Enhancing the Relationships between Society, Economy and Ecology – The Sino-German Co-operative Projects on Sustainable Land Use in a Nutshell

加强社会、经济和生态之间的联系 ——中德土地可持续利用合作项目

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Abstract

Societies and their economies as well as their environment are intrinsically tied to each other. The German Federal Ministry of Education and Research (BMBF) together with the Chinese Ministry of Science and Technology (MOST), therefore, financially support nine co-operative projects on Sustainable Land Use in order to develop and examine methods and protocols towards a reconciliation of these major pillars of human existence. Research focuses on the assessment and forecast of changes in the structure, function, and dynamics of natural and man-made ecosystems, embracing the relationships between society, economy and ecology.

Six of the nine Sino-German co-operative projects started in 2007, while the other two began in 2008. Basically all of them are interdisciplinary, and in many cases they are transdisciplinary. General management of the joint projects lies in the hands of the Division Sustainable and Environmental Research of the German Project Management Jülich (PTJ) (Projektträger Jülich) in Berlin. The projects combine the expertise of 53 partners (28 from Germany and 25 from China) from various disciplines such as agriculture, biology, ecology, economy, environmental engineering, forestry, geography, sociology, soil science, water and material flow management. Additionally the projects encompass 44 small or medium sized enterprises (SME) as partners.

The current project phases are running until 2010 and 2011, respectively. After approximately one and a half years of co-operative research, the projects have achieved a high degree of integration and cross-fertilisation amongst the different representatives of the research communities in China and in Germany. Initial scientific results have already emerged and are in part published. As the joint projects continually evolve, the opportunity exists not only to adjust but also to create new developments - for the benefit of society, economy and ecology.

摘要

社会和经济以及他们赖以生存的环境彼此间有着内在联系。德国联邦教育与研究部（BMBF）与中国科学技术部（MoST）联合给予 9 个可持续土地利用的项目财政支持，旨在开发和检验

有利于人类生存的这三个主要支柱之间和谐发展的方法和议案。研究的重点是评估和预测自然和人为的生态系统在结构、功能和动态方面的变化，包括社会，经济和生态之间的关系，。 9 项中德合作项目中的 6 项于 2007 年开始实施，其他两个项目于 2008 年开始。基本上，它们都是跨学科的综合研究。联合项目的综合管理由位于柏林的德国项目管理中心(PTJ)可持续和环境研究处负责，该项目有 53 个不同学科的合作者（ 28 名来自德国， 25 名来自中国），包括农业，生物学，生态学，经济，环境工程，林业，地理，社会学，土壤科学，水和物质流管理。此外，该项目还包括 44 个中小型企业作为合作伙伴。

目前在研项目将分别于 2010 年和 2011 年结束。经过约一年半的合作研究，该项目在中德合作研究团体代表之间已经实现了高效的结合，同时有了初步的科学研究成果，部分已出版。随着合作项目的不断发展，不仅存在项目调整的机会，而且还能创造新的发展以造福社会，经济和生态。

1 General Objectives of the Collaborative Research Activities

The general objectives are:

- To improve interactions between man and his environment by the development of technical and conceptual solutions towards sustainability.
- To assess potentials and risks of environmental changes in terrestrial and freshwater ecosystems due to land management practices.
- To develop a research network that is consistently interacting and investigating across different environmental issues and across different spatial and temporal scales of ecosystem changes.
- To provide a contribution to objective based politics, to help integrating policy and to derive outcome-oriented policy measures in the field of land management by contributing to the integrated assessment of socio-economic drivers affecting land-use.

2 The Sino–German Research Collaborations–A General Outline

In order to achieve the objectives mentioned above, MOST (Ministry of Science and Technology) and BMBF (Federal Ministry of Education and Research) have agreed on financing and handling co-operative projects to be conducted in China. Several project proposals went through a review process and finally nine proposals were selected by a steering committee. The chosen projects deal with sustainable land management in the broadest sense – reforestation, rehabilitation of watersheds, biological control and nitrogen management in agriculture, renewable products, recycling of organic residues, generation of value added products, landscape planning and coal fire research as well as elimination of odour emissions from food processing. They combine the expertise of partners from 36 institutions including 11 Non Governmental Organisations (NGO) and small or medium sized enterprises (SME) from China, and 28 research institutions and 39 SME from Germany (Tab. 1 & 2).

Table 1 List of participating Chinese and German institutions (in alphabetical order)

Scientific Partners from China	**Scientific Partners from Germany**

Beijing Normal University (BNU)	Alfred-Wegener-Institute Bremerhaven
Beijing University of Technology (BJUT), Beijing	Bergische University Wuppertal (BUW)
Center for Chinese Agricultural Policy / Chinese Academy of Sciences (CCAP/CAS), Beijing	Dresden University of Technology
Chengdu Biogas Science Research Institute, Chengdu, Sichuan	Federal Institute for Geosciences and Natural Resources (BGR)
China Agricultural University (CAU), Beijing	Federal Institute for Materials Research and Testing (BAM)
China National Bamboo Research Center	Georg-August-University Göttingen
Chinese Academy of Agricultural Sciences (CAAS), Beijing	German Aerospace Center (DLR)
Chinese Academy of Forestry	GKSS Research Centre Geesthacht
Chinese Academy of Sciences / Institute for Remote Sensing Applications (CAS/IRSA)	Humboldt University, Berlin
Hunan Normal University (HNU)	Johann Heinrich von Thünen-Institute (vTI), Federal Institute for Rural Areas, Forestry and Fisheries, Braunschweig
Nanjing Institute of Soil Science / Chinese Academy of Sciences (ISS/CAS), Nanjing	Justus-Liebig-University, Giessen
Nanjing Agricultural University, Nanjing	Laboratory of the Federal State of Hesse (LHL), Subsidiary Kassel
National Agro-Technical Extension and Service Centre (NATESC), Ministry of Agriculture (MOA), Beijing	Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg
Northwest Agricultural and Forestry University, Yangling, Shaanxi	Leibniz Institute for Applied Geophysics (LIAG)
River Scientific Research Institute, Wuhan, Hubei	Leibniz University, Hannover
Sichuan Agricultural University, Ya'an	Research Centre Borstel, Borstel
Tianjin Academy of Agricultural Sciences (TAAS), Tianjin	Technical University Braunschweig
Tianjin Agricultural Technology Information Network, Tianjin	Technical University Freiberg (TU BAF)
Tianjin University, Tianjin	Technical University Hamburg-Harburg
University of Shanghai for Science and Technology, Shanghai	Technische Universität München, Center of Life and Food Sciences Weihenstephan
Xishuangbanna Tropical Botanical Garden/ The Chinese Academy of Sciences, (XTBG/CAS) Menglun, Mengla	Trier University of Applied Sciences, Environmental Campus Birkenfeld
Yunnan Academy of Social Sciences (YASS) Huanchengxilu, Kunming	University of Bonn
Yunnan Agricultural University, Heilongtan, Kunming	University of Freiburg
Yunnan University	University of Hamburg
Zhejiang University, Hanghzhou	University of Hohenheim, Stuttgart
	University of Kassel (Witzenhausen)
	University of Kiel
	University of Passau

Table 2 List of participating Chinese and German SME* and NGOs*

China	Germany
Beijing Dao Institute for Environment and Development (Dao IED), Beijing	ABiTEP GmbH, Berlin
Center for Biodiversity and Indigenous Knowledge (CBIK), Kunming	Agraferm Technologies AG, Pfaffenhofen
China Huadian Group New Energy Development Company, Beijing	Airsense Analytics GmbH, Schwerin
China Shenhua Energy Company Ltd. (CSEC)	AMD Intectra GmbH, Harpstedt
Circular Economy Research Institute of Shaanxi Province	Areal Company, Hengstbacherhof
Feng He Co. Ltd. Kunming	Backhus Kompost-Technologie GmbH, Edewecht
Friends of the Earth (Hongkong)	Bellassana, München
Qingdao Environmental Protection Bureau	Biokraft Albersdorf GmbH & Co.KG., Heide
Shenhua Remote Sensing & Geo-Engineering Company Ltd. (BRSC), Bejing	Cargill, Hamburg
Tian Zi Biodiversity Research & Development Centre, Jinghong	Creaso, Gilching
Yangling Agriculture High-Tech Industry Zone, Yangling	Deutsches Institut für tropische und subtropische Landwirtschaft, DITSL GmbH, Kassel
	Dr. Otto GmbH, Wittenberge
	Environmental Electronic Company, Geislingen
	Gerstel GmbH & Co.KG, Mülheim/Ruhr
	gewitra GmbH, Hannover
	HarbourDom GmbH
	INFOTERRA GmbH, Potsdam
	IP Syscon, Hannover
	JatroSolutions GmbH, Stuttgart
	Kaffeehaus Willy Hagen, Heilbronn
	Kaffee-Veredelungs-Werk GmbH & Co.KG, Hamburg
	Kleeberg Umweltanalytik GmbH, Hamburg
	L.E.E. s.a.r.l., Junglinster, Luxemburg
	LINDENBERG Anlagen GmbH, Rösrath
	Lufttechnik Bayreuth, Goldkronach
	Merck KGaA, Darmstadt
	Noske-Kaeser, Hamburg
	Ölmühle, Hamburg
	Pfeffer Agri Consult Limited, Gingen
	Phyto-Energy Ltd, Scharnebeck
	Rubotherm, Bochum
	Silver & Baryte Minerals, Marl
	SKW Stickstoffwerke Piesteritz GmbH, Lutherstadt Wittenberg
	Studentenwerk Hamburg
	tec5 AG, Oberursel
	Troki Manufaktur, Witzenhausen
	Umwelt-Elektronik GmbH, Geislingen
	Wehrwissenschaftliches Institut Münster, Münster
	WESSEL Umwelttechnik GmbH, Hamburg
	Wilhelm Schwabe GmbH, Karlsruhe
	X-TERN International, Altenbamberg
	YARA, Dülmen

*SME = Small or Medium sized Enterprises
*NGO = Non Governmental Organisation

All the co-operative projects are funded by BMBF and MOST, the latter is supporting the Chinese research consortia while BMBF is financing the German research teams. General management of the German research teams is the task of the Project Management Jülich in Berlin (PtJ). Figure 1 shows the structure-activity relationships of the co-operative projects.

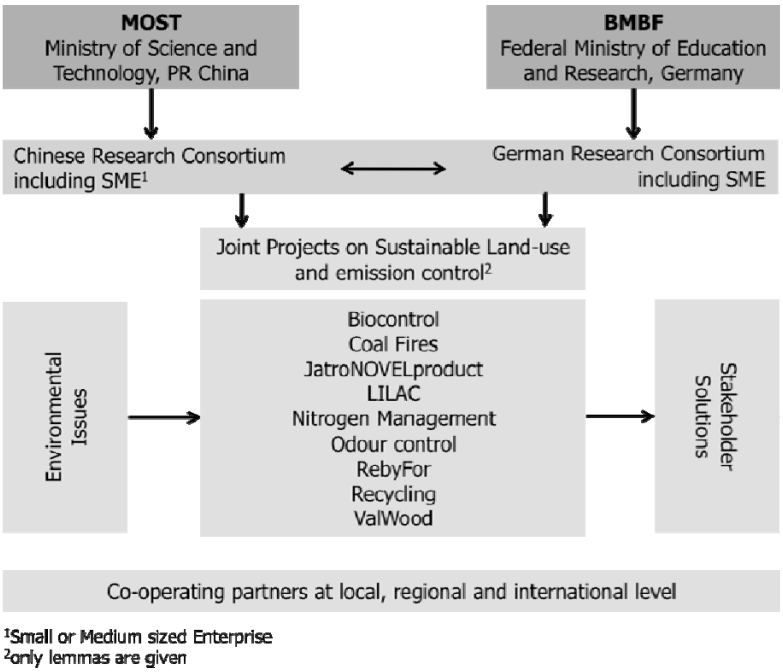

Figure 1 General structure and integration of the Sino-German co-operative projects.

3 Geographical Range of the Research Collaborations

The geographical map (Fig. 2) depicts some of the regions in China where research takes place. The Sino-German co-operation is addressing environmental issues throughout the country. The study area extends from the tropics to the temperate zone, covering remote and biologically diverse regions as well as densely populated and environmentally degraded areas.

Figure 2 Geographical map of the Sino-German co-operative projects.

4 Research Approaches and Scientific Contents

The issue of land use is simultaneously influenced by economics, society and the natural environment. Economic development, along with improvement in infrastructure, can open new opportunities for a region to market its products. However, such development can also lead to the loss of natural resources and cultural heritage. The danger of this is particularly prevalent where economic development occurs very rapidly due to increased concentration of only a few forms of land use. It is therefore the task of land use planners to offer an economic perspective, as well as to ensure the preservation of natural and socio-cultural values. In addition, it is necessary to assess the consequences of possible land use changes for the economy, society and environment, along with their reciprocal effects.

The matrix indicated in Table 3 was constructed to develop synergy and facilitate the co-operation between the different projects.

Table 3 Matrix of cooperativeness

Lemma	**RebyFor**	**LILAC**	**ValWood**	**RECYCLING**	**JatroNOVEL product**	**Biocontrol**	**NITROGEN**	**Odour Control**
RebyFor	1, 2, 3, 4, 5, 6, 8, 9, 10, 11							
LILAC	1, 2, 3, 4, 5, 6, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 8, 9, 10, 11						
ValWood	1, 2, 8, 9, 10, 11	1, 2, 3, 9, 10, 11	1, 2, 3, 4, 8, 9, 10, 11					
RECYCLING	3, 4, 5, 9	3	3, 4, 9	3, 4, 7, 8, 9, 10, 11, 12				
JatroNOVEL product	-	1, 2, 3, 5, 9, 11	3, 8, 9	-	1, 2, 3, 5, 8, 9, 11			
Biocontrol	1	1, 9, 11	1, 9	-	-	1, 9, 11		
NITROGEN	2, 3, 4, 8, 9, 11	-	-	3, 8, 9, 10, 11, 12	-	-	6, 8, 9, 10, 11, 12	
Odour Control	-	-	-	-	-	-	12	12

Legend (Key activities): **1** Agro-Forestry, **2** Poverty Reduction, **3** Biomass & Renewable Energy, **4** CO_2 Potential & Sequestration, **5** Erosion, **6** GIS-Application, **7** Recycling Management, **8** Land Use Planning, **9** Economy, **10** Sociology, **11** Soil Analysis, **12** Emission Control

4.1 LILAC(Living Landscapes China)*"Rural development by land use diversification-actor-based strategies and integrative technologies for agricultural landscapes in mountainous Southwest China"*

The Chinese province of Yunnan harbors a unique landscape, as well as great biological and cultural diversity. Over the past few years, the southern part of Yunnan, the Dai Autonomous Prefecture of Xishuangbanna, as well as the whole Mekong regions have witnessed a rapid growth of both infrastructure facilities and economy; keeping a balance between such changes and the maintenance of the natural and cultural heritage is currently the greatest challenge faced in developing the region sustainably.

The market entry into national and international markets has progressed very fast, resulting in a dramatic effect on land-use management. The production of natural rubber (*Hevea brasiliensis*) plays a prominent role in the region's economy. China is a major consumer of this natural resource. Due to its tropical origin of the plant China's land suited for cultivation of the rubber tree is restricted to the very southern parts of the country. Therefore, despite efforts to extend rubber cultivation by developing adapted clones, China is still strongly dependent on imports and further promotes its cultivation and extension.

There has been a dramatic increase in the area dedicated to monoculture rubber plantations – to the detriment of floral and faunal diversity, as well as to the traditional land use and culture. At the same time, however, due to the largely improved infrastructure, there are new opportunities for the marketing of specific regional products, such as medicinal plants, spices, or ornamentals. This opens alternative avenues for income diversification and improvement in the quality of life of rural populations.

The goal of the collaborative project Living Landscapes China (LILAC) is to develop a

GIS-based computer model that can produce precise, spatially-specific prognoses of the effects of land use changes on the economy, society and environment, and evaluate such projections, in order to achieve a stakeholder and knowledge-based procedure for land use planning. For development of the model, data are being collected in the Nabanhe catchment area near Xishuangbanna's prefecture capital Jinghong, in the three major fields of research: economy, sociology and ecology. In each of the three fields of activities submodels will be generated that will be integrated in the overall model. Additional aims of this project are to: i) develop and demonstrate the expertise of German researchers and businesses in land use and environmental planning under tropical conditions, and ii) strengthen their position in the environmental sector, which is becoming more and more important for development in China. Regular updates on the project are being provided through the project website www.lilac.uni-hohenheim.de/en

4.2 Jatro NOVEL product *"Fuel and Feed for the Future from Jatropha"*

Jatropha curcas, a multipurpose plant, has high water use efficiency, is not grazed by animals and is drought and disease resistant in the wild. Other major attributes which make *Jatropha* an exciting future crop for energy generation is its capability to grow in degraded, poor and marginal lands, with no competition for food or feed.

Environmental degradation and depleting oil reserves are matters of great concern around the world. Developing countries like China depend heavily on oil imports. *Jatropha* based biodiesel is receiving increasing attention in China because its use is benign to the environment and enhances energy security by making it less dependent on fossil fuel imports. Our financial analysis has shown that with the present production level of *Jatropha* seeds and hence of oil for conversion to biodiesel, planting *Jatropha* for biodiesel production alone is not economical. Therefore, it is imperative to generate high-valued co-products and make the oil extraction process more efficient; and the joint BMBF-MOST project on 'Fuel and Feed for the Future from *Jatropha*' aims to achieve this.

So far, we have detoxified the kernel meal (60% protein) and it has been demonstrated to be an excellent substitute for soybean meal in the diets of fish and farm animals. From the screw-pressed *Jatropha* cake high-valued protein concentrate (90% protein) having good amino acid levels has been generated. The use of by-products obtained during the process of biodiesel production from oil as a constituent of livestock feed has been investigated. Other innovations include: i) enhancement of the efficiency of screw-press based oil extraction from *Jatropha* seeds by over 30% compared, and ii) development of a low cost furnace which uses *Jatropha* seed shells as a source of energy, and of small and large scale *Jatropha* oil cleaning processes so that the oil could be used in cooking stoves.

The production of value-added coproducts would motivate the farmers and the industry for extensive planting of *Jatropha* for reclamation of marginal and degraded lands by

enhancing economy of the biofuel production and decreasing investment risk.

4.3 Odour Control *"Separation of odorous compounds by adsorption and absorption"*

Odorous emissions, especially exhaust air from restaurants, cause increasingly inconveniences and disapproval in highly populated areas. A major aim is to provide technologies to meet these large demands of the population and of the legal regulations. Modern technological methods, based on adsorption and absorption techniques deliver potentials to reduce these emissions significantly. Industrial partners delivering compounds for waste gas treatment plants see promising perspectives to market their products, such as adsorbents, and catalysts, respectively, process engineering and plants, inclusively process analyses and control, preferably in these regional market segments of Europe and China. The project is organized in the following three subprojects:

Odour Management and Analytics: In this group the industrial on-site management of diverse odour emissions as well as the process analyses on the basis of sensor arrays applied in 'electronic noses' are on focus. Chemical analyses are to be developed for the evaluation of the different industrial purification methods as well as for the identification of substances causing odorous effects.

Application of Adsorption and Absorption Technologies: Adsorption techniques employing different adsorbents, and also catalytically procedures will be evaluated to separate and convert the waste substances simultaneously. A new highly potential separation processing within a fluidized bed is also planned to be investigated. Further concentration is put on absorption processes to purify the (off-)gases of a fermentation plant converting "bio-waste" to energy.

Simulation and Process Automation: For the industrial application the developed technologies have to be integrated into whole automated processes. For the engineering the simulation tools ranging from the basic thermo-physical data to the whole process simulation become more and more important, which will contribute into the project. Additionally, the energy optimization will be calculated by the process integration.

The project homepage is accessible via: www.odour.de

4.4 Biocontrol *"Sustainable agriculture by use of bacterial formulations which supports plant growth and suppress plant diseases caused by phytopathogenic microorganisms"*

In order to secure the supply of safe and wholesome food, there is clearly a need to

develop new agricultural practices that supplement and, ultimately, may even replace existing plant disease control strategies. This is also true in Chinese agriculture, where in past the massive use of agrochemicals has damaged the environment in a manner which is not further tolerated by the government. Therefore, a strategy with the potential to supplement or to reduce the use of chemical pesticides has to be implemented now. A promising alternative is the use of formulations of selected natural soil bacteria as plant growth promoting (biofertilizer) and/or biocontrol agents. Some root colonizing bacteria (rhizobacteria) are considered as efficient microbial competitors in the root area where they are exerting their beneficial effects on plant growth and development.

In frame of the Sino-German collaboration program a highly efficient plant growth promoting bioproduct based on spore-forming natural soil bacterium *Bacillus amyloliquefaciens* FZB42® (proprietary name of Abitep GmbH Berlin, Germany) was successfully applied as microbial biofertilizer in different Chinese crops (http://www2.hu-berlin.de/chinapgp/). After positive experience during application in 2007 and 2008, the companies FengHe Co. Ltd., Kunming, P.R. China and ABiTEP GmbH, Berlin, Germany, which are partners in the Sino-German collaboration project, agreed to establish a joint venture enterprise named JV enterprise Defeng Co. Ltd. JV is aimed to apply microbial products, especially biofertilizers and plant strengthening agents, in Chinese agriculture and horticulture. The first office of the company has already been started its work at the territory of the Chinese cofounder company FengHe Co., Kunming, Yunnan province. Further offices in Nanjing and Beijing are planned, which will greatly improve efficiency of the JV.

During the first stage, the JV will concentrate on applying biofertilizer in different Chinese regions and crops in order to improve conditions of their application. In addition, a network of distributers and experts for their application will be established. Also comparison of the biofertilizer with native Chinese products including several promising bacterial strains, provided by the partners of the Sino-German collaboration program, will be performed. After a successful trial period the second stage of the JV is planned to be introduced in 2010. In this stage, a production line will be established. It is necessary to ensure, that during the process of product manufacture in a Chinese fermentation plant, all the quality parameters of ABiTEP products are rigorously fulfilled. Then, it will be possible to produce a biofertilizer according to the international standard with a price competitive for Chinese farmers. A successful introduction of such a product to a Chinese market will greatly facilitate further improvement of Chinese agriculture especially in respect of a better environment, saving of chemical fertilizers and pesticides. Scientific work performed in frame of the “Biocontrol” project will pave the way for a successful development in applying environmental friendly bioagents in Chinese agriculture.

4.5 ValWood *"Innovative sustainable land use"*

The aims of the project are the development and the introduction of an innovative sustainable land use concept that is adapted to the specific conditions of China and Germany. The developed concept should provide an alternative to the current afforestation, reforestation and landscape restoration of formerly agricultural land as well as secondary and degraded forest land.

The new system combines the production of valuable timber and the production of biomass together on the same site. Biomass can be cultivated as fast-growing tree species as well as rattan or bamboo. The combination of long-rotation cycles and short-rotation cycles leads to a multilayered stand structure and a continuous supply of resources. This generates various ecological and economical benefits. Continuous cover of land and soil with valuable crop trees offers protection against erosion caused by water and wind. The trees also have a beneficial influence on the micro-climate by reducing extreme fluctuations in weather conditions. The stand structure will in many cases improve fauna habitats. As a result of the long-term growth and the processing of valuable timber into products of high quality and long durability substantial amounts of carbon will be stored over considerably long time. If the biomass is used for energy generation fossil carbon emission can be reduced.

In addition, economic benefits are generated during the differing production periods. Cultivating plants with a short rotation leads to yields in a short time while cultivating valuable timber with a long rotation brings yields in a long time. Because of aiming for different production targets on one hand the site productivity can be increased and on the other hand the income of the land owner can be diversified and increased. For more detailed information about the ValWood project please have a look at the project homepage: www.valwood.de

4.6 NITROGEN *"Innovative nitrogen management technologies to improve agricultural production and environmental protection in intensive Chinese agriculture"*

In this joint transfer project new technologies and innovative agricultural practices together with a guidance of policy and decision makers will optimize the agricultural production and protect the environment in intensive Chinese agriculture. The project will strongly contribute to extending technology in China by formulating and implementing agro-tech extension programs, by introducing, testing and demonstrating new techniques, products, and innovative management practices in representative cropping systems and for different farm sizes. The aim is to reduce the excessive mineral nitrogen use in order to support sustainable and resource-saving agricultural production. Improvements in nitrogen and water management will be able to optimize China's

agriculture in terms of productivity, cost efficiency, resilience and self-sufficiency, and to protect the environment from nitrogen pollution.

In the TUM-coordinated research group experimentation within on-farm field trials has been started with the goal to sense increasing levels of nitrogen fertilizer applications and to develop algorithms for optimized nitrogen management. Training of Chinese scientists in proximal sensing technologies as well as on-farm quick testing has been commenced at TUM. A large survey of soil nitrate sampling has been conducted in various provinces in China with the goal to test the applicability of soil nitrate quick testing.

In the TU Braunschweig-coordinated research group, five pilot counties have been chosen from N to SE China. Studies on farmers' fields for demonstration purposes have been initiated. Exact field experiments (irrigated rice, maize) for the testing of slow-release fertilizers with nitrification inhibitors are currently in progress. For more information please refer to the project homepage: www.nitrogen-management.de

4.7 RECYCLING *"Recycling of organic residues from agricultural and munici-pal origin in China"*

The project takes advantage of different research groups and the involvement of German small and medium-sized enterprises to develop integrated strategies and solutions for the recycling of organic residues in China. It aims at reducing pollution, abating greenhouse gas emissions, improving nutrient cycling, generating renewable energy and increasing regional added value in the Chinese countryside.

In one approach, five research sites in Shaanxi, Shandong, Jiangxi and Beijing have been selected to develop economically viable and ecologically sound recycling projects through regional material flow management, stakeholders' involvement, innovative financial schemes and technology transfer. A parallel approach takes into account planning, technical improvement regarding animal production techniques, feed optimization, manure storage and treatment for minimizing emissions, as well as sanitation, designation of organic fertilizers for specific usage, carrying capacity of cropland, economic factors, administrative issues and environmental regulations. Starting from the technical situation of a selected pilot pig raising farm near Beijing, an improvement of the regional situation, as well as intensive animal husbandry in peri-urban areas of other large Chinese cities is envisaged.

On-site visits in Lingtong and Yangling (Shaanxi Province), as well as Xunwu County (Jiangxi Province) were carried out in October 2008. Representatives of four company partners joined the visits. Based on the information and data collected, the Institute for Applied Material Flow Management (IfaS) has developed the material flow analysis for

Yangling and Lingtong research sites together with the German company partners. In April 2009, data were collected in the Changping district of Beijing. Furthermore, the Trier research group was able to conclude that German biogas technologies have advantages and market potentials for type III biogas projects in China: Market potentials oriented projects with companies as independent investors.

The Bonn-Braunschweig research group started their sampling campaign in Shunyi District of Beijing following a workshop in Beijing in March 2009. A variety of different field plots with different crop rotations and fertilizer use were selected and soil was sampled to be analyzed for C, N, P, K, heavy metals and antibiotics. In questionnaires, farmers described their fertilizing practice. The nutrient fluxes on the farm are currently being investigated by balancing the nutrient and water inputs, and the outputs in form of pigs, excrement, waste water and gaseous emissions. Parallel the existing treatment technologies of the excrement such as composting and biogas production are assessed in terms of hygiene, treatment efficiency and nutrient loss. A socioeconomic survey will describe the economic, hygienic and agronomic situation of the farmers in Beilangzhong Farm and village. The data are the base to optimize the nutrient fluxes on the farm. German SMEs started their activities in the field of composting and gaseous emissions from biogas plants.

The results will improve nutrient fluxes and reduce the resource input into animal husbandry. (i). Different new organic and mineral fertilizers will be produced to create an added value to organic waste. (ii). The potential risk by excessive use of organic and mineral fertilizers will be reduced. (iii). The project is presented in details on the homepage: www.organicresidues. com

4.8 RebyFor *"Rehabilitation of degraded land ecosystems by forestation in mountainous areas in Southern Shaanxi Province, China"*

Multiple attempts have been made by the Chinese Government to improve the environmental situation and protect water resources in the south of the Shaanxi Province, as land ecosystems have been degraded due to inappropriate land use and deforestation. Rehabilitation of degraded lands is an option which offers potential commercial value as well as important ecological benefits. Therefore, the Sino-German project was initiated with the overall objective to develop and demonstrate a "land use planning system" for a sustained land use. Information to support the development of the planning system is largely gained from three field experiments on erosion, rehabilitation measures, and assessment of forest resources in addition to a study on socio-economy in the study area. The conception of the project is based on the assessment of the prevailing situation (erosion of various vegetative covers, forest resources, and socioeconomic conditions), evaluation of rehabilitation measures employed to improve the situation, and the

development of the planning system. The land use planning system will provide a range of prospective possibilities to improve the soil conservation in the region. Taking into account the particular economic and social considerations, a priority list of areas, where urgent actions must be taken, can be compiled. In addition, recommendations for appropriate land use can be formulated. www.wzw. tum.de/china

4.9 Coal Fires *"Coal Fire Research"*

China is the biggest producer of coal in the world and mines with about approx. 2000 Mt of raw coal per year. Approximately 70% of Chinas energy consumption is covered by coal. According to the 10th five-year-plan for the coal industry of the State Economic and Trade Commission[1], coal will continue to be the major source of energy for China's industries in the next years. Taking into account economic growth rates of 7-8% in the coming years it is obvious that coal is going to play an even more important role in China's economic development. At the same time it is estimated that about 10-20 Mt of coal are being burnt in uncontrolled coal fires each year, which corresponds roughly about the yearly production of coal in Germany (approx. 26 Mt in 2006). Estimation exists that significantly more coal is lost in China each year, since the fires hinder the accessibility for mining operations in the vicinity of previous fires.

The rapid expansion of uncontrolled small-scale coal mining activities in remote areas during the last 30 – 40 years is expected to have led to an increase of human-induced coal fires. Especially the arid and semi-arid belt in North China - stretching from Xinjiang the west to Heilongjiang in the east - is affected by numerous of coal fires of various dimensions. This northern coal fire belt in China extends over a huge area of 5000 km east-west and 750 km north-south. Beyond the huge economic losses of natural resources resulting from uncontrolled combustion of high quality coal deposits, another problem is the enormous environmental consequences of derelict land that results from coal fires.

Extinguishing uncontrolled coal seam fires is an extremely difficult, time-consuming, and costly enterprise. Even large-scale efforts often fail since they lack a thorough scientific understanding of the ignition processes. Based on different applied geophysical, geochemical and remote sensing related approaches, extinguishing methods are evaluated and improvements are currently under development. In addition measures derived from in-situ and laboratory experiments serve as input parameters for numerical modelling strategies to simulate and accompany the extinction activities. The aim is to maximise the extinction success and to minimise the inherent risks.

[1] In march 2003, the responsibilities of the State Economic and Trade Commission (SETC) were taken over by the National Development and Reform Commission (NDRC), SETC no longer exists as a Commission

The project will also contribute to the current ambitions to accredit coal fire extinction activities within the framework of the Kyoto Protocol and beyond. Mainly CDM-related activities will give credit and mutual benefit for reducing the greenhouse gas (GHG) emissions from coal fires in future.

5 Synthesis

China is currently at a crossroads of its agricultural and environmental development. The increas ing industrialization, with a growing urban population and an unprecedented rise in the country's economy, is leading to changes in human consumption and agricultural production patterns. At the same time, new forms of pollution from animal livestock raising, organic residues from intensive agricultural production, and over-fertilization, besides depletion of water resources and soil erosion, are increasingly common. For China, this situation is especially dramatic, as nutrient cycles which were largely closed until about 25 years ago when agriculture was mainly carried out on a farmers' household scale, are being disrupted with grave consequences. The situation is particularly serious at the rural-urban interfaces. The recent harmful developments can be grouped as environmental pollution, greenhouse gas emissions, sanitary risks and soil degradation aspects, among others, and are risking to undermine the very basis of China's recent successful economic modernization drive.

The Chinese government is aware of the current threats to its sustainable development. On the other hand, Germany is a leading nation in environmental technology and environmental management. Therefore, as has frequently been pointed out by our Chinese partners, the present time is very suitable for carrying out joint Sino-German co-operative research aimed at transferring innovative technologies and management strategies into Chinese agriculture and environmental sciences as well as to establish market links.

We are therefore convinced that this group of nine projects on sustainable land-use which have been jointly agreed upon in the Sino-German Science and Technology (S&T) Consultations between the Chinese MOST and the German BMBF in March 2007 may add a further impetus and momentum to our two countries' cooperation in the field of the environment and beyond.

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