addition, in Nanjing two keynote presentations were given about the worldwide food-feed-fuel tensions. After this conference the CATSEI team made a two-day fieldtrip to Anhui province, visiting the Anhui Agricultural University in Hefei and studying the horticultural supply chain in He Xian County.

Project conferences were held on three occasions. In December 2008 the mid-term policy conference was held in Brussels, with as theme “International food-feed-fuel competition: perspectives from China and the European Union”. In May 2010 a policy workshop was organized jointly with the TAPSIM project, in Brussels, comparing China’s and India’s agricultural transition processes. Finally, at the end of the project in November 2010 the Final Policy Forum was organized in Beijing, addressing the opportunities and challenges of China’s agricultural economy until 2030, on the basis of which a final briefing was given at the European Commission in February 2011.

Throughout the project, the website has assured access to project reports, articles and accounts of project workshops and conferences. At the end of the project it contains the final versions of all of these.

## **11. Concluding remarks**

Now that the CATSEI project has come to an end, it is time to look forward. As was concluded in November 2010 at the Final Policy Forum in Beijing, there is much scope for continuation. Indeed all partners in the consortium expressed their interest in a follow up. Of the options considered we refer to a fragment of the opening speech by the Commission’s representative Ms Jessica Fletcher:

“The European Commission’s own research centre, the IPTS in Seville will develop in the short-term an agriculture analysis group hosting outputs of various projects and DG Agriculture will follow up on this from the work of this project so there is a strong linkage with your work to further policy recommendations.”

The partners in the project welcome this initiative, and will also seek other sources of funding so as to make effective use of the investments in the Chinagro II model and the databases that were constructed. Beyond this, they will try to deepen certain aspects of their research, in the Chinagro

model as well as in special studies. Regarding *trade*, the treatment of SPS and additional food safety measures could be accounted for in a more refined way, as well as the impact of world energy prices on agricultural markets. Regarding *social aspects*, better insight should be gained in the operation of rural labor markets, the off-farm earnings of farm households, the changing age profile and the quality of governance. This may also enrich model specification and would improve scenario specification as well as the interpretation of model outcomes. Finally, regarding *environmental issues*, the gains and challenges associated with application of new technologies such as genetically modified varieties, the impact of enhanced irrigation, the recycling of nutrients and the effects of climate change are all topics for more in-depth analysis. With these issues on their common agenda, the partners will make all attempts to pursue their collaboration.

## **12. Contact details**

All project results can be found on the project website [www.catsei.org](http://www.catsei.org). Coordinator SOW-VU is located at VU University, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands, and can be contacted via e-mail [postmaster@sow.vu.nl](mailto:postmaster@sow.vu.nl) or telephone +31 20 5989321. The project's Beijing Office is at the CCAP premises, Jia 11, Datun Road, Anwai, Beijing, with e-mail [hgqiu.ccap@igsnr.ac.cn](mailto:hgqiu.ccap@igsnr.ac.cn) and telephone +86 10 64889835.