This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the United Nations System in China concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by United Nations System in China.

Working Together to Tackle Climate Change: The Government of China and United Nations System

The China Climate Change Partnership Framework - Final Report

United Nations Theme Group on Climate Change and Environment

July 2011

I. List of Contents

II. Lists of Figures, Tables, Case Studies and Acronyms

Figures

Tables

Case Studies

List of Acronyms

ACCA 21	Administrative Centre for China’s Agenda 21
CA	Conservation agriculture
CAAS	Chinese Academy of Agricultural Sciences
CCICED	China Council for International Cooperation on Environment and Development
CCICED-MEP	China Council for International Cooperation on Environment and Development, Ministry of Environmental Protection
CCPF	China Climate Change Partnership Framework
CDM	Clean Development Mechanism
CECIC	China Energy-Conservation Investment Corporation
CER	Certified Emission Reduction
CICETE-MOFCOM	China International Centre for Economic and Technical Exchanges
CIIMC	China International Institute of Multinational Corporations
COP	Conference of Parties

C-RESAP	Climate-Resilient and Environmentally Sound Agricultural Production
CSR	Corporate Social Responsibility
EEA	European Environment Agency
EH	Environmental Health
FAO	Food and Agricultural Organization
FYP	Five Year Plan for National Economic and Social Development
GBO	Green Business Options
GDP	Gross Domestic Product
GHG	Greenhouse gas
GNI	Gross National Income
Guangcai	China Society for Promotion of the Guangcai Programme,
GWP	Global-warming Potential
HIA	Health Impact Assessment
IESDA-CAAS	Institute of Environment and Sustainable Development in Agriculture of the Chinese Academy of Agricultural Sciences
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
IPPs	independent power providers
LCE	Low Carbon Economy
LEHAP	Local Environmental Health Action Plan
LULUCF	Land Use, Land-Use Change, and Forestry
MDG-F	MDG Achievement Fund
MDGs	Millennium Development Goals
MEP	Ministry of Environmental Protection
MIIT	Ministry of Industry and Information Technology
MOA	Ministry of Agriculture
MOFCOM	Ministry of Commerce
MOH	Ministry of Health
MOHRSS	Ministry of Human Resources and Social Security
MRV	Measurable, Reportable and Verifiable
MWR	Ministry of Water Resources
NDRC	National Development and Reform Commission
NEA-NDRC	National Energy Administration
NEHAP	National Environmental Health Action Plan
OECD	Organisation for Economic Cooperation and Development
PRECIS	Providing Regional Climates for Impacts Studies
RCUDE-CASS	Research Center for Urban development and Environment – Chinese Academy of Social Sciences
SARs	Special Economic Regions
SEIs	Strategic Emerging Industries
SNWD	South-North Water Diversion
SRES	Special Report on Emissions Scenarios

UNAPCAEM	United Nations Asia and Pacific Centre for Agricultural Engineering and Machinery
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization
WHRPG	Waste Heat Recovery Power Generation
YRB	Yellow River Basin
YRCC	Yellow River Conservancy Commission

Currencies:

CNY	Chinese Yuan/ Renminbi
€	Euro
US$	US Dollars

Weights and Measures:

Kg/ha	Kilogramme per hectare
km	Kilometre
m	Metre
mm	Millimetre
Mu	(亩) Unit of area equal to one fifteenth of a hectare
MW	Megawatt

Chemical Abbreviations:

CH_4	Methane
CO_2	Carbon dioxide
N_2O	Nitrous oxide

III. Foreword by United Nations Resident Coordinator and XXX National Development and Reform Commission

The China Climate Change Partnership Framework (CCPF) of 2008-2011 was part of a unique and ambitious global experiment to help promote progress towards achieving the Millennium Development Goals and catalyze UN reform. This partnership of nine UN Agencies – FAO, ILO, UNAPCAEM, UNDP, UNEP, UNESCO, UNICEF, UNIDO and WHO – and ten Government ministries – NDRC, CICETE-MOFCOM, CCICED-MEP, MOA, MOH, MOHRSS, MWR, CIIMC and the Guangcai Programme – was made possible through the generosity of the Spanish people and the commitment of their Government to delivery through the United Nations System.

In this paper, we present some of the key results of our work over the last three years under the CCPF joint programme including main findings, policy recommendations and selected case studies from our work in the field. We hope that through this occasional paper you will gain insight into the value added of the work that was completed.

The programme has helped contribute to the mainstreaming of climate change into Government policy; mitigation of GHG emissions; transition to a low-carbon economy; scientific understanding of China's vulnerabilities and adaptation to climate change. However, it must be noted that China is a large country with a large population and perhaps one of the most vulnerable developing countries in the world. Three years is not sufficient time to fully tackle all the issues that have been addressed in the programme, and further joint efforts are needed to achieve climate resilience and sustainable development in China.

We would to offer our thanks and appreciation to the Government of Spain once again for making all of this work possible.

At the same time, we would like to thank all our colleagues and partners for all their hard work over the last three years.

Renata LOK-DESSALIEN	XXX
UN Resident Coordinator	National Development and Reform
China	Commission

Foreword by Spanish Ambassador to China

Recognizing that we live in an interdependent world and face many global challenges which require coordinated solutions, in 2006 the Government of Spain gave the United Nations System € 528 million to establish the MDG Achievement Fund (MDG-F). The MDG-F aims to accelerate progress toward the Millennium Development Goals, advance UN reform and implement the Paris Declaration, while also emphasizing the alignment and national ownership of its programmes.

The MDG-F has funded more than 120 programmes in 49 developing countries around the world. The CCPF was the first to be awarded funding and is largest programme under the Fund. It was also the first of four joint programmes to be implemented in China. The other ongoing programmes are the China Culture and Development Partnership Framework, Protecting the Rights of China's Most Vulnerable Young Migrant Workers, and Improving Nutrition, Food Safety and Food Security for China's Most Vulnerable Women and Children.

The Embassy of Spain in China has followed with great interest the progress of all four MDG-F sponsored programmes in China and is delighted to have had the chance to contribute to China's efforts in tackling issues in climate change policy, mitigation and adaptation under the CCPF. It must be noted that China is still a developing country, and as this paper stresses there is still much work to be done in mitigation. At the same time China has vulnerabilities in many different areas that need to be tackled for it to be able to adapt to the effects of climate change.

In this regard, the Government of Spain, together with the European Union, will continue looking for a just and balanced approach to tackling climate change through the UNFCCC process. Our country, while respecting the principle of common but differentiated responsibilities, will continue to work to reduce GHG emissions, adapt to the effects of climate change and support, both financially and technologically, developing countries.

We congratulate the programme management on the successful completion of all programme activities and would like to take this opportunity to thank the UN System, the Government of China, academic institutions, civil society organizations and private companies along with all the other stakeholders who participated in the programme and helped contribute to its success.

Eugenio BREGOLAT OBIOLS
Ambassador of Spain to China

IV. Acknowledgements

We offer ours thanks first of all to the Government of Spain and the Spanish people for making all our work possible, to all of our colleagues at MDG Achievement Fund Secretariat, in particular Ms. Sophie DE CAEN and Ms. Paula PELAEZ for their continuous support over the last three years.

For their role in the management and coordination of this programme, we would like to thank our colleagues at the National Development and Reform Commission, Mr. SU Wei, Mme HUANG Wenhang, Mr. JIANG Zhaoli, Mme LI Liyan, Mr. WU Jianmin and Ms. LI Yan, at MOFCOM, Mme LIANG Hong, at the UN Resident Coordinator's Office, Mr. Pablo BARRERA and Mr. Steven SABEY and CCPF Joint Programme Coordinator, Ms. Catherine WONG.

For all their hard work, dedication and concrete technical contributions to both programme results and this paper, we would like to thank all our UN and Government colleagues: Ms. AI Yuxin, Mr. Sajjad AJMAL, Mr. Alessandro AMADIO, Mr. BI Shouhai, Prof. CAI Dianxiong, Mr. CHANG Ping, Ms. CHENG Qian, Ms. Amelia CHUNG, Ms. DING Zhiming, Prof. DONG Hongmin, Mr. Mathew FALKOFF, Dr. FENG Yong, Mr. Theodor FRIEDRICH, Dr. GAO Zhanyi, Mr. HAO Zhao, Mr. HAO Zhiming, Mr. LeRoy HOLLENBECK, Dr. HU Yaqiong, Ms. LEI Jun, Mr. LI Rusong, Prof. LI Yu'er, Dr. Clemencia LICONA MANZUR, Mr. LIU Faxin, Mr. LIU Hao, Mr. LIU Ke, Ms. LIU Shijun, Mr. LIU Xin, Dr. Ramasamy JAYAKUMAR, Ms. JIANG Han, Ms. JIANG Nanqing, Dr. JIANG Xiaohui, Mr. JIN Hai， Mr. Khalid MALIK, Ms. Shirley MATHESON, Ms. Marina MA, Dr. MAO Jixiang, Dr. Pillay MUNKUNDAN, Mr. James NEW, Ms. Maria PAAVALAINEN, Dr. Brent POWIS, Mr. Wolfgang PRANTE, Mr. Satoshi SASAKI, Dr. SHANG Hongqi, Mr. SONG Dongfeng, Mr. SONG Ruipeng, Mr. Hans SPRUIJT, Ms SUN Feng, Dr. SUN Xuebing, Dr. SUN Yangbo, Dr. Rhodri P. THOMAS, Mme. WANG Guiling, Mrs. WANG Ling, Mr. WU Xiuhe, Dr. XIE Yang, Dr. XING Jun, Ms. XIONG Xiaoqin, Mr. WANG Xuening, Dr. YANG Jianqing, Dr. ZHA Yan, Dr. YANG Zhenbo, Mr. ZHANG Shigang, Dr. ZHANG Weidong, Dr. ZHANG Xubiao, Dr. ZHANG Ying, Ms. ZHANG Yu, Dr, ZHAO Yuechao …along with all our experts and local and international colleagues both at HQ and out in the field.

Edward CLARENCE-SMITH
Chair, UN Theme Group on Climate Change and Environment/
UNIDO Representative to China

V. Executive Summary

Working Together to Tackle Climate Change: The Government of China and United Nations System - Executive Summary

Sponsored by the Government of Spain's MDG Achievement Fund, the China Climate Change Partnership Framework (CCPF) brought together nine UN Agencies, ten Government line ministries, local Governments, and a host of other counterparts from academia, the public and the private sectors, to deliver a series of interventions to promote the mainstreaming of climate change mitigation and adaptation into Government policy and China's achievement of MDG-7: environmental sustainability. The CCPF was approved on 17 December 2007, signed on behalf of the Government of China by the Ministry of Commerce in April 2008, and officially kicked off on 9 May 2008. It will come to a close in September 2011.

At the policy level, the CCPF has already helped the Government of China in formulating its position on post-Kyoto strategies in the international climate change negotiations, supported the formulation of China's Basic Energy Law, and helped develop rural energy strategies. The programme has also helped China to reduce its carbon intensity and GHG emissions by successfully demonstrating heat-recovery power generation technology and clean coal technology while exploring the effects on employment of a transition to a low-carbon economy.

The programme has evaluated the feasibility of the dissemination of alternative energy sources such as biomass pellets as well as the potential application of the Clean Development Mechanism (CDM), explored through in-depth studies on biogas and conservation agriculture. The awareness of more than 200 companies was raised on climate change, corporate social responsibility and the UN Global Compact, while vital information was disseminated on green finance mechanisms available to the private sector. Moreover, through training on Green Business Options, students and entrepreneurs at more than 20 universities and training institutions were given the skills needed to go out and explore green business opportunities (GBO).

The joint programme also conducted pioneering research, contributing to scientific understanding of China's climate change vulnerabilities and developing possible measures for adaptation. Specifically, the programme touched upon the effects of climate change on glacial melting in the Himalayas, water resources in the Yellow River Basin, depleted groundwater resources in Northern China, and rising sea levels in China's coastal provinces.

Furthermore, the CCPF has promoted sustainable agriculture in the Yellow River Basin by demonstrating climate resilient and environmentally sound agricultural practices to more than 1,000 farming households and hundreds of local technicians in the Yellow River area. Making the important connection between climate change and human health, programme partners developed local environment and health action plans at the provincial level; raised awareness of health professionals about the health-related impacts of climate change, and strengthened indicators, risk assessment tools and capacity for environmental health management.

In this paper we share some of our key findings and case studies (listed below) from our work in the field, as well as policy recommendations and a gap analysis identifying possible future areas of cooperation for the Government of China, the United Nations System and other local and international stakeholders in China.

Case Study 1.	Introducing Waste Heat Recovery Power Generation at Xinrong New Type Building Materials, Lingshi County, Shanxi Province
Case Study 2.	Integration of Glacial Melting into Regional Adaptation Planning in Xinjiang
Case Study 3.	Vulnerability Assessment of Yellow River Basin
Case Study 4.	Managing the Effects of Climate Change on Groundwater in Cangzhou City, Hebei Province
Case Study 5.	Integration of Sea-Level Rise into Provincial Adaptation Planning in Zhejiang Province
Case Study 6.	Strategies for Climate-Resilient and Environmentally Sound Agriculture in Shandong Province
Case Study 7.	Qijiang County High-Temperature Heat Stroke Monitoring and Intervention Programme

Our main recommendations include the following:

(1) **Universal technological and cost-sharing standards developed for the connection of independent power providers (IPPs) including WHRPG plants to the grid.** Administrative measures should also be put in place to regulate grid companies so that they contribute to the national energy conservation campaign by connecting WHRPG plants and other independent power providers when it is technically feasible to do so.

(2) **Low-carbon employment promoted through low-carbon development.** Low-carbon development promotes new types of employment in various traditional industries and carries great opportunities in newly emerging industries such as forestry management, wind power and solar power. Green employment promotion should, at the same time, focus on improving job security and welfare and on guiding the labour force transition towards both green employment and decent work.

(3) **More accurate simulation models for extreme weather events** to help predict heavy rainfall, droughts, and high and low temperatures. While we are increasing our understanding of the impacts of climate change and developing vulnerability assessments, dissemination of existing data is extremely important. The CCPF has shown that early warning systems and disaster risk reduction mechanisms need to be enhanced to prevent, or at least reduce, the effects of natural disasters.

(4) **Better policies for comprehensive management of all water resources.** Existing Government policies in this area are still very rudimentary and do not take climate change fully into account. Policy development in turn needs to be supported by accurate data collected from monitoring systems and research work. Particular attention should be given to the river basin-level management and a regional approach should also be considered. Water conservation technologies should be adopted, including building extra reservoirs to collect glacial meltwater, reinforcing existing reservoirs, and improving storage and flood control capacity.

(5) **The adaptive capacity of agricultural production strengthened.** Farmers use large amounts of water in irrigated areas, as well as fertilizers and pesticides in both rain-fed and irrigated areas. Technologies that use inputs more efficiently are urgently needed. Farmers also need better access to high quality seeds, fertilizers, pesticides and training on how to use them to adapt agriculture to climate change and reduce the impact of agriculture on the environment.

(6) **Environmental health governance, workforce capacity and information management further strengthened.** Policies need to be developed to improve Government planning and management of the environmental determinants of health. Specifically, such policies should focus on developing mechanisms to support and institutionalize risk assessment, management and communication. The effective management of the direct and indirect health impacts of climate change necessitates local/city based environmental health plans which incorporate a high level of community participation and engagement. These plans should incorporate strategies for improved environmental health service effectiveness, climate change adaptation planning and evaluation, and interagency / community participation and engagement

(7) **Cross-sector cooperation increased.** The challenges posed by climate change are complex in nature, touching upon many different sectors. Real solutions can only be identified if proper consideration is given to all sectors impacted upon and there is cooperation among all relevant stakeholders.

(8) **Greater consideration to be given to gender equality as a cross-cutting issue in the development of future climate change and environment**

related projects and programmes. Gender related targets need to be identified and incorporated into monitoring and evaluation frameworks and data disaggregated by gender. Women should be involved in decision making and should be fully represented in stakeholder and policy consultation groups.

1. Introduction

1.1 Climate Change

The international scientific community has reached an overall consensus regarding the science of climate change and its effects. In 2007, the Intergovernmental Panel on Climate Change (IPCC), the international scientific authority tasked with informing and advising the global community on climate change, concluded that *"warming of the climate system is unequivocal"*, and that there is a greater than 90 percent probability that the warming observed since the mid-20th century has predominantly been caused by human activity.[1] The effects of this are seen through increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels.

In the international negotiations undertaken in Copenhagen in the context of the United Nations Framework Convention on Climate Change (UNFCCC), the Secretary-General of the United Nations declared that, *"climate change is the defining challenge of our era. No issue is more fundamental to the global challenges we face – reducing poverty, maintaining economic growth, ensuring peace and stability"*.[2] Climate change presents a challenge to the achievement of the Millennium Development Goals (MDGs) and sustaining the hard won gains of developing countries. It threatens the environment, the health, and the livelihoods of countries all around the world, and its negative impacts will be most evident in its effects on water resources, human health, agricultural sustainability, natural ecosystems, and in the increased frequency and scale of natural disasters. These are all areas in which developing countries, and especially their poorer inhabitants, are particularly vulnerable. However, given the implications for development, environment, and poverty alleviation, climate change mitigation and adaptation have now become primary challenges for all countries.

IPCC analysis indicates that *"if warming is not kept below 2ºC (which will require the strongest of mitigation efforts, and currently looks very unlikely to be achieved) then substantial global impacts will occur, such as: species extinctions and millions of people at risk from drought, hunger and flooding, etc"*.[3] More recently, UNFCCC Executive Secretary Christiana Figueres has stressed, as did several developing countries at the 15th Conference of Parties in Copenhagen (COP-15), that an increase of 2°C would leave low-lying island countries and other coastal countries susceptible to sea-level rise and that global warming should be limited to 1.5°C.[4]

[1] "Climate Change 2007: Synthesis Report, Summary for Policymakers," Intergovernmental Panel on Climate Change (IPCC), 2007
[2] "Remarks at UNFCCC COP-15 High-Level Segment," UN News Centre, 2009
[3] "Contribution of Working Group II to the Fourth Assessment Report of the IPCC," 2007
[4] "UN chief challenges world to agree tougher target for climate change," The Guardian, 1st June 2011

The Stern Review puts the cost of not tackling climate change (termed the “business as usual” scenario) at 5-20 percent of global Gross Domestic Product (GDP).[5] For its part, the World Bank estimates at US$ 140 to 175 billion annually the cost of mitigation activities needed in developing countries to limit global mean temperature rise to 2°C.[6] However, the effects of climate change on natural resources and ecosystems around the world are already becoming apparent, and mitigation alone is not enough to counter against the effects of anthropogenic climate change. With less financial and technical resources at their disposal, adaptation to climate change also poses a great burden on developing countries. It is estimated that adaptation costs in developing countries could amount to some US$ 75-100 billion per year until 2050, with the highest costs borne by East Asia and the Pacific Region.[7]

1.2 China and Climate Change: Overview of Government Policy

In terms of progress in economic development, the Government of China has many successes to boast of. Since 1978, it has lifted 600 million people out of poverty and has made good all-round progress against the MDGs, already achieving many of the targets ahead of schedule. However, despite these impressive achievements, China is still a developing country,[8] and as such economic development and the realization of a “xiaokang” (or moderately well-off) society, where economic growth is pursued in tandem with social equality and environmental protection, is still very much a work in progress. Furthermore, there are still many types of disparities to address, in incomes and equality of access, geographically between East and West, and between the cities and the countryside.

Perhaps one of the greatest challenges to China’s continued economic development is tackling climate change and reducing the impacts that rapid economic development is having on its natural environment. As described above, the potential extra environmental degradation caused by climate change could produce far-reaching impacts on the economy and society, causing huge potential losses and even constraining China’s ability to sustain its poverty reduction achievements.

China is a critical player in global negotiations for addressing climate change. Even though the country’s greenhouse gas (GHG) emissions per capita are still very low,[9]

---

[5] Stern, Nicholas, “Stern Review on the Economics of Climate Change,” Cabinet Office, Government of UK, 2007
[6] “The World Development Report”, The World Bank, 2010
[7] “The Economics of Adaptation to Climate Change” The World Bank, 2010
[8] Between 2006 and 2009, China had gross national income (GNI) per capita of less than US$ 3,975 and was classified by the World Bank as a “lower-middle-income economy”. With a GNI per capita of US$ 4,393 in 2010, China was reclassified in 2011 as a “higher-middle-income economy”, but is still a developing country according to the World Bank definition.
[9] In 2008, according to the International Energy Agency, China’s per capita CO_2 emissions were at less than 5 tonnes per capita compared to 18 tonnes per capita for the USA, “CO_2 Emissions from Fuel Combustion,” IEA, 2010

it surpassed the USA as the world's largest aggregate carbon dioxide emitter in 2007. It is currently responsible for 21 percent of global GHG emissions. This is compounded by the fact that the country's GHG emissions are growing more rapidly than those of any other nation.

In addition, China's natural environment is under stress. Air pollution is already a major concern for the Government and per capita water availability is only a quarter of the world average, with over-extraction and pollution aggravating this already critical situation. Land degradation is also serious, affecting 37 percent of China's total territory. This, together with loss of arable land due to urbanization and industrialization, is likely to affect food security. In the 2008 white paper, *"China's Policies and Actions for Addressing Climate Change"*, the Chinese Government predicts the frequency of extreme climate events as likely to increase, along with the uneven distribution of precipitation and the occurrence of heavy precipitation in some areas. At the same time, droughts are predicted to expand in scope and the sea level along China's 18,000 kilometre coastline to rise faster than ever.

The effects of climate change on different sectors in China are already apparent. Glacial retreat has been observed to reduce precipitation in China's more drought-prone regions while increasing precipitation in south-eastern China, which has been plagued by serious flooding in recent years. The aforementioned 2008 white paper also notes that agriculture and livestock-raising sectors have been adversely affected, with instability in agricultural yields, damage to crops and livestock resulting from droughts and high temperatures.

The *"12th Five-Year Plan for National Economic and Social Development"* was adopted by the National People's Congress in March 2011. It places greater emphasis than the previous five year plans on tackling climate change, and on more even development and greater social harmony. At the centre of the current plan is the planned transition to a low-carbon economy, with specific targets being given for reductions in energy intensity and emissions; uptake of alternative energy sources in addition to promoting the growth of green industries; and clean technologies.[10] See Figure 1 for details of actual energy and environment targets.

[10] The strategic emerging industries (SEIs) targeted under the 12th FYP are: energy conservation and environmental protection, new energy, new materials, new energy vehicles, biotechnology, next-generation IT industry, and high-end equipment manufacturing.

Figure 1. Energy and Environment Targets from China's 12th Five-Year Plan for Economic and Social Development (2011-2015)

- Energy consumption per unit of GDP to be cut by 16 percent;
- Energy use to be capped at 4 billion tonnes of coal equivalent by 2015;
- Carbon dioxide emissions per unit of GDP to be cut by 17 percent;
- Non-fossil fuels to account for 11.4 percent of primary energy consumption;
- Water consumption per unit of value-added industrial output to be cut by 30 percent;
- Forest coverage rate to increase to 21.66 percent and forest stocks by 600 million cubic meters.

1.3 The CCPF as a Response to Government Policy

Given the complicated threats that climate change poses to the Chinese economy and society as a whole, a coordinated and multi-sector response by all stakeholders, including the United Nations in China, is needed to support tangible results in this area. The China Climate Change Partnership Framework (CCPF) has been one example of this. Sponsored by the Government of Spain's MDG Achievement Fund (MDG-F), the CCPF has brought together nine UN Agencies, ten Government line ministries, local Governments, and a host of other counterparts from academia, the public and the private sectors, to deliver a series of interventions to promote the mainstreaming of climate change mitigation and adaptation into Government policy and China's achievement of MDG-7: environmental sustainability. The CCPF was approved on 17 December 2007 and was signed on behalf of the Government of China by the Ministry of Commerce in April 2008. The programme officially kicked off on 9 May 2008 and will come to a close on September 30 2011. It is the largest programme under the MDG-F, having received US$ 12 million (see Figure 3 for further details on the MDG-F).

Figure 2. Map of CCPF Pilot Sites

The CCPF has helped to:

i) Incorporate the National Climate Change Strategy guidelines into national policies and legal measures, delivering a shift in climate change policies and policy enforcement;
ii) Improve local capacities and partnerships for financing technology transfer and replicating innovative technology models and;
iii) Ensure vulnerable communities' adaptation to climate change impacts.

At the policy level, the CCPF has helped the Government of China in formulating its position on post-Kyoto strategies in the international climate change negotiations, it has supported the formulation of China's Basic Energy Law, and it has helped develop rural energy strategies. The programme has also helped China to reduce its carbon intensity and GHG emissions by successfully demonstrating waste heat-recovery power generation (WHRPG) technology and clean coal technology while exploring the effects on employment of a transition to a low-carbon economy.

The feasibility of the dissemination of alternative energy sources such as biomass pellets has been evaluated and the potential application of the clean development mechanism (CDM) explored in in-depth studies on biogas and conservation agriculture. In the private sector, awareness has been raised in more than 200 companies on climate change, corporate social responsibility (CSR) and the UN Global Compact, and vital information disseminated on the green finance mechanisms available. Moreover, through training on Green Business Options (GBO), students and entrepreneurs at more than 20 universities and training institutions have been given the skills needed to go out and explore GBOs.

The joint programme has also conducted pioneering research, contributing to scientific understanding of China's climate change vulnerabilities and developing possible measures for adaptation. Specifically, the programme touched upon the effects of climate change on glacial melting in the Himalayas, water resources in the Yellow River Basin, depleted groundwater resources in Northern China and sea-level rise in China's coastal provinces.

The CCPF has promoted sustainable agriculture by demonstrating climate resilient and environmentally sound agricultural practices to more than 1,000 farming households and hundreds of local technicians in the Yellow River Basin area. Furthermore, in order to make the important connection between climate change and human health, the programme developed local environment and health action plans at the provincial level, raised the awareness of health professionals about the health-related impacts of climate change, and established indicators, risk assessment tools and capacity for environmental health management.

The programme has already disseminated its results in international conferences, including UNFCCC international meetings, in academic journals, and at the local level through various meetings, small-scale forums, and workshops. In this paper we share some of our key findings, case studies from our work in the field, policy recommendations and a gap analysis identifying possible future areas of cooperation for the Government of China, the United Nations System and other local and international stakeholders in China.

Figure 3. About the MDG Achievement Fund

Established in December 2006 with a contribution of € 528 million from the Government of Spain to the United Nations System, the MDG Achievement Fund (MDG-F) supports national Governments, local authorities and citizen organizations in their efforts to tackle poverty and inequality. At the UN High-Level Event on MDGs in 2008, Spain committed an additional € 90 million to the Fund.

Through the programmes that it sponsors, the MDG-F aims to:

- Accelerate progress toward the Millennium Development Goals;
- Identify best practices and test and scale up successful models;
- Help promote UN reform by bringing together several UN Agencies and stakeholders to address issues that cut across the mandates of individual organizations.

In line with these goals, the MDG-F programmes are "joint" programmes, bringing together an average of six UN Agencies in a collective effort and thereby strengthening the UN system's ability to deliver as one. With 128 programmes under implementation in 49 countries around the world in eight different thematic areas,[11] the MDG-F is helping over 3.5 million people, with a further 20 million people benefiting indirectly. The China Climate Change Partnership Framework is one of 17 joint programmes supported by the Fund under the "Environment and Climate Change" thematic window.

[11] The eight thematic areas are: Children, Food and Nutrition; Gender Equality and Women's Empowerment; Environment and Climate Change; Youth Employment and Migration; Democratic Economic Governance; Development and the Private Sector; Conflict Prevention and Peace Building; Culture and Development.

Figure 4. Our Partners

UN Agencies:

Food and Agriculture Organization of United Nations (FAO), International Labour Organization (ILO), United Nations Asia Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM), United Nations Development Programme (UNDP), United Nations Environmental Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Children's Fund (UNICEF), United Nations Industrial Development Organization (UNIDO) and World Health Organization (WHO)

Government Counterparts and Implementing Partners:

Department of Climate Change, National Development and Reform Commission (NDRC), China International Centre for Economic & Technical Exchanges (CICETE-MOFCOM), China Council for International Cooperation on Environment and Development, Ministry of Environmental Protection (CCICED-MEP), Ministry of Agriculture (MOA), Ministry of Health (MOH), Ministry of Human Resources and Social Security (MOHRSS), Ministry of Water Resources (MWR), Administrative Centre for China's Agenda 21 (ACCA-21), China International Institute of Multinational Corporations (CIIMC), China Society for Promotion of the Guangcai Programme, Institute of Agricultural Resources and Regional Planning (IARRP-CAAS), Institute of Environment and Sustainable Development in Agriculture of the Chinese Academy of Agricultural Sciences (IESDA-CAAS), National Energy Administration (NEA-NDRC), Research Center for Urban development and Environment - Chinese Academy of Social Sciences (RCUDE-CASS), Yellow River Conservancy Commission (YRCC-MWR)

2. China's Transition to a Low-Carbon Economy

2.1 Introduction

The term low-carbon economy (LCE) first appeared at the end of the 1990's but only caught the attention of the general public in 2003 with the publishing of the White Paper *"Our Energy Future – Creating A Low-Carbon Economy"* by the UK Government. [12] Subsequently, many different organizations have sought to elaborate on the concept and so has come to incorporate various aspects of the international development agenda along the way. In its work on Green Industry, UNIDO emphasizes the "decoupling", either absolute or relative, of environmental pressures from economic growth, as does the China Council for International Cooperation on Environment and Development (CCICED) in its 2009 report on LCE to the State Council. UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing

[12] "Our Energy Future – Creating a Low Carbon Economy", Energy White Paper, Department of Transport, Government of United Kingdom, 2003

environmental risks and ecological scarcities". ILO defines a low-carbon economy through the transformation of economies, enterprises, workplaces and labour markets, while the OECD and European Environment Agency (EEA) describes a green economy as one that generates increasing prosperity while maintaining the natural sustaining systems.[13] Policymakers and economists alike now generally agree that economic growth can no longer be pursued without consideration of environmental protection and sustainability. Governments around the world are also recognizing that making the transition to low-carbon development is imperative to sustaining economic growth.

The CCPF has contributed to low-carbon development in China by promoting an enabling environment. Through the drafting of the Basic Energy Law (Section 2.2), the programme has helped shaped the provisions of future energy legislation in China. Employment is a cause for concern among many nations following the financial crisis of 2008. The programme addressed this in the context of the LCE, and the effect of low carbon development on employment in China is explored in Section 2.3. Diversification of energy sources is important for the Government in its 12th FYP, and the CCPF has helped explore the feasibility of alternative energy sources such as biomass pellets, the potential of CDM application in biogas (Section 2.4) and conservation agriculture (Section 2.5). Industrial energy efficiency remains a priority for the Government of China in its transition to a low carbon economy given its reliance on coal. In this regard, the programme investigated clean coal technology and successfully piloted waste heat recovery power generation technology in the coal gangue brick sector (Section 2.6).

2.2 Drafting of China's Basic Energy Law

Ensuring a secure and stable energy supply for the country's future economic development is a key priority for the Government of China. At the same time, the Government recognizes the threat from pollution caused by energy production and consumption and the need for a framework to address all these energy issues in a coherent, holistic manner. Addressing some of these concerns, there are a number of laws in China addressing various aspects of energy production and conservation – the Electric Power Law (1995), the Coal Law (1996), the Energy Conservation Law (1997) and the Renewable Energy Law (2005), to name just a few. However, there is no Basic Law on energy that fully articulates the nation's overall energy strategy.

In January 2006, the State Council established an inter-ministerial task force to draft such a Basic Energy Law. This Law would become the highest authority on all energy related issues, superseding existing sector-specific energy legislation. Recognising the value of international input in drafting such a law, the Government

[13] "The European Environment – State and Outlook 2010," European Environmental Agency, 2010

enlisted the United Nations System (through the CCPF) as a principal international partner in this work.

2.2.1 Development of the Basic Energy Law

UNDP, the National Energy Administration, and NDRC, together with a team of experts from leading Chinese academic institutes, carried out a number of studies under the CCPF, which contributed to the development of the provisions of the Basic Energy Law. A summary of the key findings of these studies follows.

Rural Energy Issues

The development of energy systems in rural China is not only expanding, but it is doing so during a period of rapid structural transformation. Energy development in rural areas is faced with both new problems and development trends. Key recommendations include:

(1) Increased Government investment in rural energy to ensure stable growth;

(2) Establishing rural energy development and use policies and regulations, along with pricing policies and incentive systems, as well as the necessary management and supervision mechanisms to properly guide the restructuring of rural energy consumption;

(3) Strengthened technical support for rural energy, and development of the capacities of persons able to develop rural energy technologies and offer industrial services;

(4) Awareness-raising to create a favourable environment for rural energy development. Advocacy and statistical work should be strengthened so as to improve society's understanding of rural energy development.

China’s Energy Law and the Development of Nuclear Energy

Over the last 20 years, nuclear laws and regulations have ensured the safe development of nuclear energy. However, the rapid increase in demand for nuclear power plants has revealed a number of weaknesses in the current legal and regulatory framework. For instance, the current laws and regulations give inadequate attention to promoting the development of the industry, lag behind changes in the management systems of the industry, and are not coherent with other domestic laws and regulations. Recommendations include that the Government:

(1) Develop financial and taxation policies to encourage the development of a nuclear power industry;

(2) Strengthen international cooperation in the development and trade of natural uranium;

(3) Establish a uranium resources reserve system to ensure a reliable supply for a sustainable development of nuclear power;

(4) Impose strict controls on nuclear materials, uranium products, nuclear fuel and the import-export of related technology; and implement a radioactive waste treatment franchise system to protect the environment and public health and safety.

Liquid Biofuels Development in China

According to current rates of growth, China's demand for oil is forecasted to reach 620 million tonnes in 2020 and 810 million tonnes in 2050. In such a growth scenario, development of alternative liquid fuels and improvement of the liquid fuel consumption structure has strategic importance for China.

Further research and development (R&D) is needed into liquid biofuel technologies, advanced biomass cultivation techniques, fuel conversion technologies and development of commercial-scale cellulosic ethanol systems. In the meantime, the Government should encourage the recycling of waste food oil for biodiesel production. In the long term, the ratio of second-generation to first-generation liquid biofuel production and consumption should be expanded.

Analysis of China's Coal Law

The analysis of the current Coal Law identified several underlying problems. After the Coal Law was enacted in 1996, supporting rules and regulations were also developed. Soon thereafter, the State Council reformed the major management institutions and abolished the Ministry of Coal in 1998. Provincial agencies were also abolished or their functions reduced, and related planned legislation and regulations were abolished. The result was that the Coal Law became difficult to implement. A proper law enforcement body was lacking, and incoherencies between the Coal Law and other laws and regulations arose which were not fully resolved, while principles regarding legal liability remained ambiguous.[14]

China's Electricity Legal Framework

The overall purpose of the Electricity Law is to promote the reform and development of the electric power sector in China. However, with the subsequent development of the electricity industry and various electricity sector reforms, the electricity legal framework is now out of date. The following are some of the main problems with the current electricity legal framework:

(1) The concept of sustainable development is inadequately reflected in the legal texts;

(2) The current legal texts are not well adapted to recent progress in the reform of the electricity system;

[14] The Coal Law has since been revised. The amended law was submitted to Legislative Affairs Office of the State Council for approval in August 2010.

(3) Many provisions are essentially guiding principles, and the lack of accompanying rules and specific implementable measures makes implementation infeasible;
(4) Certain provisions of the Electric Law are not coherent enough with other related legislation.

2.2.2 The Main Provisions of the Draft Legislation

These studies have helped contribute to the development of the Basic Energy Law. With energy concerns in mind, the proposed text provides that all energy resources belong to the State, with the State Council exercising ultimate ownership rights. It further stipulates that the State must hold a controlling interest in any enterprise operating in a key energy area. The draft energy law also places great emphasis on energy conservation and goes beyond China's existing energy regulation scheme, establishing an "energy emergency" resolution system.

An overview of the draft law’s detailed provisions is given in Figure 5.

Figure 5. The Basic Energy Law[15]

Chapter I: states the **main objectives** of the law.
Chapter II: emphasizes the **integrated management of energy**, including the energy management system, in which it provides that the State Council Department is responsible for the unified management of national energy work.
Chapter III: outlines the **national energy strategy** to guide the overall planning and sustainable development of the energy industry and ensure energy security.
Chapter IV: emphasizes **energy development and processing**, and the need to follow the principles of rational distribution, optimal structures, conservation efficiency and environmental protection.
Chapter V: defines the **Government's principles on energy supply**. It requires Government institutions at all levels to take measures to promote a sound energy infrastructure and transport system, diversify energy sources and strengthen the organization and coordination of energy supply.
Chapter VI: addresses **energy conservation**, in particular requiring that Government institutions at all levels take energy conservation as an economic and social development priority.
Chapter VII: provides for the establishment of an **energy reserve system** which would regulate the building up and management of energy reserves, the improvement of energy emergency response capabilities, and the protection of energy supplies.
Chapter VIII: addresses **energy emergencies** and includes a range of emergency plans at different levels.
Chapter IX: addresses **rural energy issues** by supporting rural energy development in the wider context of promoting the harmonious development of urban and rural areas.
Chapter X: outlines policies for **energy pricing and taxation**.
Chapter XI: focuses on **energy technology**, emphasizing energy efficiency and supply; energy security and environmental protection.
Chapter XII: emphasizes **international cooperation** on energy matters, stressing the development of mutually beneficial cooperation on energy resources through the conclusion of international treaties, participation in international organizations, coordination of energy policy and exchange of information, etc.
Chapter XIII: outlines **supervision and inspection mechanisms** at different administrative levels.
Chapter XIV: defines the **legal responsibilities** of the Government, energy utilities and end-users.

2.2.3 The Current Status of the Draft Legislation

The draft Basic Energy law was submitted to the Legislative Affairs Office of the State Council in early 2010, where it is being reviewed. Upon completion of this

[15] At the time of publication of this paper, the Basic Energy Law has not yet been promulgated, so the detailed provisions may possibly be revised in the final text of the Law.

review, the Legislative Affairs Office will submit the proposed draft to the National People's Congress. It is estimated that this review process will be complete by late 2012.

2.3 Low-Carbon Development and Green Jobs

The Government of China has committed to promoting low-carbon development and reducing carbon emissions per unit of GDP by 40 to 45 percent by 2020 compared with 2005 levels.[16] Such a strategy and pathway requires structural adjustments both in industry and energy, thus directly influencing employment in different industries and regions. Under the CCPF the ILO and the Ministry of Human Resources and Social Security undertook a study to investigate the influence of low-carbon development on employment in China, and elaborated recommendations on the key policies necessary for realizing the dual objectives of employment promotion and low-carbon development.

2.3.1 The Impacts of Low Carbon Development on Employment

The research compared **carbon productivity** (carbon emissions per unit of value-added) and the **carbon employment rate** (corresponding employment per unit of carbon emitted) in eight major industries – forestation and reforestation, sustainable forestry management, forestry tourism, thermal power, wind power, solar power, and steel The analysis shows that in general, low-carbon development has a positive effect on employment in major industries, with primary industry having predominant advantages in terms of a carbon employment rate, and tertiary industry in terms of both a high carbon employment rate and high carbon productivity. The evidence suggests that China's economic structure can be adjusted to a lower carbon intensity by encouraging the development of both primary and tertiary industries with highly efficient carbon productivity, such as forestry and subsidiary industries. At present, secondary industry still needs to improve in the areas of technology and management efficiency and increase energy intensity and carbon productivity to achieve energy saving and emission reduction targets.

The study also revealed that important policy measures such as increasing energy efficiency and reducing emissions will adversely affect employment in the fossil fuels-related sectors. However, technological advances and reduced operating costs will benefit the long-term development of the entire economy. For example, measures like ecosystem conservation can positively impact employment in the forestry sector, including afforestation and reforestation activities, forest ecosystem management and forest tourism.

[16] "China's National Climate Change Program," NDRC, Government of PRC, 2007

2.3.2 Employment Effects of Low-Carbon Development on Major Sectors

The employment effects of low carbon development fall into three categories:

(1) *Direct employment*, that is employment related to the increase in the output of goods for a specific sector;

(2) *Indirect employment,* employment related to an increase in the input of goods from the suppliers of that sector, with a ripple effect through the supply chain; and

(3) *Induced employment*, or employment that results from the effect on the supply chain of an increase in income in the economy and the subsequent spending of that increased income.

The effects of energy-saving and emission reduction policies on employment in the above mentioned major sectors vary. As shown in Table 1 below, from 2005 to 2020, more than 30 million green jobs will be created in the major sectors.

More than 25 million jobs can be created in the forestry sector alone between 2005 and 2020, of which 7.8 million direct and around 19 million indirect green jobs will be generated in the afforestation, reforestation and forest management sectors. Another 6.8 million green jobs can be created in the forest tourism sector, driven by the development of tourism-related services such as catering and transport.

In the power generation sector, the implementation of low carbon development will impact on green jobs in two contrasting ways. On the one hand, policy measures related to energy efficiency and emissions reduction will force the closure of inefficient small-scale thermal power units, resulting in job losses. On the other hand, low carbon energy generation and the introduction of desulphurization projects in the thermal power sector will lead to job creation. Approximately 4.4 to 5.05 million new green jobs, mainly indirect jobs, will be created between 2005 and 2020 in the power sector as a whole.

Low carbon development will affect fossil and non-fossil sectors differently. For instance, in the thermal power sector, the replacement of high-coal consumption and low-efficiency small thermal installations with high-energy efficiency ones will result in a net decrease in employment; whereas between of 2.8 to 3.4 million new green jobs will be created in the wind power sector, and 1.2 million new jobs in the solar sector. Given the different employment effects on enterprises within the power generation sector, low carbon energy generation should be promoted to speed up the replacement of inefficient energy installations and to bring about more green jobs. In the meantime, skills upgrading through vocational training is needed in order to cope with the changing employment structure in this sector, with expanded channels for green employment.

In primary industries, such as iron and steel, total job losses between 2005 and 2010 are estimated to be around 15 million, with average annual loss of 3.068 million due to the employment elasticity of these sectors. However, these sectors can mitigate employment effects by replacing excess capacity, adopting technology that will create energy efficiency and reduce emissions, and by improving production processes.

Green investment is another key component that can stimulate the creation of green jobs. For example, it is estimated that 5.3 million green jobs have been created due to the US$ 586 billion economic stimulus package launched in 2008.

As illustrated in Table 1, low carbon development could potentially have a positive impact on employment in China.

Table 1. Total Employment Effects of Low-Carbon Development in Major Industries in China (Unit: millions of jobs)

Sectors	Sub-sectors	Direct Employment	Indirect Employment	Total
Forestry (2005-2020)	Afforestation/ & Reforestation	7.6	11.085	18.685
	Sustainable Forest Management	0.188	0.061	0.249
	Forest Tourism	3.154	3.616	6.77
Power Industry (2005-2020)	Thermal Power	0.251	0.029	0.279
	Wind Power	0.848	2.309	3.157
	Solar Power	0.050	1.237	1.287
Basic Industry	Iron and Steel (2007~2011)	-0.200	—	-0.200
Green investment (2008-2011)		0.175	0.357	0.532
Total[17]		30.759		

2.3.3 Policy Recommendations

Low-carbon development calls for economic development with low-energy consumption and production. To this end, the programme recommends the following to achieve the dual-challenge of employment promotion and emissions reduction:

(1) Promoting low-carbon employment through low-carbon development: Low-carbon development carries great opportunities in newly emerging industries such as forestry, wind power and solar power, and at the same time will create low-carbon employment opportunities.

[17] Due to different methodologies and data sources, the total is used as a reference only as it includes incomparable data between sectors such as forestry and iron and steel. Some of the employment data in the table also uses values which are averages.

(2) **Developing low-carbon service industries and optimizing the industrial structure:** Industrial and employment policies should support the development of tertiary industries such as consumer service providers which drive domestic demand. Sectors such as manufacturing should be developed through technology and research; and high value-add primary industries such as eco-agriculture, forestry and specialized agricultural should be supported with services sectors such as tourism.

(3) **Facilitating employment-oriented green investment:** In general, the CNY 4 trillion economic stimulus package has favoured infrastructure projects such as transportation, construction and urban and rural reconstruction. The priority of low-carbon development should be fully embodied in the design of infrastructure projects to avoid a "carbon lock-in" effect; and therefore the proportion of green investment should be increased to promote employment opportunities and achieve structural optimization.

(4) **Focusing on decent jobs as part of green employment:** Green employment does not necessarily mean decent employment. Therefore, green employment promotion should at the same time focus on improving job security and welfare and on guiding the labour force transition towards green employment and decent work.

(5) **Promoting low-carbon employment pilots and progressive promotion:** Pilot programmes should be launched in selected regions and typical industries (or enterprises), and further promotional activities should be undertaken to disseminate experiences from these pilots. After pilots and testing, at the appropriate time policies should be issued to promote low-carbon employment. To further promote low-carbon employment, relevant policy support also will be needed in areas such as in finance, tax, training and social security.

For further information on low-carbon development and green jobs, see the CCPF research report on "Low-carbon Development and Employment – Empirical Analysis in China".

2.4 CDM Potential of Domestic Biogas in China

Agriculture is one of the major anthropogenic sources of greenhouse gas emissions in China, particularly through methane (CH_4) and nitrous oxide (N_2O) emissions, as well as loss of soil carbon stores. However, thus far mitigation programmes in China have paid insufficient attention to controlling emissions from the agricultural sector even though various tools to support this are available, for example, the CDM.

As indicated in Section 2.2, the Chinese Government attaches great importance to the development of rural energy, including the dissemination of biogas systems. Laws, regulations and policies issued by the central Government highlight the importance placed upon biogas for building a new socialist countryside. Biogas projects both contribute to the reduction of GHG emissions and prevent deterioration of the natural environment of rural areas. Furthermore, the methane recovered from the biogas digesters can be used for cooking and heating, thus reducing CO_2 emissions from firing coal.

It was hypothesised that these projects could also generate economic returns and increase farmers' income if developed as small-scale CDM projects. Therefore, under the CCPF, UNAPCAEM and the Institute of Environment and Sustainable Development in Agriculture of the Chinese Academy of Agricultural Sciences (IESDA-CAAS) conducted a study to determine the feasibility of developing CDM projects to financially support the installation of rural household biogas digesters.

The framework used in the case study was based on the “one digester plus three innovations” (hereafter referred to as “one-plus-three”) model, which involves installing a household biogas digester and modifying the toilet, kitchen and animal enclosures into an integrated unit. The study explored project activity boundaries, definition of baseline, Certified Emission Reductions (CERs) calculation, additionality assessment, and monitoring plans.

2.4.1 Main Findings of CDM Feasibility Study

The one-plus-three model requires a certain amount of investment in biogas digesters and associated equipment as well as in the modifications required. However, according to the study, farmers generally live on subsistence farming and have few savings to invest in a biogas digester. In addition, in the one-plus-three model farmers would use the biogas produced themselves without generating marketable products. As a result, it would be almost impossible for farmers to get the necessary loans from commercial banking institutions, since official fund-raising channels do not provide loans for non-productive activities, and current subsidies provided by the Government are inadequate.

Therefore, to facilitate the construction of biogas digesters and encourage the involvement of lower- and middle-income farmers, additional financial support needs to be supplied. In principle, financing from CDM projects could provide this support. However, the analysis showed that a cost-effective CDM project would require the bundling of hundreds, possibly thousands, of farming households because each farming household in China has only a very limited emission reduction potential from biogas digesters.

Furthermore, the study indicated some technology barriers. Construction and maintenance of biogas digesters requires qualified technicians, who must be certified by the Ministry of Agriculture. Lack of such qualified technicians in rural areas constitutes a major obstacle in the development of biogas projects. With increasing urban wages, it is becoming difficult to keep biogas technicians in the village. According to the study, it takes a biogas technician seven days to complete the construction of a biogas digester, for which he would either be paid a lump sum of CNY 400-500 or a daily rate of CNY 55-65. In addition, the biogas technician is supposed to provide free maintenance service for one year. Rapidly rising urban wages allow them to earn a daily rate of CNY 100 if engaged in other economic activities. In this context, the fee they receive for building a biogas digester is less profitable. This situation has seriously affected the supply of biogas technicians to build and maintain biogas digesters.

2.5 CDM Potential of Conservation Agriculture in China

Conservation agriculture employs techniques such as no-tillage, micro-terrain rebuilding, land covering, and weed management without soil engaging tools so as to reduce the disturbance to the soil, thereby increasing its organic carbon content and removing CO_2 from the atmosphere. According to FAO statistics (AQUASTAT 2011) Conservation Agriculture is currently applied on all continents and across all climatic zones on a total area of 117 million hectares, corresponding to 8 percent of the total cropland.

At present, China is also experiencing an important transition from small-scale piloting to broader dissemination of conservation agriculture techniques. During the 11th Five-Year Plan period (2006-2010), the Ministry of Agriculture (MOA) set the target for arable land under conservation tillage to 4 million hectares nationwide. Currently, there are some 3 million hectares of cropland in China subject to conservation agriculture, 6.67 million hectares of cropland with conservation tillage,[18] and 20.0 million hectares of cropland employing straw return management techniques. Government policies also emphasize the establishment of a sound technical support system for conservation agriculture, quality improvement of machinery, and measures to increase the ecological, economic and social benefits of conservation agriculture to farmers.

Although soil carbon sequestration in agricultural soils has huge potential, the first phase of the Kyoto Protocol only takes land use, land-use change and forestry (LULUCF) into account to a limited degree.[19] Whether cropland management, including conservation agriculture practice, can become an eligible project activity under CDM post-2012 is still uncertain. However, in anticipation of such projects becoming eligible, UNAPCAEM and IESDA-CAAS undertook a study under the

---

[18] "Conservation tillage" is defined as any tillage operation that leaves at least 30 percent of the soil surface covered with crop residues. This excludes inversion tillage, but includes all other tillage operations as long as residue cover can be maintained.

[19] Under Article 3.3 *"net changes in GHG emissions by sources and removals by sinks through direct human-induced LULUCF activities, limited to afforestation, reforestation and deforestation that occurred since 1990, can be used to meet Parties' emission reduction commitments."* Under Article 3.4, Annex I countries may *"elect additional human-induced activities related to LULUCF specifically, forest management, cropland management, grazing land management and revegetation, to be included in their accounting of anthropogenic GHG emissions and removals."*

CCPF to establish an effective, transparent and operational CDM methodology. A case study was conducted in Shandong Province.

2.5.1 Main Findings of CDM Feasibility Study

According to the study, CDM projects can be developed in conservation agriculture to help increase carbon stock, reduce fossil fuel consumption and GHG emissions, and improve sustainable natural resource management. However, the study also recommends that CDM projects related to conservation agriculture be undertaken in dry land.[20] Returning rice straw to paddy soils greatly increases methane emissions. The global-warming potential (GWP) of methane is 21 times higher than that of the equivalent amount of carbon dioxide. Though returning rice straw to the soil can increase the soil organic carbon stock, the GWP caused by increased methane emissions is greater than the reduction from carbon dioxide sequestered.

More generally, even though there has been noticeable progress in conservation agriculture in China, many challenges remain. Custom-built conservation agriculture machines (for example, low-disturbance direct seeding devices) are not available in many provinces, and locally available equipment underperforms compared to that used elsewhere, for example in Brazil, particularly in the handling heavier residues. Imported machinery is beyond the means of most farmers. This has hindered the popularization of conservation agriculture in China.

A shortage of Government funding is another stumbling block. The existing non-chemical alternatives for weed management and the effects of residue cover and crop rotation on pest incidence in conservation agriculture requires specialist knowledge and well-trained extension staff, to reduce the side effects of using herbicides and pesticides. Wider adoption of conservation agriculture would therefore require greater financial support for extension services to farmers, training on machine operation and maintenance, subsidies to personnel and dissemination campaigns. At present, there are limited funds from both the central and local Governments. Meanwhile, there are still various problems with regards to the performance, efficiency and maintenance of conservation agriculture machinery.

In conclusion, while conservation agriculture maintains soil water content, protects soils from erosion and increases soil organic matter, it also presents practical problems to farmers such as weed and pest control. Application of herbicides and

[20] This study assumes traditional irrigated paddy fields and so, given the high methane emissions, finds only CA employed on dry land crops as having CDM potential. However, outside the scope of the CDM study, pilots by FAO in Jiangsu Province have demonstrated that in CA pilots of rice crops using only the exact amount of water required and then rice straw mulch to manage weeds instead of extra water, carbon dioxide, methane, and nitrous oxide emissions could be reduced while yields could be increased. See also "Strategies for Mitigating Rice GHG Emissions: Modeling and Geospatial Monitoring," William SALAS 2010: http://nicholasinstitute.duke.edu/ecosystem/t-agg/april-experts-meeting-2010/Salas_T-AGG_Chicago2010.pdf.

pesticides may increase the risk of soil pollution, which have negative impacts on grain quality and biodiversity. In addition, non-tillage may also affect sowing quality and seedling emergence, which in turn dampens farmers' enthusiasm for adopting conservation agriculture.

For the full report please see "Feasibility Study: Rural Household Biogas and Conservation Tillage CDM Project Development", 2010.

2.6 Application of Waste Heat Recovery Power Generation in the Coal Gangue Brick Sector

Heavy industry is one of the most important sectors to consider in regard to climate change mitigation, as it is directly responsible for approximately one third of global energy consumption and 36 percent of global greenhouse gas emissions. Industry must therefore be properly engaged, incentivized and assisted where necessary to adopt new energy efficient and low-carbon technologies and production methods. Over the past few decades much of the industrial growth, and hence growth in industrial energy demand, has taken place in emerging economies. China alone has accounted for about 80 percent of the growth in global industrial energy usage in the past 25 years and is today the world's largest producer of iron, steel, ammonia and cement, all energy-intensive industries. While overall global industrial energy efficiency has improved substantially in the past 25 years, in emerging economies such as China industrial energy consumption is still 20 to100 percent higher per unit of production than in OECD countries.

2.6.1 Case Study I: Introducing Waste Heat Recovery Power Generation at Xinrong New Type Building Materials, Lingshi County, Shanxi Province

As China's economy continues to rapidly develop, the demand for building materials expands with it. Consequently, the Chinese brick-making sector has become a major industrial sector: by 2008, it was producing about 1 trillion bricks a year. Consequently, the sector has become a significant consumer of energy, both in terms of brick-firing fuels (predominately coal) and of electricity, which is needed to operate the different brick-making processes.

Anxious to protect existing agricultural land resources from further encroachments, as well as looking to promote the reuse of industrial wastes in industrial production, the Government of China has been increasingly promoting coal-gangue brick production. Coal gangue is the waste left over from coal mining and is generally made up of a variety of rocky waste, but also including – importantly – coal particles. Coal gangue is often dumped indiscriminately during mining, creating huge hill-like mounds (see Figure 6.). It has been estimated that by the end of 2007 China had piled up some 5 billion tonnes of coal-gangue. In coal-gangue bricks, a percentage of the clay used to make the bricks is replaced by coal gangue. Not only does this reduce the demand for clay and reduce the amount of coal-gangue waste, it also reduces the coal requirements of the brick kilns since there are sufficient coal particles in the coal gangue to heat the kilns without the use of extra coal. The coal-gangue brick sub-sector is still quite small, representing 2.2 percent of the total output of the entire Chinese brick sector, with an annual production of approximately 20 billion bricks. However, this figure is increasing rapidly, with the sector now consisting of approximately 2,000 brick factories across China.

Figure 6.Coal-Gangue Piles in Zibo, Shandong Province

Often, there are sufficient coal particles in the coal gangue for them to produce too much heat, and the quality of the bricks suffer if some of it is not drawn off the kilns. The way in which this is normally done is by venting the excess heat as waste-heat up a chimneystack into the atmosphere. However, coal-gangue brick factories also consume considerable amounts of electricity, which can cost millions per year in electricity bills. The potential therefore exists to recover the waste heat from the brick kilns, use it to produce high temperature and pressure steam, and then pass the steam through a turbine to generate electricity. The factories can use this electricity on-site for their own needs, cutting their electricity bills, or sell it to the grid. There is an added climate change benefit since using electricity generated on-site displaces many thousands of tonnes of greenhouse gas emissions each year from the grid-electricity now no longer used.

The technology for doing this, Waste Heat Recovery Power Generation (WHPRG), is quite mature and is already widely applied internationally and in China in sectors such as cement, iron and steel, coking and glass making. However, these WHRPG installations typically have an installed capacity in the range of 10 to 12 megawatts. The type of WHRPG systems required in the coal-gangue brick sector are smaller, in the 1 to 2 MW range, see Figure 7. There are very few existing installations in this range.

Figure 7. Schematic Diagram of a Coal-Gangue Brick WHRPG Plant

Under the CCPF, the United Nations Industrial Development Organization (UNIDO) in partnership with the Ministry of Agriculture (MOA) promoted the application and deployment of these smaller WHPRG systems in the Chinese coal-gangue brick sector. An important part of this promotion campaign was the establishment of two functioning and well-performing pilot plants. One was installed in the Xinrong New Type Building Materials Company under the Juyi Industrial Group, located in Shanxi Province, the other in the Hebei Guoneng New Materials Company, part of the state-owned China Energy-Conservation Investment Corporation, located in Hebei Province.

Figure 8. Installation of WHRPG Components at the Xinrong Pilot Plant

The two pilots have proved that the smaller WHRPG systems are both technically and economically sound. The pilot at Guoneng is a 1 MW installation, while the pilot at Xinrong is a 1.5 MW installation. The plant at Guoneng is expected to meet 60 percent of the factory's power needs, while the plant at Xinrong will meet 100 percent of that factory's electricity needs. This will result in estimated energy savings of CNY 2 million per year for Guoneng and CNY 2.5 million per year for Xinrong. The pilots have proven to be highly profitable investments for these enterprises, with their investment having attractive payback periods of four to five years and post-tax internal rates of return of over 20 percent. In terms of environmental performance, these systems provide a meaningful way for brick enterprises to reduce their environmental and climate change impacts, by each displacing many thousands of tonnes of greenhouse gas emissions each year.

Figure 9. WHRPG Boiler at Xinrong Pilot Plant

2.6.2 Policy Recommendations

In light of the experiences of these pilot projects, the CCPF has the following policy recommendations:

(1) **Universal technological and cost-sharing standards should be developed for connection of independent power providers (IPPs) including WHRPG plants to the grid.** Administrative measures should also be put in place to regulate grid companies so that they contribute to the national energy conservation campaign by connecting WHRPG plants and other independent power providers when it is technically feasible to do so. The Government should also examine and revise the indicators for grid connection of independent power providers (including companies employing WHRPG technology) in future energy conservation and emission reduction policies and plans.

(2) **The National Energy Administration should formulate technology regulations for connecting distributed energy projects including WHRPG coal gangue brick plants to the grid.** Given the technological and economic features of WHRPG and distributed energy, the measurement, automation, protection and communication systems required for such systems should be simplified, while ensuring the safety of the maintaining system and transmission lines.

(3) **WHRPG projects should be promoted through the "Special Development Fund for Small and Medium-Scale Enterprises"** which is managed by Ministry of Industry and Information Technology (MIIT). The brick industry should enhance its communication with the Fund, and brick companies should

be encouraged to apply to the Fund to support the construction of WHRPG projects.

(4) **A communication platform should be established within a suitable Government institution** (for example, NDRC, MIIT or MOA) where all stakeholders in the financing of this technology, including both the demand side (brick enterprises) and the supply side (Including all kinds of international financial institutions, domestic commercial banks and energy service companies), can come together and develop suitable financial channels to facilitate the promotion and implementation of WHRPG within the Chinese brick sector.

3. Climate Change Adaptation

3.1 Overview

In 2011, the Yangtze River, the largest river in Asia, experienced the worse drought it has seen in 50 years, leaving 400,000 people without access to drinking water and threatening 870,000 hectares of farmland in Hubei Province.[21] Water scarcity in China dates back to ancient times. However, extreme weather events have become more frequent and water security a more urgent concern for China, which has only 7 percent of the world's total water resources. Between 2000 and 2009, total groundwater reserves in China decreased by 13 percent, with water scarcity most evident in its northern and western provinces. However, studies show the groundwater table in parts of Northern China beginning to fall as early as the 1970's.[22] Moreover, not only have groundwater resources shrunk, groundwater quality has also deteriorated.

Home to 20 percent of the world's population, China has only 7 percent of total arable land. Rapid economic growth, industrialization and urbanization, in particular in Eastern China, have resulted in a reduction in China's arable land in recent years from 130 million hectares in 1996 to 122 million hectares in 2008, which is equivalent to just 13 percent of the nations total territory.[23] The Government estimates that annual average economic losses in China's agricultural sector due to climate disasters have exceeded CNY 100 billion per year (equivalent to US$ 15.2 billion) since the 1990's.[24] Apart from lower agricultural yields, agricultural prices, rural incomes, livelihoods and food security are also likely to be impacted. Human health will also be affected, as vector-borne diseases such as malaria and dengue are likely to increase with changes in water distribution. With increased flooding, increased illness and death to diarrheal disease is expected to increase.

---

21 "China Faces Worse Drought in Fifty Years," The Financial Times, 24th May 2011
22 "Beneath Booming Cities, China's Future is Drying Up," The New York Times, 28th September 2011
23 "China vows to preserve arable land amid urbanization," China Daily, 10th March 2011
24 Climate change worsens food security in Asia, Xinhua, 30th March 2011

The joint programme investigated the effects of climate change on all aspects of the hydrologic cycle, from the Himalayan glaciers in Xinjiang Province (Section 3.2), to the surface water resources of the Yellow River Basin (Section 3.3) and the groundwater in Northern China (Section 3.4), and finally to sea level rise in China's coastal provinces (Section 3.5). In addition, agriculture's vulnerability to climate change was addressed (Section 3.6), as was the link between human health and climate change (Section 3.7).

3.2 Glacial Melting in the Himalayas

China is one of the countries with the most abundant glacier deposits in the world, accounting for 14.5 percent globally and 47.6 percent in Asia. The Himalayan glaciers are the source of more than 10 rivers including the Yangtze River, the Yellow River, the Tarim River, the Ganges and the Indus. These glaciers are distributed in the Western regions of China, which are arid and semi-arid areas, and annual glacial runoff can account for up to 40-60 percent of annual runoff. In these areas, glaciers are like an oasis making an important economic contribution; however, such ecosystems are also highly vulnerable. This region is becoming a key national development zone, and is a pivotal hub connecting the country to Central and Western Asia along with Europe. These glaciers are a major source of fresh water, storing up snow and ice in the winter and releasing meltwater in the summer. Glacial meltwater is therefore critical to the region's social-economic development.

Glacier melting has been accelerating in China**,** especially after 1980's; some have even shrunk to 82 percent of their volume that they had in 2000. Variations in the "glacierization" or the size of glaciers in upstream areas and the level of economic development in the downstream areas has resulted in greater asynchrony in the peak times of water supply and demand. Meanwhile, Western regions are less developed, with the local economy dominated by agriculture and a GDP per capita of just 50 percent of the national average. It is clear that regardless of whether water resources are abundant or insufficient, water has to be managed to avoid flooding or droughts. Given the impacts on the availability of total water resources, the effects of climate change and glacial melting on water management need to be taken into consideration in regional/ provincial planning.

3.2.1 Case Study II. Integration of Glacial Melting into Regional Adaptation Planning in Xinjiang Province

Under the CCPF, a team led by the UNEP, NDRC and the Administrative Centre for China's Agenda 21 (ACCA 21) developed vulnerability assessments to help manage the effects of climate change on glacial melting in Gansu and Xinjiang.

Xinjiang is China's largest administrative province, comprising one-sixth of the nation's total area. The Altai Mountains in the North, Kunlun Mountains in the South and Tianshan Mountains in the middle split the province into Southern, Northern and Eastern Xinjiang. Xinjiang is typified by an arid and fragile ecosystem; 47.6 percent of its territory is either desert or at risk of desertification. Local GDP per capita is about 75 percent of the national average.

The volume of ice locked up in Xinjiang's glaciers comprises 46.9 percent of total national ice volume - the largest in China. Spread across the Altai, Tianshan, Pamir, Karakorum and Kunlun Mountains, meltwater from glaciers is an important source of water for the province's rivers. In the Tarim Basin alone, meltwater amounts to 22.6 percent of its total annual runoff and 40 percent of the total surface runoff. Meltwater contributes significantly to the variations in river runoff during different seasons.

There are numerous areas affected by glacial melting in Xinjiang, including the river systems of the Tarim River (including the Yarkant and Aksu Rivers), Yili River, inland rivers originating from the north slope of the Tianshan range, and the Ertix River from the Altai Mountains. With regard to the vulnerability of water resources, agricultural production and vulnerability of ecosystems, the Aksu and Yarkant River Basins are identified as major affected areas, while the north of the Urumqi and Manas River Basins are sub-key affected areas.

Results revealed that:

- China has witnessed an accelerated pace of ice loss over the past five decades. As a result, almost all of the glaciers in Xinjiang have retreated Glaciers around the source of Urumqi River have experienced the most obvious retreat since the 1960's. Glaciers with an area of less than two square kilometers are most sensitive to climate change and are melting faster.

- In the short term, the fresh water from glacier melting will increase the river runoff in Xinjiang region and relieve the region's water scarcity to some extent. However, this increased runoff will only last a few years, or decades, as the glaciers shrink. At the same time, the risk of floods during summer time will also increase. In the Tarim River Basin, the average rate of loss of glacial mass in the Basin after 1991 was as much as 240 mm/yr, 155 mm higher than that during 1961-1990. In recent years, an acceleration in glacial melting has been seen. Glacial runoff in the Tarim River area is projected to increase up to 2050 and the variability in the frequency and volume of floods will increase significantly. However, meltwater runoff in the Manasi and Urumqi River Basins will see a continuous decline by 2050 due to the reduced glacier coverage.

- With respect to the matching of water supply and demand during the year, it appears that the times at which glacier runoff, on the one hand, and of water demand, on the other will be peaking will be further out of phase, which will lead either to a shortage of water supply or to the risk of flooding, or increased debris flow in the summer depending on the amount of glacial coverage.

- Agriculture is a highly vulnerable sector against the backdrop of glacial retreat. The pressures on arable land will be exacerbated by population growth. The Urumqi River Basin will become the most vulnerable area, while Yarkant River Basin will be at a medium-level of vulnerability.

- Glacial melting in key areas of Xinjiang leads to an increase in potential outburst floods from glacial lakes. The accelerated glacier retreat since the 1980's could potentially result in the failure of ice- or moraine- dams, which would result in glacial lake outburst floods (GLOFs). Such floods in source regions of the Aksu and Yarkant rivers will remain a threat to downstream areas for a long time.

There are also added concerns about the effects of future human activity. The region's economy will grow significantly due to the Government's national development strategy. By 2050, per capita GDP will be five times of that in 2005; and there will be even greater water shortages.

3.2.2 Policy Recommendations

(1) **Industrial restructuring is the best policy choice for the region to adapt to glacier melting and climate change. Planning strategies for the autonomous region's sustainable development need to prioritize the installation of industry that uses little water as well as the development of water saving technology**, such as high efficiency water-saving systems in agriculture.

(2) **Adoption of water-conservation technologies**, for example, reservoirs to collect meltwater and thereby also help control flooding. Likewise, appropriate areas in the upper and middle reaches of the province's rivers should be selected for the piloting of groundwater storage facilities (also see Section 3.4) so that excess water is saved for drier spells. Conservation agriculture should also be used together with 'in-situ rain harvesting' to improve the absorption capacity of soils and reduce rainwater runoff. In addition, better coordinated management practices are needed in the exploitation of surface and ground water resources.

(3) **Integration into the region's existing early warning emergency system of early warning capabilities for detection of disasters related to glacial retreat.** The existing capacity of the system needs to be complemented with new remote-controlled hydrological and meteorological automatic stations. In addition, planning of mountain reservoirs in the high mountains could help

reduce the impact of extreme weather events and slow down the loss of glaciers.

(4) **Increased investment in the sustainable management of mountain forests and grassland for the upper reaches of all river basins.** Ecosystems should be restored for the downstream reaches of river basins by establishing water-saving shelter forest systems. Farmers should be given training to improve their knowledge of sustainable farming practices (also see Section 3.6).

3.3 The Yellow River Basin and Climate Change Threats

The Yellow River is the second longest river in China. Originating 4,700 meters above sea level in the Qinghai-Tibetan plateau, it travels 5,464 kilometres through nine provinces before emptying into the Bohai Sea in Shandong Province. Its waters supply a catchment area of 795,000 km^2, in which 113 million people live including 44 million people settled in cities. The average population density is 142 persons per square kilometre, which is higher than the national average.

3.3.1 Case Study III. Vulnerability Assessment of the Yellow River Basin

Under the CCPF, UNESCO in partnership with the Yellow River Conservancy Commission (YRCC) of the Ministry of Water Resources, conducted a holistic vulnerability assessment of climate change impacts on water resources in the Yellow River Basin to provide support for policy making, institutional development, planning and strategy making.

Figure 10.Location of the Yellow River Basin

Basin area	790,000 km^2
River length	5,464 km
Elevation drop	4,480 m
Average rainfall	450 mm
Population	120 million
Total water resources	58 billion m^3
Per capita water	550 m^3

Historical Climate Change

Given that most existing data on climate change and its impacts applies to the last 200 years, this study investigated historical documents and geological data to better understand climate change in the Yellow River Basin from a wider historical perspective. The data revealed that the Basin has seen climate fluctuations over a period of several thousand years. Over the last 5,000 years alone, cycles of colder and warmer periods, each lasting 400-800 years, have affected the middle and lower reaches of the Yellow River.

Modern and Future Climate Change

Very noticeable climate changes have been observed over the recent decades in the Yellow River Basin. For instance, the annual mean temperature has risen continuously since the 1990’s, while precipitation has consistently decreased. In all the regions, annual water surface evaporation is larger than the annual precipitation, with complex variations in evaporation. The frequency and intensity of extreme climate events has also changed in recent years.

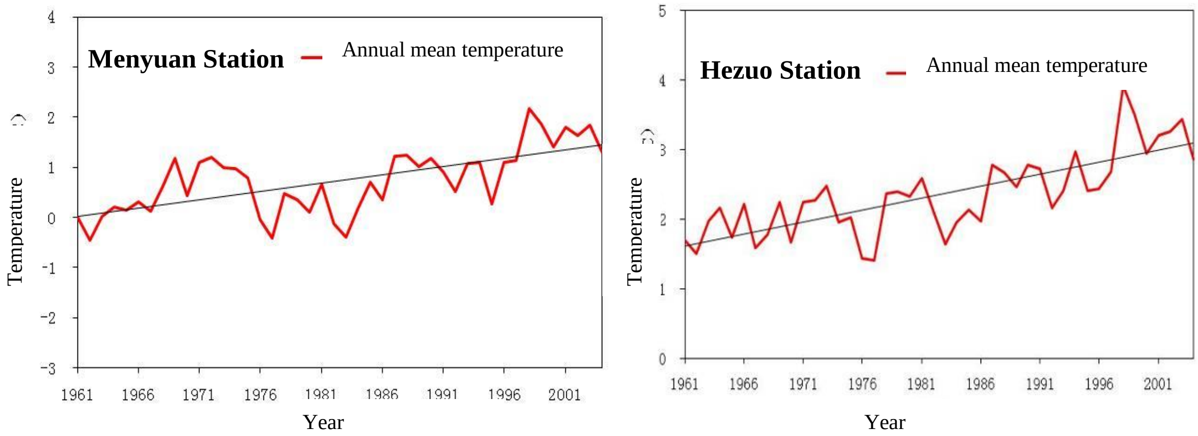

Figure 11.Air Temperature Changes at the Menyuan and Hezuo Stations, 1961-2004

The research also simulated 30-year monthly mean temperatures, precipitation and actual evaporation for the periods of 2040-2069 and 2070-2099, respectively. The results were used to make climate predictions for 2050 and 2100, applying the IPCC A2 and B2 scenarios[25] and the PRECIS (Providing Regional Climates for Impacts Studies). The results, shown as a comparison to the historical data from the period 1961-1990, are shown in Figures 12-14 for the month of January.

[25] “SRES” refers to the scenarios described in the IPCC Special Report on Emissions Scenarios (SRES, 2000). Four scenarios, A1, A2, B1 and B2, are used to explore alternative development pathways, covering a wide range of demographic, economic and technological factors and resulting levels of GHG emissions. Of the two scenarios used here, A2 describes a very heterogeneous world with high population growth, slow economic development and slow technological change, while B2 describes a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental sustainability.

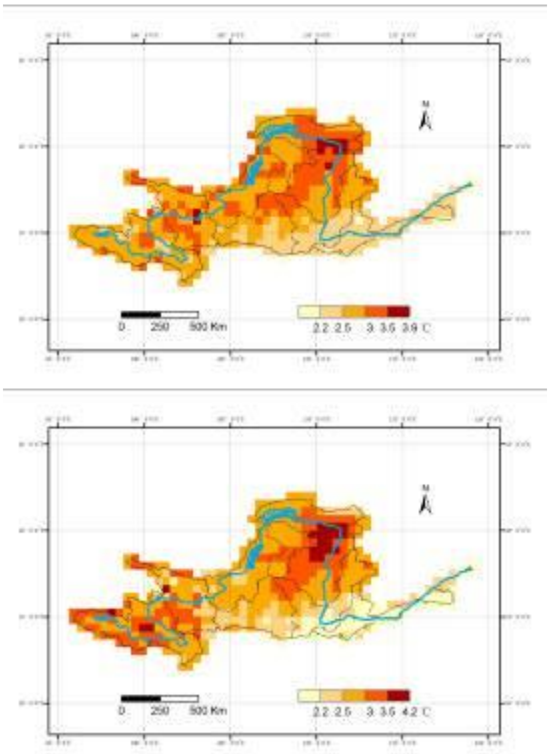

Figure 12. Mean Temperature in January between 1961-1990 and 2040-2069 under Scenarios A2 (left) and B2 (right)

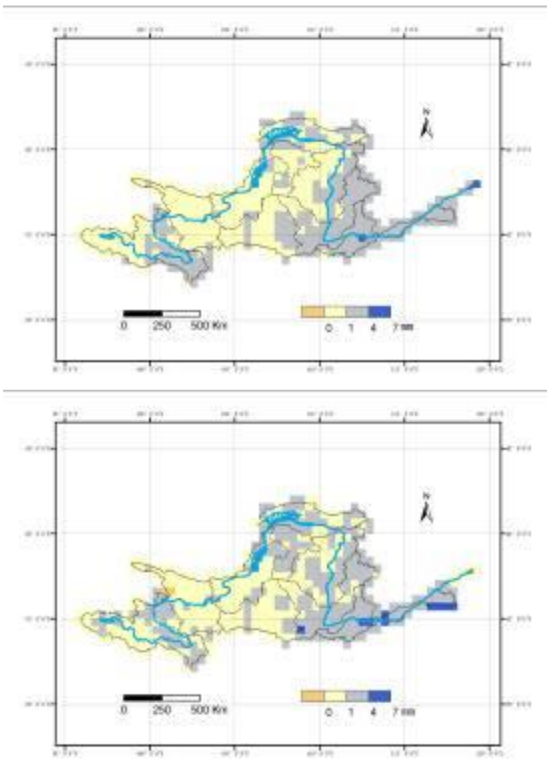

Figure 13. Mean Precipitation in January between 1961-1990 and 2040-2069 under Scenarios A2 (left) and B2 (right)

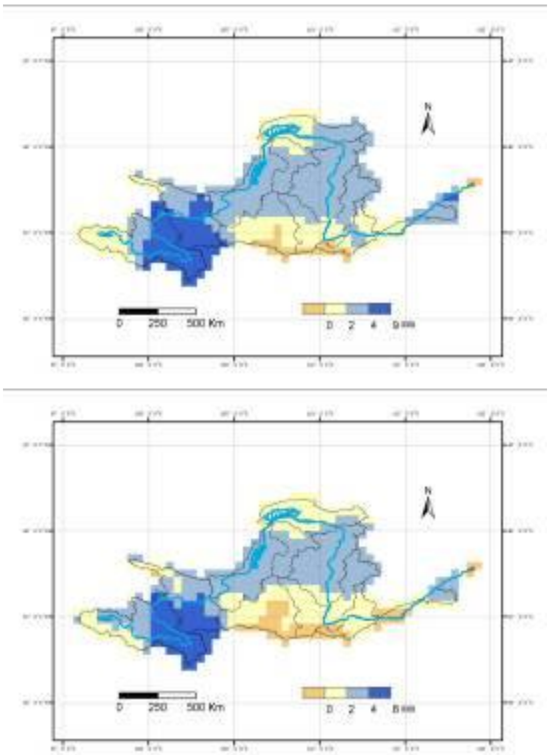

Figure 14. Actual Evaporation in January between 1961-1990 and 2040-2069 under Scenarios A2 (left) and B2 (right)

In Figure 12, there is an increasing trend in the mean temperature between scenarios A2 and B2. On average, the January mean temperature could increase by 3^{o} C in the whole basin in both scenarios. There are noticeable temperature rises in the Loess Plateau, Ordos Plateau and in the source area.

In Figure 13, precipitation is predicted to increase slightly (≤7mm) in January during 2040-2069. The spatial patterns of the precipitation increases are very similar in both scenarios A2 and B2. Generally speaking, precipitation in the middle and lower reaches of the basin might increase more than that in its upper reaches.

In Figure 14, the January actual evaporation increases in most areas of the basin and shows similar spatial patterns between the two periods. The increases in evaporation are higher in the Longzhong and Songpan Plateaus under the two scenarios.

Variation of Hydrology and Water Supply and Demand

The assessment also considered river runoff which, as discussed above, is an effect of glacier and permafrost melting in the Tibetan Plateau (discussed in Section

3.2). Analysis of the data showed that the variations in annual natural runoff from 1955 to 2008 was similar to variations in precipitation, and were the same as flood season data from 1955 to 2006, which indicates that change of rainfall is also a major factor influencing runoff. From the correlation analysis shown in Figure 15, the simulated runoff levels in the A2 and B2 scenarios derived with the Yellow River Water Balance Model are relatively similar to variation of precipitation and natural runoffs in the basin.

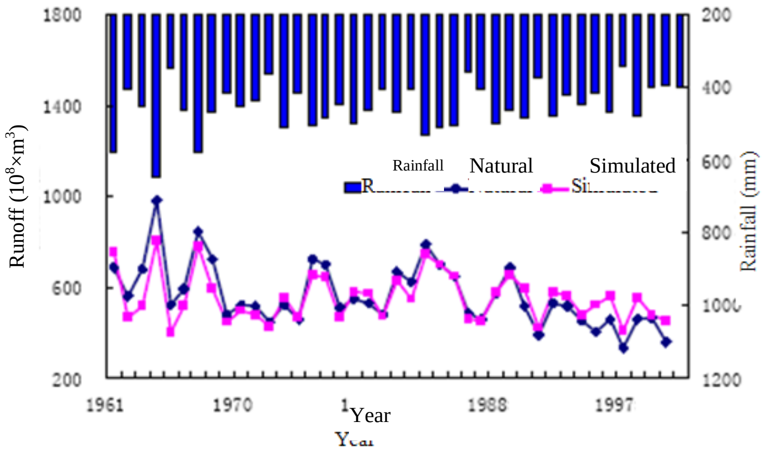

Figure 15. YRB Rainfall, Natural and Simulated Runoffs, 1961-2000

In summary, since 1990 the annual runoff in the Yellow River Basin and natural runoff in the flood season have all shown a decreasing trend. In turn, because runoff is a source for groundwater recharge this results in the depression of the groundwater cone, especially in drought years. In the upper reaches of the Basin, glacier retreat and permafrost thawing due to climate change are reducing the supply for river runoff. The conclusion is that water resources in the Yellow River Basin have already been greatly affected by climate change.

The six integrated scenarios composed from the two SRES scenarios A2 and B2 and three socio-economic scenarios (rapid economic growth, stable growth, and slower growth) also indicate that future water shortages will generally occur in all scenarios. A vulnerability model, based on the parameter system and background value methods, showed the vulnerability of water resource systems increasing year by year due to climate change and human activities. As such, there may be more severe shortages than can be predicted at this time. It is also worth noting that it is likely that women, who account for just 48.7 percent of the population in Yellow River Basin, will face greater challenges due to water scarcity than men under the same conditions due to gender disparities in these areas.

The Impact of Climate Change on Ecosystems and Agriculture

A large reduction in the water resources in the Yellow River Basin over the next 100 years would have a significant impact on the basin's ecosystems and its agriculture. Grasslands and wetlands have already been affected in recent decades by both human activities and by climate change. Future increases in temperature and evaporation and decreases in rainfall would lead to the further shrinking of wetlands. It is expected that the surface area of estuary wetlands would also be further reduced. However, the likely changes in sediment are still uncertain due to the impacts of factors other than climate change.

Climate change impacts on plant and animal phenology, crop structure and agricultural production, are resulting in adverse effects to the agricultural economy in the Yellow River Basin. For example, an increase in the average temperature in the Puyang area of Henan province has meant that winter wheat has been replaced by semi-winter wheat. Additionally, early ripening corn has been replaced by a middle-to-late maturing variety. Due to the combined effects of climate warming and market changes, the planting of thermophilic crops like corn and cotton would have significant economic benefits including increased yields.

3.3.2 Policy Recommendations

(1) **Sound water allocation policies in Yellow River Basin** such as improved water use licensing and quota management systems with a total cap on water consumption are necessary and need to take into account extra water resources from the West Line Project for South-North Water Diversion project (SNWD) to the Yellow River.

(2) Apart from water allocation, **adequate policies and measures concerning water conservation and security should be developed**, given that the gap between supply and demand of water resources in the Yellow River Basin is likely to persist in the immediate future and that serious water shortages can affect the health of the Yellow River.

(3) **The adaptive capacity of agricultural production needs is strengthened.** Agricultural irrigation uses large volumes of water. Crop structure should be diversified, the development of high-water consuming crops limited to protect the agricultural eco-environment, and conservation agriculture employed to increase water-use efficiency.

(4) **It is crucial to identify and limit discharge of pollutants into rivers and waterways** to avoid the reduction or loss of water's functional qualities. A rapid response mechanism for major water pollution incidents should be established along with a compensation mechanism for water pollution as well as the development of sewage treatment in the Yellow River Basin.

(5) **Preventive measures should be taken** given that the statistical scenario models indicate increases in the frequency of extreme weather events. Examples are the building of river embankments, improving maintenance of downstream riverways, ensuring safe construction of retention basins[26] and beach areas, and improving water and sediment adjustment systems.

(6) **Promote gender equality.** The study also indicated that the impact of climate change on women might be far greater than the impact on men. In order to improve the unequal impacts of climate change on women, climate change mitigation and adaptation measures must consider gender, such as participation in decision-making.

3.4 The Vulnerability of Groundwater Resources to Climate Change in Northern China

Groundwater is an essential water resource, making up 20 percent of the world's freshwater supply, and is naturally recharged by precipitation, streams and rivers. At 760 billion cubic metres, groundwater resources account for 26.8 percent of China's total water resources. However, in many parts of China, especially in the North, long-term overexploitation of groundwater has resulted in a continuous fall in the groundwater table and a series of geological and environmental problems, such as ground sedimentation, karst collapse[27], seawater intrusion and desertification. Pollution from agriculture and industry has also contributed to the decline of groundwater quality. Climate change is further compounding these problems. For example, more frequent extreme droughts, floods and other natural disasters cause variations in groundwater recharge rates and changes in groundwater circulation. Better monitoring, protection, use and recharging of groundwater resources are therefore critical to coping with the impacts of climate change.

3.4.1 Case Study IV. Managing the Effects of Climate Change on Groundwater in Cangzhou City, Hebei Province

Under the CCPF, a team led by the United Nations Children's Fund (UNICEF) and the Ministry of Water Resources (MWR) worked in pilot sites in Hebei, Shandong and Shaanxi Provinces, to help manage the effects of climate change on their groundwater resources.

Cangzhou City in Hebei province, located in a region that has suffered from severe water shortages, was one of the pilot sites. Following a long-term decrease in river flows, groundwater has become the major source of water supply. Over-exploitation

[26] An artificial lake used to manage stormwater runoff to avoid flooding and downstream erosion
[27] The subsidence of underground drainage systems typically characterised by subterranean limestone caverns carved by groundwater

and contamination by industrial and domestic sources have all contributed to its depletion. Therefore, the city had an urgent need to monitor its groundwater with the aim of maintaining a safe water supply and sustainable groundwater use.

The team first built up of the necessary local capacities, updating monitoring systems and installing portable water quality meters. The programme also provided technical assistance and on-site training to technicians on groundwater monitoring, well maintenance, water sampling, and data storage and analysis. With the improved capacity for groundwater monitoring, relevant data necessary for modelling and developing adaptation measures was then collected from the pilot site.

Figure 16. Portable, Multi-Parameter Water Quality Meter
Figure 17. Protected Monitoring Well Built by CCPF
Figure 18. On Site Technical Support in Cangzhou City (I)
Figure 19. On Site Technical Support in Cangzhou City (II)

Based on the data collected and through a statistical analysis of long-term historical meteorological data, the team were able to model the future impacts of climate change on groundwater. Furthermore, the team explored the effects of climate change and human activity on changes in precipitation, temperature, evaporation and groundwater table over the past 30-40 years. The major findings from this vulnerability study are as follows:

(1) The temperature in Cangzhou has increased by 0.045°C per year (Figure 20) while precipitation has gradually decreased since the 1950's;
(2) Changes in evaporation and temperature have had a slight impact on the groundwater table, but have affected water use significantly and so have had a significant indirect impact on the groundwater table;
(3) The groundwater table in Cangzhou has fallen continuously (Figure 21.). Water consumption from human activities has been a principal cause of this but climate change has also played a part. The groundwater table is influenced by human

activities with a weighting of 70-90 percent and precipitation with a weighting of 10-30 percent;

(4) The fall in the groundwater table could be effectively lessened through improved water conservation, which would reduce consumption by 10 percent;

(5) Techniques such as low-quality water use and rainwater harvesting could decrease groundwater extraction and effectively reduce the fall in the groundwater table. A 10 percent decrease in groundwater exploitation would mean a reduction in the water table of only 1.06 m by 2050;

(6) Deep groundwater extraction could intensify the rate at which the groundwater table falls.

Figure 20. Air Temperature Trends in Cangzhou City, 1975 - 2010

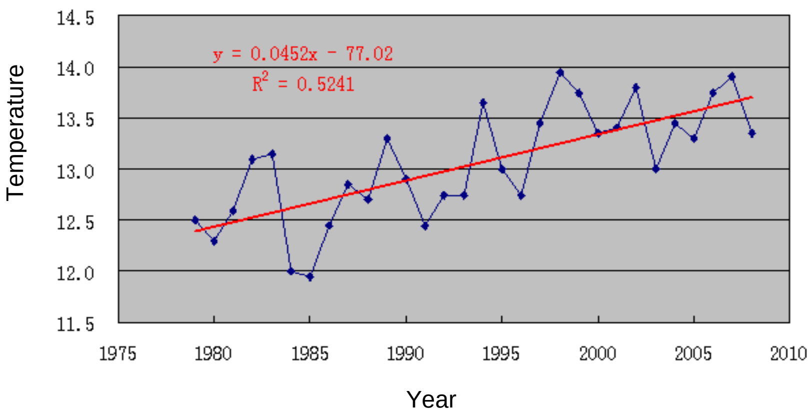

Figure 21.Changes in the Groundwater Table in Cangzhou City, 1975 - 2010

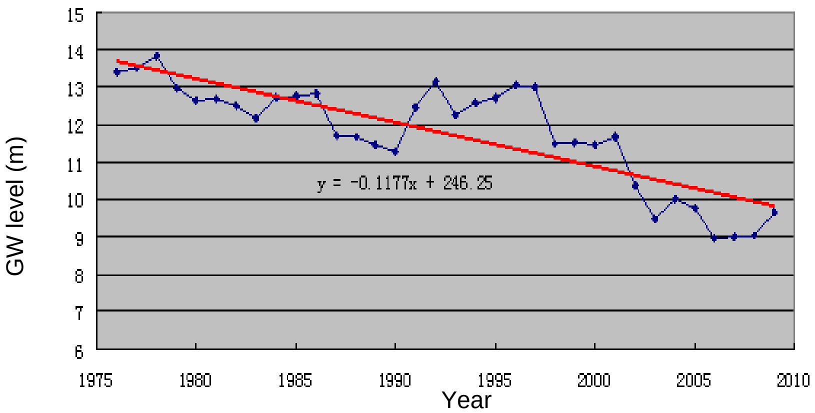

Figure 22. Calibration and Validation of the Groundwater Model

Based on the above findings and analysis of future scenarios, possible adaptation measures were proposed and shared in trainings and workshops in the field, including:

1) Reducing pumping of groundwater by adopting water saving practices and using alternative water resources;
2) Taking measures to increase groundwater recharge during the wet season, such as using field canals and low lands to retain more runoff to recharge groundwater; reserving some groundwater as strategic water resources for use in mitigation during extreme droughts, and strictly adhering to total extraction limits in groundwater development;
3) Adopting integrated surface water and groundwater management when making groundwater development planning in order to keep groundwater in dynamic balance, thereby enhancing groundwater resources protection and groundwater recharge;
4) Sharing data among stakeholders, enhancing groundwater related research and training, and basing groundwater development on comprehensive scientific research, and;
5) Enhancing advocacy and education of groundwater knowledge, regulations and policies, to increase public awareness of and participation in on groundwater protection.

Figure 23. Trainings and Workshops on Groundwater Monitoring (I)

Figure 24.Trainings and Workshops on Groundwater Monitoring (II)

Through implementation of the programme, the capacity of Cangzhou City to monitor and manage groundwater in the context of climate change has been strengthened, particularly the Government's ability to build and use groundwater models. At the same time, the research team of Cangzhou City was exposed to best practice and the latest technologies for effective groundwater management. The pilot site also plays an important role in the demonstration of better groundwater management by employing appropriate measures along with the latest technologies.

3.4.2 Policy Recommendations

The impact of climate change on groundwater is still a new field, with few existing scientific reference points to draw on. Recommendations include:

(1) A greater understanding is still needed of the interaction between the direct and indirect influences of climate change on groundwater. For example, the direct effects of droughts on recharge rates are exacerbated by the indirect influences of human activities such as more intensive extraction of groundwater brought about by droughts. Groundwater modelling needs to take into account both these influences.

(2) The Government should develop better policies for comprehensive management of both surface and groundwater. Such policies should provide for proper management of water abstraction licenses, water metering and emergency responses to natural disasters. In particular, they should address the systemic integrity of the circulation of groundwater to better protect water resources and ensure prioritization in water resource allocations, with the aim of balancing water abstractions and recharges. The Government has developed some polices on groundwater management already, however they are still very rudimentary and do not fully take into account the impacts of climate change. In turn, policy development needs to be supported by accurate data collected from monitoring systems and research work. River basin-level and regional level groundwater management is particularly important in this context.

(3) **Cooperation among Government agencies and research institutes should be further enhanced**. Many different sectors are involved and working in different aspects of groundwater, including monitoring, exploitation and management, and research. Cooperation and sharing of information between stakeholders involved in these various aspects is currently lacking, but would greatly assist in forming an understanding of the full effects of climate change on groundwater.

(4) **Awareness of the climate change impacts on groundwater should be promoted,** as should the interaction between climate change and human activities that both had received little attention in China prior to the CCPF.

3.5 Sea-Level Rise in China's Coastal Provinces

Sea-level rise is a long-term phenomenon whose effects can be more severe when combined with other marine disasters**.** China's coastline is long (18,000 km), approximately 70 percent of China's medium and large sized cities are located in coastal areas which account for some 60 percent of GDP. According to State Oceanic Administration's statistics, while global sea level rise averages 1.7 mm per year, it reaches 2.6 mm in China's coastal areas. In 2009 alone, the sea level around China's coastal provinces rose by 8 mm.[28]

Under the CCPF, UNEP, NDRC, and ACCA 21 carried out an assessment of the effects of sea level rise on China's coastal provinces under different scenarios, to help better formulate adaptation strategies. The study focused on China's most vulnerable areas:

(1) The Yellow River Delta (including Shanghai, Southern Jiangsu, Northern Zhejiang);

[28] "Rise in sea level reaches record high," China Daily, 28th January 2010

(2) The Pearl River Delta (the nine administrative areas which comprise it, including Guangzhou, Shenzhen as well as the Special Administrative Regions of Hong Kong and Macau), and;

(3) Tianjin City.

3.5.1 Case Study V. Integration of Sea Level Rise into Provincial Adaptation Planning in Zhejiang Province

The fourth richest province in China, Zhejiang was selected as one of the pilot case studies because of its economic importance and due to its long coast line (6,486 km). Zhejiang is the centre of aquaculture in China and is the country's single largest fishery. Marine development is one of priorities outlined in both the National and Provincial 12th Five-Year Plans (2011-2015).

Seawalls are vital to the protection of all the economic activities in the province, not to mention the safety and welfare of the local population. Only the Yangtze River Delta area or approximately 40 percent of Northern Zhejiang is protected by seawalls, so the unprotected areas suffer the effects of high tides. A sea-level rise of 0.5m would mean that existing sea walls would no longer adequately protect against marine disasters, and the risk of flooding in any given year would increase from 0.001 percent to 1 percent. Seawalls are one of the most important sea defence systems, protecting 18 million residents and 1 million hectares of land. However, most of the seawall is open or semi-open and vulnerable to sea-level rise and high tides. Through the 1997 "Thousand Mile Seawall" project, the 2,132 km long seawall was reinforced to withstand more frequent storm surges.

Sea level rise can have other knock-on effects: the water level in coastal rivers can rise, causing hydraulic resistance and increasing the risk of urban flooding, as well as drainage and sewage problems. Furthermore, a rise in the relative sea level can increase saltwater intrusion into coastal groundwater. This can threaten the water supply through increased salinity, a problem that is exacerbated during dry seasons when water extraction from groundwater is highest. About 80 percent of the water supply in Hangzhou, the provincial capital, is from the Qiantang River, whose estuary is located in a tide-sensitive section affected by sea level rise; this would affect the quality of drinking water supplied from groundwater. To complicate the problem, a series of inland dams and reservoirs reduce river runoffs, which would increase saltwater intrusion into both surface water and groundwater.

Figure 25. Storm Surge off the Coast of Zhejiang

Figure 26.Seawall in Zhejiang

Unless preventive action is taken, sea-level rise could also lead to massive destruction of the province's coastal landscape and its associated marine ecosystems and natural resources. The fishing industry has already been greatly affected by sea-level rise, not to mention loss of land reclamation areas, disruption of fish migration patterns, and changes in the marine community structure. Zhejiang's famous bedrock coastal landscape, a major local tourist attraction, is likely to be adversely affected, with sea-level rise making such areas unsafe and less accessible. Although the existing sea wall will continue to protect large areas against tidal surges, nearshore erosion can cause the loss of the coastline along the upper slopes, and a reduction in the areas for coastal aquaculture between the coast and sea wall.

3.5.2 Policy Recommendations

In light of these findings, the CCPF has the following recommendations:

(1) **Risk assessments should be conducted** and specific areas designated as protected marine zones and any further development prohibited. In this regard, it is essential to focus risk identification efforts on drinking water safety, destruction of coastal ecosystems and other issues related to sea level rise including flood drainage capacity and saltwater intrusion.

(2) **Seawall construction and safety testing is needed and must be based on the latest standards** and give due consideration to sea-level rise. Grading and classification standards for seawalls need to be improved to ensure that the majority of the existing seawalls can be reinforced and their height increased. In addition, new seawalls need to be built based on actual needs.

(3) **Policy makers should strengthen marine ecological conservation and restoration projects** to protect wetlands' natural capacity for flood control and reducing the impact of waves caused by sea-level rise.

(4) With urbanization taking place at such rapid speed in China, **regulations on land use and planning in provinces such as Zhejiang need to keep pace**. The government should strengthen standards of urban planning and municipal projects, especially those related to infrastructure projects.

3.6 Climate-Resilient and Environmentally Sound Agricultural Production in the Yellow River Basin

Under the CCPF, the Food and Agriculture Organization of the United Nations (FAO), the Chinese Academy of Agricultural Sciences (CAAS) and the Ministry of Agriculture (MOA) worked together to introduce practices for climate-resilient and environmentally sound agricultural production (C-RESAP) in the Yellow River Basin and to propose potential policy support options for the Chinese Government.

C-RESAP is agricultural production in which, taking into consideration climate change threats and the status of natural resources, yields are maximised, emissions and waste are reduced, negative impacts to ecosystems are minimised and the resulting agricultural products are safe. The work was carried out in Henan, Ningxia, Shaanxi and Shandong; four provinces located in the Yellow River Basin and all areas of major agricultural production. Agriculture there faces several challenges, including the degradation of natural resources, competition for resources with other sectors and large urban-rural disparities in economic development.

The work carried out through this programme included:

- Improving coordination mechanisms between different institutions and levels of work;
- Research and analysis on the challenges that the agriculture sector face in relation to climate change and natural resource use;
- Comprehensive needs and environmental assessment to identify the set of C-RESAP practices that could also be employed in these and similar regions (to be classified as C-RESAP, a practice should also have multiple environmental benefits, for example, saving water, reducing pesticide and fertilizer use or avoiding soil erosion).
- Providing farmers and field technicians with the opportunity to participate in field demonstrations and learn about C-RESAP practices in 13 pilot sites (a total of 1,100 households benefited from demonstrations);
- Training authorities, farmers and field technicians to better understand the challenges posed by climate change and natural resource degradation and empower them to look for potential ways to improve agriculture. A total of 140 authorities, 400 field technicians and 1,500 farmers participated in training across the project provinces;
- The preparation of four Provincial Action Plans with technical and policy recommendations on how to make agriculture less polluting, more productive and resilient to climate change.

This process resulted in training approaches and manuals, strategies for engaging different stakeholders for planning for C-RESAP, and province-specific recommendations. Case Study 6 summarises the approach used in Shandong, together with some policy recommendations.

3.6.1 Case Study VI. Strategies for Climate-Resilient and Environmentally Sound Agriculture in Shandong Province

Shandong is located on the eastern coast of China, on the lower reaches of the Yellow River. It is the second largest province in China and it has the third largest net GDP. Shandong agricultural produce accounts for a quarter of the nation’s total.

Meteorological disasters have increased in the province in recent years and have resulted in losses for agriculture and other sectors. In 2002, the most severe drought recorded in China's history affected 3.71 million hectares of cultivated land in Shandong (of which 0.3 million hectares had no harvest at all). This drought resulted in estimated economic losses of over CNY 10 billion. In addition, climate change is affecting the already fragile water resource supply; changing conditions for crop growth; affecting crop yield; and is likely to change the distribution of crop species, as discussed in Section 3.3. In 2007, unusually high rainfall caused mass losses in corn production in Shandong, to an estimated cost of over CNY 64 million.

The work carried out in Shandong under the CCPF has contributed to making agriculture more resilient and reducing its impact on the environment. Activities took place in 3 pilot counties: Yuncheng, Shouguang and Zhangqiu Counties, which were felt to be representative of agricultural production areas across the province. They also had the advantage of being located close to research institutions and were all urgently in need of assistance.

A technical multidisciplinary team was formed to support the activities. The team prepared a situation analysis to document the status of agriculture, climate change and environmental management in the province. It was found that the climate change projections were similar to those described in Section 3.3. The study also found evidence of a decline in water resources; over-extraction of groundwater; loss of soil fertility; salinisation; and soil and water pollution from excessive use of fertilizers. More details on the results are available on the C-RESAP website (www.cpesap.net). The situation analysis also identified the need to increase the awareness of farmers, field technicians and authorities on climate change and problems with agricultural pollution. Therefore, sponsored trainings were piloted to the local authorities, field technicians and farmers in Shandong Province.

Figure 27. Farmers Discussing Actions to Combat Climate Change in Shouguang

Figure 28. Training for Field Technicians in Zhangqiu

The situation analysis also identified the most appropriate and effective C-RESAP practices for these areas. Farmers attending the training participated in demonstration experiences where, together with field technicians and scientists, they tried out these practices in their own fields. The technical staff assisted by monitoring the performance and showing other farmers the progress and results. The following technologies were applied:

- **Precise nutrient management and stalk mulching[29] for scallion-wheat rotation.** This technology was demonstrated in Zhangqiu County, which

[29] Mulch is a protective cover usually of organic matter placed over the soil to prevent water loss and weeds

traditionally grows onions, wheat and corn. There are three major climate problems concerning the current production: 1) the early seeding of wheat tends to result in too much growth of wheat before winter, reducing its capacity to resist low temperatures or frost in spring; 2) farmers apply large amounts of fertilizers (up to 1,305 kg/ha), some of which end up in the water and air; and 3) farmers tend to burn the stalks, producing CO_2 emissions. All these also result in less efficient production. Therefore, the proposed C-RESAP practices involved a number of steps, including delaying the initial sowing; applying fertilizer according to the soil status (as measured by soil analysis) and the stages of crop growth; returning stalks to the field as compost after harvest, and increasing the water applications when needed to assist plant growth.

- **Mechanised direct planting for a winter wheat-summer corn rotation.** This practice was applied in the Yuncheng County, which traditionally produces wheat and corn. There are several identified problems with the current production methods: 1) farmers use large amounts of nitrogen and phosphorous fertilizer and almost no potassium, which results in soil fertility imbalances, problems with plant maturation, and greater emissions to the environment; 2) early seeding of wheat results in reduction of yield due to frost damage; and 3) the harvesting of corn in the region has traditionally taken place in late September and therefore has not been adapted to climate changes that could boost corn yields. Therefore, the proposed practices included delaying seeding of wheat and the harvesting of corn, as well as using an integrated nutrient management system by returning stalk to the fields and reducing synthetic fertilizers. Conservation agriculture machinery was used to plant directly into the wheat residues (without ploughing). This practice preserves moisture in the soil system, avoids soil erosion, and accumulates carbon in the soil.

- **Protected cultivation of vegetables with fertigation.** This practice was applied in Shouguang County, which specialises in vegetable production. The current problems with production include: 1) Farmers use fertilizers in large quantities and consequently there is now a high content of nitrates in groundwater. This also results in unnecessarily high production costs; 2) Most farmers use flood irrigation, which uses a large amount of water; 3) poor cultivation techniques have resulted in salinisation and soil acidification. The proposed practice was applied to the production of loofah (*Luffah acutangula*), which is a type of gourd. After land preparation and ridging, drip irrigation was installed, where irrigation water and fertilizer are mixed beforehand and applied to soil at the same time (fertigation). Drip irrigation is more effective than flood irrigation, and the practice of irrigating and fertilizing at the same time allows the control of fertilizer application and saves on labour. Farmers were also guided in the safer application of pesticides.

Data collected from the demonstrations showed that all the C-RESAP practices increased yields or maintained them at the same level as the traditional practices.

They also resulted in savings of fertilizers, pesticides and water. The increase in yields in many cases came from the shifting of planting dates, using more resistant crop varieties and increasing water-use efficiency. These practices also successfully reduced the impact of agriculture on the environment and mitigated climate change by reducing emissions from agrochemicals or burning practices while also increasing the carbon content in soils.

For example, Table 2 shows that the use of precise nutrient management and stalk mulching for scallion-wheat rotation in Zhangqiu increased yields of wheat and scallion by an average of 6.9 percent and 11.5 percent, respectively. For the same practice there were equivalent increases in profits of 10.5 percent and 16.9 percent. Table 2 also shows that the use of mechanised direct planting for a winter wheat-summer corn rotation in Yuncheng increased the average yields of winter wheat and corn by 7.4 percent and 14.5 percent, respectively. In addition, profits increased by 11.1 percent for wheat and 16.2 percent for corn harvests.

Table 2. Findings from Precise Nutrient Management and Stalk Mulching for Scallion-Wheat Rotation and Mechanised Direct Planting for a Winter Wheat-Summer Corn Rotation.

	Yuncheng				**Zhangqiu**			
	Wheat		**Corn**		**Wheat**		**Scallion**	
	DP	**FP**	**DP**	**FP**	**DP**	**FP**	**DP**	**FP**
Yield (kg/mu)	540	503	488	427	428	401	3 915	3 510
Difference in yield (%)	7.4		14.4		6.9		11.5	
Fertilizer (kg/mu)	28	35.2	17.8	20.4	27	29	41.6	62.4
Saving (%)	20.5		4.7		6.9		33.3	
Profit (CNY/mu)	762	686	847	729	600	543	7 580	6 432
Difference in profit (%)	11.5		16.2		10.5		16.9	

DP = Demonstration practice; FP = Traditional farmer practice

As illustrated in Table 3, the data showed that the practice of protected cultivation of vegetables with fertigation could reduce water and fertilizer use by 12.2 percent and 16.9 percent per mu,[30] respectively. Fertigation also resulted in a decrease in costs of fertilizers equivalent to CNY 305/mu and a saving of CNY 500/mu on labour. Overall profits thereby increased by CNY 6,240 per mu compared to the traditional practice, a 22.9 percent increase. As a result, farmers in the pilot areas mentioned that they were keen to continue these new practices.

Table 3. Findings from Protected Cultivation of Loofah with Fertigation

	Inputs			**Outputs**	
	Fertilizer (Kg/mu)	**Water (m^3/mu)**	**Labour (CNY/mu)**	**Yield (Kg/mu)**	**Profit (CNY/mu)**

[30] Mu, 亩, a traditional Chinese unit of area equal to one fifteenth of a hectare

Demonstration	418.7	342.4	188.3	11 052	33 432
Traditional farming	503.6	390	214.5	9 550	27 192
Difference (%)	16.9	12.2	12.2	15.7	22.9

Note: Profits include costs from fertilizers, pesticides, water, labour and machinery.

Figure 29. Farmers in Demonstration Fields in Zhangqiu.
Figure 30. Farmers in Demonstration Fields in Yuncheng.

3.6.2 Policy Recommendations

Briefly mentioned below are some policy recommendations which apply to all pilot sites:

(1) **Increase access to high quality inputs**. Farmers need better access to high quality seeds, fertilizers and pesticides to adapt agriculture to climate change and reduce the impact of agriculture on the environment. Existing markets should be better regulated to ensure farmers can access these at reasonable prices. In addition, mechanisms should be in place for propagating and distributing seeds from stress-resistant varieties produced by research institutions, so that farmers can benefit from them.

(2) **Improve disaster risk reduction mechanisms**. These should include, in particular, improving weather forecasts and outlooks, information dissemination mechanisms and increased funding for disaster risk reduction.

(3) **Increase funding and investment for addressing the agricultural impacts of climate change**. Innovative mechanisms to raise funds from multiple sources (including private, Government and international sectors) should be used. For example, green funds and adaptation funds can be put together from Government shares, green taxes, carbon trading schemes and enterprise involvement with capacity and infrastructure building.

(4) **Increase public awareness and participation in decision making**. Adaptation of agriculture to climate change and a better environmental management of agriculture depend heavily on the understanding of local stakeholders of the situation and ways to improve it. Awareness-raising campaigns through television, radio, newspapers, magazines, local meetings, internet and telephone hotlines, can increase the participation of farmers, field technicians and local authorities in C-RESAP.

(5) Rethink incentives and insurance schemes. The current systems of subsidies and agricultural insurance should be rethought in the light of climate change and the need to preserve ecosystem services. Key questions include ways to provide insurance for smallholders (and different production types), the advantages and disadvantages of subsidies and how they compare with environmental incentives. In addition, more efficient locally developed technologies and also those tested in other countries, like conservation agriculture, need to reach farmers.

(6) Enhancing extension systems. More field technicians need to be trained in C-RESAP to be able to transfer technologies to farmers. The current work force needs to be increased as it is not sufficient to provide the technical support that farmers need.

3.7 Protecting Public Health: Building Environmental Health Capacity

The overall goal of the CCPF in the area of environmental health in China was to build environmental health management capacity to develop and implement climate change adaptation measures that protect public health from the adverse impacts of climate change.

IPCC policy advice reiterates recent observations that climate change is likely to lead to changes in existing health burdens rather than to the emergence of new and unfamiliar diseases. Therefore, policymakers should focus on protecting public health from existing health burdens that are likely to worsen due to climate change as well as on promoting the co-benefits for public health from mitigation.

The National Environmental and Health Action Plan (NEHAP) of 2007 stresses that policies and capacities need to be developed to manage environmental health issues arising from current economic development as well as from climate change. The Plan pays particular attention to the need to improve the Government’s capacity to use a range of risk management tools, including health risk assessment, through a greater focus on monitoring, information management and education.

Under the CCPF, WHO and the Ministry of Health developed a programme consistent with both the NEHAP and IPCC principles to assure the following:

- Environment and health governance, through developing mechanisms that support greater public participation in development planning; integrate environment and health considerations, particularly at the local level; and further develop effective legislation and enforcement strategies;
- Workforce development, through mainstreaming environment and health into Government policies and planning, through leadership development, and by ensuring human resource development that is in line with needs;

- Equity, environmental justice and sustainable development through assessing risk, building resilience and reducing the distribution of impacts from proposed developments on the whole population, with a particular reference to how development will affect vulnerable groups of individuals;
- Monitoring and information management, through increasing the use of quantitative and qualitative evidence linking environmental change to health, including monitoring and research into environment/health linkages.

Environment and Health Governance

The team's first step was to perform a baseline assessment. This revealed:

- Poor collaboration, including a lack of knowledge and policy development, between Government ministries, particularly on climate change and health.
- Weak public participation on environmental health issues, with a need for mechanisms at the local levels to increase community engagement
- A lack of effective management systems for facilitating cooperation and information sharing among all Environmental Health (EH) management stakeholders to develop "local" (province/ county/ city) plans that can link local implementation to national policy.

To address these challenges, key objectives of the programme included strengthening local planning and management to address the impacts of climate change. The new concept of Local Environmental Health Action Planning (LEHAP) was developed in four provinces.

This resulted in the development of a provincial level management model with two core elements: a critical review framework to monitor and review the management of environmental health services essential for climate change management, and a county level strategic management system aimed at both specific climate change adaption strategies and building more climate resilient environments and communities.

Several pilots at the county level took place to demonstrate the development of county level strategic management systems. While the focus of the pilot county programmes plans ranged from the development of a heat wave monitoring system (see case study) to improving rural sanitation and drinking water, all saw improved use of strategic planning, interagency collaboration and community participation, and hence served to demonstrate that improved environment and health governance is essential to address the impacts of climate change on health.

In parallel, two cities developed China's first city-based Climate Change Adaptation Plans. The plans focused on 'prevention' in the context of the development of both mitigation and adaptation strategies that address the health impacts of climate change. This involved the development of an overall health and climate change prevention framework that addressed specific environment and health issues according to climate change projections for each city. The included conducting a city health profile, stakeholder consultations, a vulnerability assessment, a critical review of the current capacity to manage impacts, and the development of specific adaptation strategies to address the cities needs.

The LEHAP and city based Health Adaption Plans represent the first attempt to develop a management process that is explicitly linked to the framework of the NEHAP. As such, it provides early insights into the development of models for potential replication across all provinces. This preliminary work now needs to be extended over a longer implementation time frame and to include a larger number of counties and cities given their diverse demography, development and ecological conditions and the associated range of health impacts.

Workforce Capacity and Risk Assessment

A review of environmental health organizations and their workforces revealed very low levels of awareness, policy development and overall activity in the area of climate change and health. Key findings included:

- The educational background of environmental health staff in health agencies is weak, which impacts on leadership and management capacity. In many agencies, the composition of educated staff is primarily comprised of junior college and technical secondary school graduates;
- The knowledge base of the current workforce cannot meet the current and emerging needs of environmental health work, particularly in the area of the health impacts of climate change. To improve this situation rapidly, the in-service education of environmental health staffs needs to be enhanced;
- The current curriculum providing professional training at sub degree, degree and postgraduate levels lack any detailed learning related to the various tools needed to support risk assessment in climate change management. These areas include burden of disease analysis, health impact assessments (HIA), strategic EH assessment and cost-benefit HIA analysis.

To address these challenges, the programme rolled out extensive training programmes, developed curricula on risk assessment, and conducted pilot activities to apply new risk assessment tools to climate change impacts on health.

A curriculum for short-course training was developed for the local situation in China. Case studies were developed and trainings delivered in the four pilot provinces to improve the ability and skills of Ministry of Health staff to use risk assessment tools on climate change.

In order to generate case studies needed for the training, several projects were undertaken, for example *Burden of Disease and Health Impacts of Drought in*

Gansu, and *Vulnerability Assessment of Climate Change in Changchun*. While useful in supporting the development of risk assessment capacity, this work was hampered by difficulty in accessing health data, particularly that related to non-communicable diseases, which highlighted the need to improve environment and health surveillance systems.

Development of risk assessment tools and associated curricula now provides the opportunity for Government to review current training. However, there remains a need to review and further develop longer term training at both undergraduate and postgraduate levels to ensure the workforce education meets current and future needs. There remains a need provide both greater experience in the use of such technologies and to apply the principles of vulnerability assessment and adaptation planning from the level of city Government upwards.

Surveillance and Information Management

A key challenge that China faces in designing and implementing climate change adaptation strategies is developing a robust monitoring system. On the basis of a review, the following key issues were identified:

- Relevant ministries need to enhance funding, human resources, and training;
- The indicators used to reflect the scope and scale of environmental health issues need to be expanded, including ones specifically for climate change;
- There is a lack of effective mechanisms for inter-sectoral cooperation and data sharing among different agencies.

To address these challenges, the programme developed a critical review of current environmental health monitoring systems; elaborated recommendations on how to improve the types of indicators used; supported a national approach to monitoring the quality of drinking water; tested new approaches to monitoring and surveillance, including the potential for new climate change indicators (e.g., heat waves and health); used new technology to enhance the use of data; and harmonisation of existing monitoring systems.

China has made considerable progress in areas such as drinking water and outdoor air quality surveillance. It needs to be extended to high priority areas such as indoor air quality, heavy metal pollution and climate change, and to use the work undertaken to develop new and improved indicators. One significant barrier to overcome is the need to improve the access to data between relevant Government agencies.

3.7.1 Case Study VII. Qijiang County High-Temperature Heat Stroke Monitoring and Intervention Programme

In China, climate change is likely to make heat waves more frequent and intense, as well as increase the number of hot days during the summer, thereby increasing mortality. The health impacts of heat waves include cerebro-cardiovascular and respiratory diseases; China already has already one of the highest rates of cerebro-cardiovascular and respiratory diseases in the world. These rank as the highest contributors to mortality and are undergoing a rapid increase because of other vulnerability factors such as aging and urbanization

Past studies have revealed that many cities in China experience severe heat waves and that death rates were elevated during these periods. The number of deaths increased 2-3 times above what is expected during summer periods. Mortality was particularly high among those over 60. Heat waves also present risks to infants. Unless effective adaptation measures are implemented to prepare the population, this will increase morbidity and mortality.

The Pilot Site

The pilot site is located in the Qijiang County within the Municipality of Chongqing. Chongqing itself is experiencing distinct change in climate, and extreme weather events occur frequently. From 1986 to 2007, there were nine warm winters in Chongqing. In 2006, Chongqing suffered a hundred-year extreme temperature highs and droughts. It saw heavy rainfall in 2007, which caused the heaviest flooding in the past 115 years. All of these weather events have significant direct and indirect health impacts. How to effectively deal with the effects of climate change on human health within Chongqing is now an urgent problem.

Qijiang County is located south of Chongqing in a subtropical humid climate zone, with characteristics of a typical subtropical East Asian monsoon climate. Annual temperature is 1-2 degrees higher than the average temperature of the whole municipality. The maximum temperature recorded (44.5ºC) is the highest in Chongqing meteorological records. Heatstroke is common due to hot summer weather. The emergency response system was identified as weak in a number of key areas including: poor high temperature heatstroke monitoring and warning strategies, and the capacity to diagnose report and respond to heatstroke cases.

Purpose of the Case Study

The aim of this pilot was to increase the ability of health system institutions and field practitioners to respond to and manage the health effects of increased frequency and intensity of heat waves arising as a result of climate change. This was to serve as a model for the province as a whole.

The key objective was to develop and implement a County-Level High-Temperature and Heat Stroke Action Plan. The national, provincial and county level agencies from within the Ministry of Health and National Meteorological bureaus all collaborated in this effort.

As the first step, a heatstroke index was developed taking into account cases of heatstroke, the impact of factors such as temperature, relative humidity, grade of wind, and hours of sunshine. Following an analysis of historical data, a heatstroke grading system was developed with associated community and Government actions recommended for each of the established warning grades.

The Qijiang health department also established and implemented an improved monitoring and reporting system for high temperature heatstroke cases, designed to be incorporated into regular reporting systems from June to September every year.

A public warning system was established which included a forecasting analysis of high temperature weather conditions and heatstroke cases and trends. Prevention and control strategies were provided to county Government to allow it to implement graded response measures, treat and cure patients and conduct meteorology monitoring, health education and information management. The warnings were designed to be disseminated to the public through the television, mobile phones, special reports and other relevant methods. Key groups and locations that were targeted included vulnerable groups such as school children, high temperature areas such as transport hubs, outdoor work environments and construction sites, and general public places like shopping centres, hospitals and hotels.

Figure 31. Community Awareness Raising on Heat Stroke Prevention

Figure 32. Staff Training on Heat Stroke Prevention

Implementation of the County-Level High-Temperature and Heat Stroke Action Plan

The summer of 2010 saw the plan put into full action. Figure 33 is an excerpt from a typical weekly report:

Figure 33. Qijiang High Temperature Heatstroke Information Analysis, Qijiang Centre for Disease Control and Prevention, 26th July - 1st August 2010

In the week of 26th July - 1st August 2010, the County Meteorology Bureau released 12 high temperature warnings, including three red warnings (above 40°C) and nine orange warnings (above 37°C). Warnings were released once on 26 and 31 July 2010 and twice on each of the other five days. The three red warnings were released on the mornings of 29th, 30th July and 1st August 2010 respectively. Meanwhile, the Bureau included high temperature warnings and heatstroke prevention reminders in the weather reports on television and sent high temperature warnings to related professionals in project units through mobile messages. The County Centre for Disease Control issued high temperature warnings to all the medical institutions in the county through a QQ[31] group to remind them to strengthen their heatstroke monitoring and conduct and report on their heat prevention work. Other project units, including the long distance bus station and Wenlong street health centre, published high temperature warnings by electronic screen.

3.7.2 Policy Recommendations

The health impacts of climate change necessitate building capacity within the public health system that enables it to develop and implement specific adaptation strategies particularly at the local level. To this end, it is recommended that policies be developed in the following areas;

(1) As part of the National Environmental Health Action Strategy, **Local Environment and Health Protection Plans should be implemented** using the models and methods developed under the CCPF. This planning process needs to incorporate all the environmental determinants affecting health outcomes and provide an enabling institutional environment for collaboration between the Government, community and the private sector.

(2) Increased urbanization poses increased health risks arising from climate change. **City based climate change adaptation which focuses on health protection and promotion is needed to address this threat**. The framework developed in this study can be used to address this need. There is an opportunity to incorporate this policy within the 'Healthy Cities' approach also being currently developed by the Government.

(3) **The curriculum and training for environmental health professionals should be reviewed at the national level.** Incorporating the proposed changes recommended in this project, in particular a risk assessment curriculum, should be incorporated into undergraduate, postgraduate and continuing education of environmental health professionals.

(4) **The risk assessment methodologies trialled in this project should be further developed** and the potential for greater use of risk assessment techniques such as Health Impact Assessment should be incorporated into the development approval process.

(5) **Environmental health monitoring and information management should be expanded and improved upon**. Increased access to existing data sets across Government agencies needs to be provided. The revised set of environmental

[31] A Chinese social networking website

health indicators developed should be further tested for use in the assessment of climate change impacts on health.

4. Conclusion

4.1 Overall Conclusions

This paper presents a synopsis of some of the key findings, case studies and policy recommendations developed during the implementation of this three-year joint programme. The programme delivered interventions in numerous pilot sites across 16 provinces in China, and in the very limited space of this paper we are only able to highlight some of our key findings and, in an abridged form, a small number of case studies. For details of the full reports from which these findings and case studies originate, the reader is invited to consult the bibliography. The reader is also invited to consult the last section of this chapter which summarizes the results of the CCPF, output by output.

The effects of climate change are already evident in all sectors of the economy in China. In particular, and not surprisingly, **many of the issues tackled in the joint programme can be traced back to underlying concerns over the effect of climate change on water security**. What is clear from our results is that the geographic distribution of water resources in China is likely to be affected by climate change in the years to come. Likewise, agriculture remains extremely vulnerable due to the underlying tensions between the availability of water resources, China's large and still growing population, and limited arable land. Unless China's water resources are effectively managed, water scarcity could have serious knock-on effects on livelihoods and human health and ultimately, if it grows too significantly, on broader economic and social development. Policies and technologies concerning water allocation, conservation and pollution control as well as adaptation of agriculture to climate change need to accurately reflect the current, but also probable future, situation, and their enforcement should be a priority.

Overall, less work has been done on China's vulnerability to climate change and its climate change adaptation needs than on climate change mitigation. In its 2007 Climate Change Strategy, the Government put adaptation high on its agenda, raising the priority for adaptation measures for grasslands, agriculture, nature reserves, glaciers and water resources, and calling for strengthened monitoring of sea-level change as well as science-based regulation of marine ecosystems to reduce possible impacts caused by sea level rise. China's Scientific and Technological Actions on Climate Change (2007) also identified as priority areas the assessment of impacts on the major vulnerable sectors and the development of adaptation measures. Through the actions taken in this joint programme, the UN in China has responded to these policy directives from the Government, although clearly much more can still be done.

While there is a strong emphasis on vulnerabilities and adaptation in this paper, the Government of China and the UN System both recognize **the importance of**

climate change mitigation and of a just transition to a low-carbon economy. Despite significant recent progress in introducing alternative sources of energy such as biomass pellets and biogas, the Chinese economy is still very reliant on fossil fuels, and especially coal, for its energy needs. National People's Congress Deputy, Professor HU Weiwu, noted that there is still room for China to significantly improve its energy efficiency as it has an energy intensity 1.5 times higher than the average level in developed nations.[32] The programme has, in this regard, investigated clean coal technologies and rural energy issues, demonstrated waste heat recovery power generation in the coal gangue brick sector, and at a national level has helped contributed to the development of the Basic Energy Law.

Cross-sector cooperation must be increased. The CCPF was supported by the MDG Achievement Fund, which was financed by the Government of Spain. Apart from accelerating progress towards meeting the MDGs, the Fund also intended, through the "joint programme" modality, to help promote UN reform through joint action by the various UN bodies. From the many issues tackled under the CCPF, it is apparent that the challenges posed by climate change are complex in nature, touching upon many different sectors. As such, they are resistant to being divided up by administrative or geographic areas, and cannot be solved effectively by any one agency alone. Real solutions can only be identified if proper consideration is given to all sectors that are impacted. Such solutions can only be properly implemented if there is cooperation among all the relevant administrative Government agencies and other relevant stakeholders. The joint work undertaken in the CCPF has been a testimony to the power of working together.

Many of the issues presented in this report were little understood at the start of the CCPF and on which little research had been previously conducted in China. Although progress in understanding has been made, three years is not sufficient to understand fully the issues that have been covered. Further research would be needed in order to generate more detailed future scenarios. In particular, the results of the CCPF have shown that **more accurate simulation models for extreme weather events** need to be developed, to help predict heavy rainfall, droughts, high and low temperatures. While we are increasing our understanding of the impacts of climate change and developing vulnerability assessments, dissemination of existing data is extremely important. The CCPF has shown that early warning systems and disaster risk reduction mechanisms need to be enhanced to prevent, or at least reduce, the effects of natural disasters.

The funding available for addressing climate change needs to be increased to be able to widely disseminate best practices and further scale up results. Given the competition to attract funding from international sources, fundraising at provincial and national levels should be a priority. Contributions from different sectors of

[32] "New Energy Targets to Produce a Greener Target," China Daily, 6th June 2011

society, including the Government, the private sector and communities, should also be explored, as should green taxes, carbon trading and enterprise involvement with capacity and infrastructure building.

Increasing public awareness and participation in decision making. Local authorities, communities, farmers and technicians in all fields need to understand better the challenges posed by climate change and environmental degradation. They also need to know how to improve and adapt to climate change. There is a need to step up awareness-raising campaigns to inform and prepare all sectors of society.

Gender equality should be recognized as a cross-cutting issue in the development of future climate change and environment related projects and programmes. Gender inequality remains one of the most pervasive social structures in the world and along with climate change continues to remain an obstacle to many developing countries in their achievement of the MDGs. Women in developing countries have less access to economic resources and less influence in policymaking, while they are, generally speaking, more socially and environmentally conscious than men. In the context of climate change, the frequency of natural disasters such as droughts, flooding and landslides is likely to increase along with that of vector-borne diseases. Women's share of agricultural production has increased over the years, making them more vulnerable to climate change impacts, and in the face of such natural disasters, women who naturally play the role of caregiver in the family are likely to face an increased burden of work. Further work is needed to understand the gender-related impacts of climate change. Gender related targets need to be identified and incorporated into monitoring and evaluation frameworks and data disaggregated by gender. Women should be involved in decision-making and should be fully represented in stakeholder and policy consultation groups.

4.2 Contribution Towards Achievement of MDG Goals by CCPF

As noted above, a key objective of the joint programme was to contribute to China's ability to meet the Millennium Development Goals. Specifically, the CCPF focused on **MDG 7: ensure environmental sustainability**. With respect to the target of *"integrating the principles of sustainable development into country policies and programmes"*, the CCPF notably supported the development of the Basic Energy Law (Section 2.2) and the incorporation of policy recommendations on reducing the impacts of agriculture on climate change, sea-level rise and glacial retreat, into some of the provincial 12th Five Year Plans (Sections 3.2 and 3.6). As for the target of *"reducing by half the proportion of people without sustainable access to safe drinking water"*, the CCPF has successfully contributed more broadly to safe and sustainable water resources by helping revise technical regulations on groundwater monitoring (Section 3.4) and supporting a vulnerability assessment on the impacts of climate change on water resources in the Yellow River Basin (Sections 3.3. and 3.4).

The CCPF also contributed to **MDG 1: eradicate extreme poverty and hunger**. It did so primarily through the assessments that were conducted of agriculture's vulnerability to climate change and by supporting the incorporation of recommendations into provincial action plans to adapt agriculture to climate change (Section 3.6). A contribution was also made to **MDG 6: combat HIV/AIDS, malaria and other diseases** through the support given to preparing local environmental action plans through which local communities can assess and manage health impacts from climate change, including changes in the range of vectors for diseases like malaria (Section 3.7). This work also contributes to **MDG 4: reduce child mortality**, since children are among the groups more vulnerable to changes in health impacts due to climate change.

4.3 Summary of CCPF Programme Results

The key results associated with each programme output are given below. Also see the bibliography for details of all research outputs and other publications produced under the joint programme.

OUTPUT 1.1 Improved policies and partnerships at national level to mainstream climate change mitigation and adaptation into policy frameworks:

- Assistance has been provided to China in formulating its position over the future post-2012 international negotiation process on climate change and the climate change regime. Studies on topics such as MRV, technology transfer, the carbon budget etc. have been shared at UNFCCC Conferences of Parties;
- A Global Climate Change Centre to serve as an international hub for best practices and south-south cooperation on mitigation and adaptation is being established at NDRC;
- The Rural Task Force on Climate Change, Environment and Rural Development was established, research conducted and policy recommendations presented at the 2009 CCICED annual meeting;
- Assistance has been provided to the Government of China in developing the Basic Energy Law.

OUTPUT 1.2: UN-business partnerships and new 'green' financing mechanisms to mainstream climate change and energy into investment frameworks and business practices:

- A UN-Business Compact on Climate Change between multinationals and local companies in China was created to share best practices and explore strategic partnerships;
- A series of climate change-friendly products have been developed for private enterprises;
- A Green Business Options programme has been developed which provides participants a skill set to explore green business opportunities;
- 500 participants including students, graduates, former servicemen, village officers, unemployed, farmers and migrant rural workers in 11 provinces were trained in GBOs.

OUTPUT 2.1: Development and dissemination at the local level of innovative models for energy efficiency:

- Demonstrations of clean coal technology were conducted in 10 enterprises, including three of China's major coal companies. Results were shared with 500 other companies across the industry;
- Two pilots for waste heat recovery power generation in coal gangue brick factories were completed and the systems tested. A health and safety assessment for the coal gangue brick sector was jointly carried out by y WHO and ILO;
- Feasibility studies were conducted and methodologies prepared for the application of CDM in the dissemination of biogas and conservation agriculture in China.

OUTPUT 2.2: Development and dissemination at the local level of innovative models for renewable energy in rural areas:

- A feasibility study was conducted on biomass pellet dissemination in China. The team was invited to help formulate an ongoing incentives programme for biomass energy development based on crop residues;
- A survey was conducted of rural off-grid renewable power stations.

OUTPUT 3.1: Climate proofing of poverty reduction in less developed areas of West China and vulnerable coastal areas of Southeast China:

- Vulnerability assessments were conducted and adaptation measures developed to help tackle (i) glacial retreat the Himalayan region of West China and (ii) rising sea levels in coastal areas in Southeast China;
- An assessment was conducted of the employment impacts of the transition to low carbon economy in China by 2020.

OUTPUT 3.2: Policies and capacities developed to manage environmental health issues from climate change:

- Awareness was raised and knowledge developed on the health impacts of climate change and adaptation planning in 180 senior staff at national and provincial levels in the four pilot Provinces: Gansu, Chongqing, Jiangsu and Guangdong;

- Local Environment and Health Action Plans were developed for all four pilot Provinces, incorporating critical reviews on the nature and effectiveness of environmental health services, and strategies for improvement were implemented;
- Climate Change Adaptation Plans for health protection and promotion were developed and implemented in two cities;
- Risk assessment methods, curriculum and China case studies were developed, and the capacity of more than 200 health professionals at the local level to conduct environmental health risk assessments was built;
- Environmental Health monitoring and information management was assessed, new indicators were developed to address climate change impacts on health, and case studies were conducted.

OUTPUT 3.3: Capacities enhanced and policies developed for understanding and adapting to impacts of water management changes on China's environment and development:

- A vulnerability assessment was conducted for river resources in the Yellow River Basin, and policy recommendations were made to the Yellow River Conservancy Commission (YRCC);
- A conceptual model for groundwater simulation and management was built, scenarios identified, and groundwater responses to climate change tested;
- Technical regulations on groundwater monitoring were revised and recommended for nation-wide adoption.

OUTPUT 3.4: Enhanced strategies for climate-resilient and environmentally sound agricultural production (C-RESAP) in selected agro-ecosystems of the Yellow River Basin:

- Situational analyses regarding agricultural production, climate change and agricultural pollution threats were conducted in four pilot provinces along the Yellow River Basin: Henan, Ningxia, Shaanxi and Shandong;
- One national and four provincial multidisciplinary teams to deal with C-RESAP were formed, and will be able to transfer experience and skills to other projects in the future;
- Climate-resilient and environmentally sound agricultural practices were identified and demonstrated to more than 1,000 farming households, 400 technicians and 140 local authorities in 13 pilot sites across the four pilot provinces;
- A comprehensive multidisciplinary training programme was introduced to the authorities, farmers and field technicians, to help adapt to climate change and reduce pollution from agriculture. In total, 260 authorities, 1,500 farmers and 400 field technicians received training;
- Provincial Action Plans for C-RESAP were formulated in the four pilot provinces, with the participation of farmers, field technicians, researchers and authorities.

5. Bibliography

See below for a list of research reports and studies etc. produced under CCPF. Published materials are highlighted in bold typeface.

- **Analysis of Characteristics of Groundwater Level Changes in Yundong Plain from 1976, UNICEF/MWR, 2010**
- Analysis of China's Nuclear Energy Law, LAI Jiangnan, UNDP/NDRC, 2009
- **Analysis on the Relationship between Shallow Water, Human Activities and Climate Change in the Yundong Plain, UNICEF/MWR, 2010**
- Analysis of the Current Petro & Gas Legislative Situation, UNDP NDRC, 2009
- **Activities Impacts on Groundwater: A Case Study of Wuqiao in North China Plain，UNICEF/MWR, 2010**
- **Artificial Neural Network Approach for Quantifying Climate Change and Human Activity, Impacts on Climate Change, UNICEF/MWR, 2010**
- Assessment of Climate Change Impacts and Water Resources of the Yellow River Basin, UNESCO/YRCC, 2008
- **Best Practice Guide for Industrial Energy Efficiency and GHG Mitigation in China, UNIDO/MOA, 2010**
- **Case Study Report on the Yellow River Basin, United Nations World Water Development Report III (WWDR-3), UNESCO/YRCC, 2009**
- **Case Study Report on the Yellow River Basin, to be published in WWDR-4, UNESCO/YRCC, 2012**
- China Energy Law System Research, SU Miaohan, UNDP/NDRC, 2009
- China-India Joint Research on MRV & Emissions Reductions, UNDP/NDRC, 2008
- China Clean Coal Industrial Fund Feasibility Study Report, UNDP, 2008
- China replaceable liquid fuel research, ZHU Weitao, UNDP, 2009
- **Climate Change and Adaption for Water Resources in Yellow River Basin, China, UNESCO/YRCC, 2010**
- **Climate Change Impacts and Adaptation Strategies in the Yellow River Basin, UNESCO/YRCC, 2011**
- **Climate Change and Corporate Social Responsibility Report, Climate Change Friendly Financing Guide, UNDP/UNIDO/GUANGCAI, 2009**
- Climate Change and Environmental Health Training Manuals, WHO/MOH, 2010
- **Climate Change Friendly Financing Guide, UNDP/UNIDO/GUANGCAI, 2011**
- Coal Gangue Brick Factory Pilot-Site Selection Methodology, UNIDO/MOA, 2008
- Coal Law System Analysis, SI Pocen, UNDP/NDRC, 2009
- Comparability of Developed Country Mitigation Efforts, UNDP/NDRC, 2010
- A Consumption Based Calculation of Carbon Budget for Meeting Basic Needs, including Technological and Financial Mechanisms, UNDP/NDRC, 2008
- **C-RESAP Website: www.cpesap.net, FAO/IARRP-CAAS, 2010**
- The Current Legislative Situation of China Electric Law, GU Yuanbin, UNDP/NDRC, 2009
- The Design of Beijing International Climate Change Centre, UNDP/NDRC, 2008

- The Energy Law and the Development of Nuclear Energy, ZHOU Fengao, UNDP/NDRC, 2009
- An Environmental Evaluation of Biomass Pellet Dissemination, December, UNDP/NDRC, 2008
- Environment and Health Management for Climate Change in China – Environmental Governance and Management, WHO/MOH, December 2008
- **Feasibility Study: Rural Household Biogas and Conservation Tillage CDM Project Development, UNAPCAEM/IESDA-CAAS, 2010**
- The Heat-Recovery Power Generation Sector in China and a Survey of Potential Project Pilot Sites, UNIDO/MOA, 2008
- Impact Assessment of Glacier Melting in Himalaya Regions on Social-Economic Development of Northwest Region and Adaptation Strategy, UNEP/ACCA 21, 2010
- An Impact Assessment of Rising-Sea Level on Social and Economic Development in Coastal China, UNEP/ACCA 21, 2010
- An In-depth Analysis of Key Problems Concerning the International Technology Cooperation Mechanism, UNDP/NDRC, 2008
- Investigation Report on Permanent Facilities for Sino-International Organizations Cooperation in China, UNDP/NDRC, 2008
- Local Environmental Health Action Plan Development Training Manual, WHO/MOH, 2010
- **Low-carbon Development and Employment – Empirical Analysis in China, ILO/RCUDE-CASS, 2010**
- MRV - Mitigation Action and Support, UNDP/NDRC 2010
- Preliminary Study on Financial Mechanisms for Full, Effective and Sustained Implementation of UNFCCC Beyond 2012, UNDP/NDRC, 2010
- Private Chinese Enterprises' Response to Climate Change and Energy Consumption, UNDP/UNIDO/Guangcai, 2009
- Proposal on Innovative Mechanism for Development and Transfer of Environmentally Sound Technologies, UNDP/NDRC, January 2010
- **Proposed Action Plan for CRESAP in Henan Province, FAO/IARRP-CAAS, 2011**
- **Proposed Action Plan for CRESAP in Ningxia Hui Autonomous Region, FAO/ IARRP-CAAS, 2011**
- **Proposed Action Plan for CRESAP in Shaanxi Province, FAO/IARRP-CAAS, 2011**
- **Proposed Action Plan for CRESAP in Shandong Province, FAO/IARRP-CAAS, 2011**
- Reduced Emissions from Degradation and Deforestation, UNDP/NDRC, 2010
- The Relationship between China's Energy & Electric Laws, LIU Chunrui, UNDP/NDRC, 2009
- Rural Development and Energy, Environment and Climate Change Policy Recommendations, UNDP/NDRC, 2008
- Rural Energy Issues in China, ZENG Ming, UNDP/NDRC, 2009
- **Sectoral Approach & International Technology Development & Transfer, UNDP/NDRC, 2009**
- A Sectoral Study of the Coal-Gangue Brick Sector, UNIDO/MOA, December 2008

- **Situation Analysis of Henan Province (Agriculture and Environment), FAO/CAAS, 2011**
- **Situation Analysis of Ningxia Province (Agriculture and Environment), FAO/IARRP-CAAS, 2011**
- **Situation Analysis of Shandong Province (Agriculture and Environment), FAO/ IARRP-CAAS, 2011**
- **Situation Analysis of Shaanxi Province (Agriculture and Environment), FAO/ IARRP-CAAS, 2011**
- Social-Economic Analysis of Himalayas Affected by Glacier Melting, Adaptation Strategy and Practice of Glacier Melting in Himalayas **-** Preliminary Report, UNEP/ACCA 21, 2010
- **Tending to the Ailing 'Mother of China', published in A World of Science, UNESCO/YRCC, 2009**
- Training Manual on CRESAP, FAO/ IARRP-CAAS, 2011
- **Variations of Shallow Groundwater Depth and Its Response to Climate Change in Weihai, UNICEF/MWR, China, 2010**

[BACK COVER]

For any queries about the contents of this occasional paper please contact UNTGCCE Chair, Mr. Edward CLARENCE-SMITH, at e.clarence-smith@unido.org or CCPF Joint Programme Coordinator, Ms. Catherine WONG, at c.wong@unido.org

[UN Agency Logos]

FAO ILO UNAPCAEM UNDP UNEP

UNESCO UNICEF UNIDO WHO