

Climate Change in China
by Denise Tonolo

Venice International University
Isola di San Servolo,
30100 Venezia
denise.tonolo@univiu.org

Introduction	5
Impacts of Climate Change in China	9
Agriculture and Livestock Breeding	10
Forestry and Other Natural Ecosystems	10
Water Resources	11
Coastal Zones	11
Society, Economy and Other Fields	11
Greenhouse Gases Emissions in China	13
Challenges	13
Current Development Pattern	15
Energy Structure Dominated by Coal	15
Innovation on Energy Technologies	16
Conservation and Development of Forest	16
and other Natural Resources	16
Long-term Adaptation in the Agricultural Sector	17
Water Resources Development and Conservation	17
Coastal Regions Adaptation	17
Institutional and Legal Framework	19
Strategies	21
Mitigation	23
Energy Production and Transformation	21
Institutional Innovation and Relevant Policies and Measures	25
Energy Conservation Technologies in Key Sectors	26
Industrial Processes	29
Agriculture	29
Forestry	30
Municipal Waste	30
Adaptation	30
Agriculture	31
Forests and Other Natural Ecosystems	31
Water Resources	31
Coastal Areas	32
Public Awareness	32
Clean Development Mechanism	33
Conclusions	37
Bibliography	39

Introduction

Scientific research findings agree that the climate is becoming warmer. Data recorded from the last century show how the average earth temperature has increased by 0.5°C, from 13.5°C to 14°C.

Most scientists think the increasing temperature trend began in the mid 20th century and is mainly caused by human activities and not just by the natural fluctuating change in temperature. The industrial revolution meant a change in human lifestyles, which led to an increase in the concentration of greenhouse gases in the atmosphere (mainly carbon dioxide, methane and nitrous oxide) deriving from both the burning of fossil fuels and a change in land use.

On the basis of these perspectives the average atmospheric temperature is predicted to rise even further, from 1.0°C to 3.5°C by 2100. However, these changes will be irregular in their global geographical distribution: less consistent on the equator but generally increasing up to 15°C at the Poles. This will lead to the melting of glaciers and cause the sea level to rise from 0.5 to 1.0 meters.

However, global warming could cause even more serious types of changes to the climate, such as floods, droughts, storms, hurricanes and in consequence, forest survival at risk and hindering agricultural productivity. Besides the increasing hydrological disasters and losses in economic productivity and sales, the scenario would be worsened by an increase in aid costs, damage control, insurances complaints and sanitary services.

Even though the concept of “global warming” has been developed during the XIX century, it was only in 1988 that UNEP (United Nations Environmental Programme) and the WMO (World

Meteorological Organization) created the IPCC (Intergovernmental Panel on Climate Change). This panel, made up of hundreds of scientists and climate change experts, was given the task of evaluating the full knowledge available regarding these problems and finally, predicting the impacts and proposing solutions (UNEP Collaborating Centre on Energy and Environment).

The 1st Assessment Report by IPCC confirmed the scientific basis of climate change, which had a tremendous impact on policy makers, and as a result, led to the request of a treaty on climate change.

A series of intergovernmental conferences were held, and in 1990, after the second World Climate Conference involving official authorities from 149 Countries, the United Nations General Assembly started the negotiations for a Framework Convention, culminated on May 19, 1992. The Convention was signed by 154 countries in Rio de Janeiro the following month. Its ultimate objective was the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”. (UN, 1992)

In order to reach this target, all countries had the general commitment to show interest in climate change and to report their actions for implementing the Convention. Countries were divided into two groups: Annex-I Parties, the industrialised countries, which historically contributed to most of the change in climate, and the non Annex-I Parties, which mainly included developing countries.

This division was based on the principles of equity and common, but differentiated, responsibilities which required Annex-I Parties to take the lead in the effort to reduce greenhouse gases emissions at the 1990 level by 2000.

During the 1st Conference of the Parties (COP1), held in 1995, it became clear that the emission targets decided in Rio were insufficient and there was a need for new commitments for the post-2000 period to be established in a Protocol. An agreement on what is now known as the Kyoto Protocol was signed two years later, during the COP3.

With this instrument industrialised countries were legally binding themselves to reach stabilised reduction targets, as opposed to the very general provisions of the UNFCCC. Developing countries, on the other hand, were recognised as needing help in order to adapt and mitigate climate change impacts through a specific mechanism that could be seen as a channel for financial aid, investments to promote sustainable development, technology transfer and promotion of equity.

Negotiations for a new and developed Protocol are ongoing, as the Kyoto Protocol timeframe will end in 2012.

The aim of this paper is to give a general idea on how China, the most important non Annex-I country concerning CO₂ emissions, is dealing with this global issue, the challenges it needs to address and the strategies it plans to undertake.

The present overview concerning climate change issues in China is mainly based on the country's National Climate Change Program (2007). The Program, in fact, clearly explains the challenges linked to climate change and the strategies the country is planning to adopt in this regard.

Impacts of Climate Change in China

China's increase in temperature has basically kept pace with global warming but with a slightly higher increase with respect to the world average. The latest information released by the China Meteorological Administration, in fact, show that the average temperature of the Earth's surface in China has raised by 1.1°C over the past century, from 1908 to 2007.

This increase in temperature was not equally distributed, therefore, some areas were more affected than others: warmer temperatures affected mostly western, eastern and northern regions, and, when this increase was most noticeable, 21 consecutive warm winters were observed nationwide from 1986 to 2007. The latter was also the warmest year since the beginning of systematic meteorological observations in 1951.

Following this path, precipitation gradually decreased in the same period of time and with the same, though inverse, geographical distribution. The effects were most severe in the northern regions (20~40 mm/10a less in average), while southern China saw an increase in precipitation (20~60 mm/10a more in average). Extreme climate and weather events have intensified their capacity, with droughts in the north and floods especially in the south-east occurring with a higher frequency (NDRRC, 2007).

A rise in sea level and melting glaciers have been identified as other consequences of climate change: the first saw an increase of 2.5 mm/y over the past 50 years, thus threatening the 14,500 Km of China's coastline, the glaciers have retreated and this trend seems to be accelerating.

If these are the data identified thus far about the past, future

projections do not seem to be overly optimistic. In fact according to the National Climate Change Program (2007), the mean temperature will continue to rise by 1.3~2.1C° in 2020, and 2.3~3.3C° in 2050, compared with that in 2000. The distribution of this increase will mostly affect the north-west and north-east regions, reaching 2.2~2.6C° in the Qinghai-Tibetan Plateau.

With regards to precipitation, the increase could possibly reach 5~7% by 2050, with the south-eastern coastal regions affected most. Moreover, the occurrence of extreme weather and climate events, as well as desertification, sea level rise and glaciers melting will continue to follow the trend observed so far, and possibly see these processes accelerating.

The adverse effects China is facing because of climate change have been identified by the country's Policies and Actions for Addressing Climate Change white paper (CPACC), issued by the State Council Information Office in October 2008, and include:

Agriculture and Livestock Breeding:

climate change has already produced visible adverse effects on China's agriculture and livestock-raising sectors. They include increased instability in agricultural production, severe damage to crops and livestock breeding caused by drought and high temperatures in some parts of the country, aggravated spring freeze injury to early-budding crops due to global warming decline in the output and quality of grasslands, augmented losses caused by meteorological disasters.

In the future, consequences of climate change on agriculture and livestock breeding have been predicted as being mainly adverse. It is likely that a drop in the yield of the three major crops will be seen (wheat, paddy rice and corn); changes in the agricultural production layout and structure; accelerated decomposition of organic elements in the soil; widened range of crop diseases and insect pests; accelerated potential desertification trend of grasslands; rising frequency of natural fire disasters; sagging livestock production and reproductive ability; and growing risk of livestock epidemics.

Forestry and Other Natural Ecosystems:

impacts are mainly manifested in the north-ward shift of the northern boundaries of eastern subtropical and temperature zones and early phenophase; upward shift of the lower boundaries of forest belts in some areas; elevation of lower line of highland permafrost and decreased area of permafrost; rising frequency of animal and plant diseases and insect pests with marked changes in the regional distribution; reduced area and overall shrinking trend of glaciers in north-western China; and threat to the oasis ecosystem posed by accelerated melting of glaciers and snow cover. Predictions for the future include: a further increase of the fragility of the ecosystem; decreasing areas of distribution regarding afforestation and rare tree species; the spreading of forest diseases and insect pests; increased frequency of forest fires and fire-vulnerable areas; shrinking of inland lakes; a decrease and functional degeneration of wetland re-

sources; the acceleration in the reduction of glaciers and permafrost areas; significant alteration of the spatial distribution pattern of permafrost on the Qinghai-Tibet Plateau; bio-diversity damage.

Water Resources:

The change in the distribution of water resources all over China is already visible. The gross amount of water resources of the Yellow, Huaihe, Haihe and Liaohe rivers in northern China has been reduced over the last two decades, whilst the rivers in southern China have slightly increased. Floods happen more frequently, droughts get worse, and extreme climate phenomena show a conspicuous rise.

The temporal and spatial distribution of water resources is predicted to worsen in the future. Some impacts include the augmentation of annual and inter-annual changes and the increase in the occurrence of extreme natural disasters, including flood and drought. In particular, accelerated melting of glaciers in western China due to climate warming will further lessen the glacier areas and glacier ice reserves, thus having significant impacts on rivers and run-offs with sources in glacier melt water. The possibility of a reinforcement of the drought trend in northern China will increase, together with an intensification of water scarcity and contradiction between water supply and demand.

Coastal Zones:

Over the past 30 years China has witnessed an accelerating trend in the rise in sea level, which has caused seawater intrusion, soil salinization and coastal erosion, damaged the typical marine ecosystems of coastal wetlands, mangrove swamps and coral reefs, and diminished the service functions and the biodiversity of coastal zones. An increase in sea temperature and seawater acidification as a result of the change in climate have given rise to a lack of oxygen in some maritime areas, the degradation of marine fishing resources and the survival of rare and endangered species.

The sea level in the coastal zones of China are predicted to rise continually and this will undermine the capacity of public drainage facilities in coastal cities, and impair the functions of harbors.

Society, Economy and Other Fields:

Climate change will also produce far-reaching impacts on society, economy and other fields, and cause huge losses to the national economy. Corresponding economic and social costs will have to be paid in order to address climate change. In addition, there will be increased chances in the occurrence of disease and spread, ensuing dangers to human health, rising possibilities of geological and meteorological disasters and consequent threats to the security of major projects. The eco-environment and biodiversity of nature reserves and national parks will be affected, accompanied by adverse effects on natural and cultural tourism resources, together with augmented threats to the safety of life and property, and to the normal order and stability of social life.

Greenhouse Gases Emissions in China

The National Climate Change Plan states that “as a developing country at a low development stage, with a huge population, a coal-dominant energy mix and relatively low capacity to tackle climate change, China will surely face more severe challenges when coping with climate change along with the acceleration of urbanization, industrialization and the increase of residential energy consumption. With its ongoing economic development, China will inevitably be confronted with growing energy consumption and CO₂ emissions. The issue of GHG mitigation will pose a challenge to China to create an innovative and sustainable development pattern”.

When we look at the country’s greenhouse gas emissions, the only official national inventory issued by China is dated from 1994, and indicates that the total amount was 3,650 million tons of carbon dioxide equivalent, of which carbon dioxide, methane, and nitrous oxide accounted for 73.05%, 19.73%, and 7.22% respectively. Most of the emissions were attributable to the energy sector and in particular, fossil fuel combustion, as shown by comparing the total amount abovementioned with the figures in Table 1.

Table 1. World CO₂ emissions from the consumption and flaring of fossil fuels (million metric tonnes)

Country	1994	2000	2006	emissions pro capita 2006	% change since 1994
China	2855.77	2966.52	6017.69	4.58	111%
United States	5267.00	5860.38	5902.75	19.78	12%
Russia	1725.02	1582.37	1704.36	12	-1%
India	740.51	1012.34	1293.17	1.16	75%
Japan	1126.55	1203.71	1246.76	9.78	11%
Germany	877.03	856.92	857.6	10.4	-2%
Canada	498.92	565.22	614.33	18.81	23%
UK	574.77	561.23	585.71	9.66	2%
South Korea	352.81	445.81	514.53	10.53	46%
Iran	250.86	320.69	471.48	7.25	88%

Following economic development, greenhouse gases increased by almost double in one decade, seeing China overtake the USA as the major emitter. However, according to the International Energy Agency, China's CO₂ emission intensity (carbon dioxide emissions compared with the GDP) decreased to 2.76 kgCO₂/US\$ in 2004 as compared to 5.47 kgCO₂/US\$ in 1990.

Source: EIA,
Energy Information
Administration

Challenges

Given these specific impacts and forecasts which climate change is causing and will cause to the country, China has acknowledged that its current development pattern needs to be addressed by taking action to both adapt to the ongoing problems and mitigate those in the future. However, as it is a developing country, striving to improve its economy and society, China will need to face different, and sometimes more demanding challenges in order to protect the environment.

The NCCP specifically highlighted these challenges:

Current development pattern

China is a country with a large population and at a relatively low level of development, and its economic development has long been constrained by the scarcity of per capita resources and it will continue to be so for a long time. Historically, development has always been positively correlated with per capita CO₂ emissions, commercial energy consumption and economic development level and there is no precedent where a high per capita GDP is achieved with low per capita energy consumption. With its ongoing economic development, China will inevitably be confronted with growing energy consumption and CO₂ emissions. Trying to reduce greenhouse gases emission will pose a challenge to China to create an innovative and sustainable development pattern.

Energy structure dominated by coal

China's energy mix has been, and is still, dominated by coal. As shown in Fig. 1, according to official statistic data in 2007, more



Fig 1:
Sources of energy
production in China
(2007)

Source: National
Bureau of Statistic
of China.

than three-fourths of the country's primary energy consumption was coal, followed by crude oil, while only 12% was derived by renewable sources (natural gas, hydro and wind power) and nuclear power. Compared with oil and natural gas, coal's carbon content per unit calorific value is 36% and 61% higher, respectively.

The country will be facing more difficulties than other countries in decreasing its carbon intensity per unit of energy for mainly three reasons: its energy mix adjustment is constrained by the mix of energy resources to a certain extent; its energy efficiency improvement is subject to the availability of advanced technologies and financial resources; its coal-dominated energy resources and consumption structure will not change substantially for a long-term period in the future.

Innovation on energy technologies

One of the main reasons for China's low energy efficiency and high greenhouse gases emission intensity is the old technologies used for energy production and utilization.

Despite the country's rapid development, there are still relatively large gaps between China and the developed countries in terms of energy exploitation technologies, supply and transformation, transmission and distribution, industrial production and other end-use energy. At the same time, a high proportion of key industries still employ out-of-date processes and technologies.

Because of this lack of advanced technologies and the large proportion of out-of-date processes, China's energy efficiency is about 10% lower than that of developed countries, and its per unit energy consumption of energy-intensive products is about 40% higher than the advanced international level.

As the country is currently undergoing large-scale infrastructure works for energy, transportation and buildings, which do not make use of advanced and climate-friendly technology and processes, innovation will be one of the main challenges for China in addressing climate change and mitigating greenhouse gases emissions.

Conservation and development of forest and other natural resources

One of the resources China could exploit in order to combat climate change is the strengthening of forest and wetland conservation to enhance its adaptation and carbon sequestration capacity. However, forest resources in China are far below the needs for social and economic development and with the acceleration of industria-

lization and urbanization, the quest for forest and wetland conservation is increasing. Aridification, desertification, soil erosion, and wetland degradation remain severe environmental problems. Lands available for afforestation/reforestation are mostly located in areas suffering from sandy or rocky desertification, which pose a great challenge to forestation and ecological restoration.

Long-term adaptation in the agricultural sector

China not only encounters frequent agricultural meteorological disasters that cause long-time instability in agricultural production, but also features low per capita cultivated land, a less developed agricultural economy and a very limited adaptation capacity. In coping with the climate change, some of the aspects that pose long-term challenges for China's agricultural sector in terms of improving its capacity of adapting to climate change and resisting climatic disasters are how to rationally adjust agricultural production distribution and structure, improve agricultural production conditions, control the prevalence of plant diseases and pests/insects and spread of weeds, reduce production costs, prevent the potential desertification expansion, and ensure the sustainable development of China's agricultural production.

Water resources development and conservation

There are two objectives for the development and conservation of water resources in adapting to climate change in China: to promote sustainable development and the utilization of water resources, and to enhance adaptive capacity of the water resource system to reduce its vulnerability to climate change. The long-term challenges on water resources development and conservation in terms of enhancing climate change adaptation capability are: enhance water resources management, optimize water resources allocation, strengthen infrastructure construction, ensure the anti-flood safety of large rivers, key cities and regions, promote nationwide water-saving program, guarantee safe drinking water and sound social and economic development, and make good use of river functions while protecting aquatic ecosystems.

Coastal regions adaptation

The coastal regions in China are characterized by dense population and most economic activities. Since most of these coastal areas are low and flat, they are vulnerable to marine disasters caused by a rise in sea level. At present, China clearly lacks capacity in marine environment monitoring, resulting in insufficient capacity of early warning and emergency response to ocean disasters associated with climate change. Lower standards for coastal anti-tide engineering also weaken the ability to resist ocean disasters. In the future, coastal erosion, seawater intrusion, soil salinization and back flow of seawater into the river estuaries caused by rising sea levels will be among realistic challenges in coping with climate change in China's coastal areas.

Institutional and legal framework

China has embraced the world's belief that manmade activities over the past centuries are the major sources of greenhouse gas emissions and therefore, responsible for climate change. However as it is considered a developing country, it doesn't have any binding commitments to reduce greenhouse gases emissions in the framework of the Kyoto Protocol and this is why China is less strict in its approach to tackle climate change.

Although common opinion claims that climate change is a global problem, and everyone should take action in finding solutions to reduce emissions, each country has its own specific issues caused by climate change and therefore, needs to study the best solutions for both adaptation and mitigation based on their own characteristics and peculiarities.

Since the problems connected to climate change affect not only the environment but also society and economy, it was necessary to set up a plan which could provide detailed policies and measures to be adopted for mitigation and adaptation.

On June 4th, 2007, China issued its first National Climate Change Program, prepared by the National Development and Reform Commission (NDRC). The agency, under the direct control of the State Council, is in charge of the main long-term policies for economic and social development. It also has an important role inside the National Leading Committee on Climate Change, a cross-ministries body responsible for the deliberation and coordination on climate related policy issues and activities.

The Department of Climate Change inside the NDRC is comprised of four divisions: Division of Strategic Planning and Com-

prehensive Affairs; Division of Domestic Policies and Convention Performance; Division of International Policies and Negotiations; Division of Foreign Co-operation. The NDRC's task is to comprehensively analyze the impact of climate change on economic and social development and organize the formulation of major climate change strategies, planning and policies. Moreover, it will take the lead in fulfilling China's commitment to UNFCCC and in organizing its joint participation in international climate change negotiations with other relevant parties and to co-ordinate international climate change cooperation and capacity-building.

The Committee also plays a major role in the framework of CDM projects to be developed in the country. These functions are explained in more detail further on in the paper.

Strategies

In order to achieve further developments in tackling climate change, China will follow some clearly stated principles in its NCCP: address climate change as part of the general sustainable development framework, implement the principle of “common but differentiated responsibilities” defined by the UNFCCC, place equal emphasis on both adaptation and mitigation, integrate climate change policy with other interrelated policies, rely on the advancement and innovation of science and technology, actively and extensively participate in international cooperation.

Particular strategic objectives have been identified and China will make great efforts to achieve specific targets by 2010. Tab. 2 shows the objectives and correlated targets.

Table 2. China's strategic objectives and targets to tackle climate change

Strategic objectives	Specific targets to be achieved by 2010
Control of Greenhouse Gas Emissions	<p>20% reduction of energy consumption per unit GDP, consequently reducing CO2 emissions;</p> <p>augmentation of renewable energy share (including large-scale hydropower) in primary energy supply up to 10%;</p> <p>extraction of coal bed methane up to 10 billion cubic meters;</p> <p>stabilization of nitrous oxide emissions from industrial processes at 2005 levels;</p> <p>increase the forest coverage rate to 20%;</p> <p>increase carbon sinks capacity up to 50 million tons over the 2005 level.</p>
Enhancement of Adaptation Capacity	<p>increase improved grassland by 24 million ha;</p> <p>restore the grassland suffering from degradation, desertification, and salinity by 52 million ha;</p> <p>increase the efficient utilization coefficient of agricultural irrigation water to 0.5;</p> <p>effective protection of 90% of typical forest ecosystems and national key wildlife;</p> <p>nature reserve area accounting for 16% of the total territory;</p> <p>22 million ha of desertified lands under control;</p> <p>completion of anti-flood engineering systems in large rivers and high standard for drought relief in farmland;</p> <p>construction and expansion of mangroves and construction of coastal shelterbelt system.</p>

Enhancement of Research and Development

strengthening of basic research on climate change;

further developing and improving research and analytical methodology, intensifying the training and capacity building for professionals and decision-makers on climate change;

building up of independent innovation capacity;

promotion of international cooperation and technology transfer, to achieve breakthrough in R&D on energy development, energy conservation and clean energy technology;

significant enhancement of adaptation capacity of agriculture and forestry.

Raising of public awareness and management improvement

transfer the knowledge of climate change to all residential communities;

raise the whole society's awareness and create a friendly social environment to address climate change;

establishment of a suitable and high-efficient institutional and management framework to address climate change in the future

Source: Elaboration of data from China's National Climate Change Plan (2007)

As underlined in the National Climate Change Plan “China will make its efforts to realize the objectives and tasks presented in this program through adopting a series of institutional, legal, economic and technological instruments in order to strengthen energy conservation, optimize energy mix, improve ecological environment, enhance adaptation capacity, intensify research and development and improve research capacity, raise public awareness and improve mechanisms for climate change administration”.

Strategies for mitigation, adaptation and public awareness are presented in the following pages.

Mitigation

Before taking a look at the key areas in need of intervention, it is important to underline that China has so far made significant efforts by adopting a series of policies to adjust its economic structure, change development patterns, save energy and improve energy use efficiency.

Industrial policies aimed at reducing the use of resources and energy consumption have been formulated. In making energy conservation and emission reduction a priority, establishing goals for energy conservation and emission reduction in key fields, accelerating the realization of major energy conservation projects, increasing energy development and conversion efficiency, implementing economic policies and by strengthe-

VIUPapers.01
TEN Center
Climate Change in China
D. Tonolo

ning the legal system “energy consumption per-unit GDP in 2006 and 2007 was lowered by 1.79% and 3.66% respectively”. (NDRC, 2007)

The development of renewable energies was promoted through the enactment of the Law on Renewable Energy and related policies in 2005. These policies give priority to renewable energy when transmitted on the state power grid, to purchase renewable energy at full price and to give price discounts to users of renewable energy. A dedicated fund was created to support the evaluation and investigation of renewable energy resources, related technological research and development, construction of pilot and demonstration projects, and the development and utilization of renewable energy in the countryside.

Significant attention was also given to the reduction of the amount of resources consumed and reuse and recycling, so as to reduce greenhouse gas emissions from their sources and in the course of production. In particular, laws regarding waste treatment promoted the retrieval and utilization of landfill gas to reduce emissions of methane and other greenhouse gases.

In rural areas activities dealing with the reduction of nitrous oxide emissions and renewable energy technologies are also being carried out, such as the use of marsh gas, solar energy and stoves that save on firewood and coal.

With regards to afforestation, billions of trees have been planted also involving the local population and particularly farmers, who have been motivated by the reform of the collective forest rights system. It is estimated that approximately 5 billion tons of CO₂ emissions were avoided thanks to these tree planting activities together with improved forest management and protection.

Finally, China has continuously increased investment in scientific and technological studies related to climate change. “During the 10th Five-year Plan period (2001-2005), the government invested more than 2.5 billion yuan in scientific and technological research dealing with climate change through national science and technology plans such as the Gongguan Plan1, 863 Plan2 and 973 Plan3. By the end of 2007, the National Science and Technology Plan for the 11th Five-year Plan period (2006-2010) had appropriated more than seven billion yuan for scientific research into energy conservation and emission reduction” (NDRC, 2007).

Despite these results there is still room for improvement and the NCCP indentified the following as major key areas of intervention.

Energy production and transformation.

It is necessary to expedite the constitution and amendment of laws and regulations that are favorable to greenhouse gas mitigation, and further intensify preferential policies to develop and utilize clean and low carbon energy.

Besides the legal framework, China plans to adjust the energy mix, by promoting an energy price reform and an institutional reform of foreign trade in order to create an import and export structure favorable to promote a cleaner and optimal energy mix.

Specific strategies are also provided regarding hydro, nuclear and thermal power, coal bed and coalmine methane industry, bio-energy and wind, solar, geothermal and tidal energy. Hydropower development is seen as an important countermeasure to promote a cleaner and less carbon intensive energy mix. Nuclear power is also regarded as an important component of the national energy strategy and its proportion in China's national primary energy supply will be increased gradually, supported by the construction of power stations in the coastal regions with faster economic development and heavy electricity load.

The expected emissions reduction predicted by promoting all these different types of energy could reach 950 Mt CO₂ by 2010.

Institutional innovation and relevant policies and measures.

In order to improve the energy consumption per unit of GDP, the country will need to "carry out a comprehensive resource planning and electric power demand side management, integrate the amount of energy saving as a kind of resource into overall planning so as to guide reasonable resource allocation, adopt effective measures to enhance end-use efficiency and electricity utilization, optimize electricity use pattern and save electricity" (NDRC, 2007). Using an energy-efficient label management system is one of the solutions to encourage and guide consumers to purchase energy-saving products.

In regards to the industrial structure, the country needs to promote the development of a service industry and increase its proportion in the national economy, with particular attention in the information industry field, as this plays a leading role in the economic growth with lower energy consumption. For this purpose, the already existing Industrial Restructuring Guiding Catalogue should be implemented in order to control the scale of energy-intensive and pollution-intensive industries and to downsize them, encourage the development of new and high-tech industries, develop and implement plans and policies for steel, non-ferrous metals, cement and other energy-intensive industries, and finally, develop and improve policies governing the export of domestically-scarce resources and energy-intensive products.

In the case of transport, stricter financial and tax policies are needed in order to encourage industries to take the lead in the development of energy-saving and environmentally-friendly vehicles, such as hybrid and electric cars. In addition, the public transport system should keep improving by increasing the share of rail transport in urban areas.

Energy conservation technologies in key sectors.

Many industrial key sectors in the country have the opportunity to improve their energy performance by gradually phasing out old low-efficiency equipment. The NCCP, has made a list of all these specific interventions and technologies that the iron and steel industry, nonferrous metal industry, oil and petrochemical industry, building material industry, transportation and agricultural machinery could improve for this objective.

Table 3. Specific actions to improve energy efficiency in key sectors

Iron and steel industry

- coke dry quenching facilities in coke ovens;
- top pressure differential power generating equipment (TRT) in new constructed blast furnaces;
- other advanced technologies and equipments (e.g. beneficiated material feeding, rich oxygen coal spurt, molten iron pretreatment, large-scale blast furnace, converter, and super power electric arc furnace, external furnace refining, continuous casting, continuous rolling, controlled casting, controlled cooling)

Nonferrous metal industry

- *Copper*: advanced oxygen-enriched flash and oxygen-enriched bath smelting processes;
- *Aluminium*: large pre-baking electrolytic cell for the smelting process;
- *Lead*: new smelting process by oxygen bottom blowing and other technologies of direct smelting by oxygen;
- *Zinc*: new wet process for the smelting.

Oil and petrochemical industry

- *Oil and natural gas*: systematic optimization technology for oil exploitation, energy saving supplementary technology for thick oil hot exploitation, optimized operation technology for water filling system;
- *Ethylene production*: optimization of the raw material structure and retrofitting of ethylene cracking furnaces;
- *Synthetic ammonia*: large-scale plants should deploy advanced energy saving technical processes, new catalyst and highly-efficient energy saving equipment, recovery of residual heat from fuel gas of one-section furnace for gas-based synthetic ammonia, replace oil with clean coal or natural gas for oil-based synthetic ammonia while medium- and small-scale synthetic ammonia should apply energy saving equipment and variable pressure absorption recovery technology and coal water slurry or advanced pulverized coal gasification technology;
- *Caustic soda*: ion membrane method needs to be increased in order to gradually eliminate the graphite anode diaphragm process.

Building material and building industry

- *Cement industry*: development of a new dry process kiln with precalcinator technology; use of energy efficient grinding equipment and power generating technology through the use of waste heat recovered from cement kiln;
- *Glass industry*: development of the advanced float process; promotion of technologies for overall heat insulation for both furnaces and kilns as well as enriched oxygen and full oxygen combustion;
- *Architectural and sanitary ceramics industry*: promotion of slab kiln, multi-hole kiln, and roller kiln technology; use of clean gas fuel in order to apply sagger-free burning technology;
- *Buildings construction*: priority for the development of green building design technology, energy saving technology and equipment, integrated

renewable energy devices in buildings, environmental friendly technology and equipment for construction, energy saving and environmentally-friendly building materials; better definition of technical standards for energy savings in new and existing buildings;

- *Other*: application of new wall materials and thermal insulation and high-quality, environmentally-friendly and efficient sound insulation material, waterproof material and sealing material; increase the proportion of high performance concrete application and extend the life span of buildings

Commercial and residential energy conservation

- promotion of household and office electric appliances such as highly-efficient energy saving refrigerators, air conditioners, televisions, and washing machines;

- reduction of energy consumption of stand-by power appliances;

- implementation of energy efficiency standards and labelling;

- promotion of high-efficient fluorescent lamp products (such as phosphorus energy saving lamp, high intensity gas discharge lamp and electronic ballast) and at the same time gradual elimination of high pressure mercury vapor lamp; implementation of energy efficiency standard on lighting products.

Agricultural machinery

- advanced energy-saving diesel engine technology to reduce diesel consumption;

- advanced mechanized farming technology such as non-tillage and combination processes;

- adoption of more electric motors in fixed production sites;

- application of renewable energy such as hydro, wind and solar energy to agricultural machineries

Transportation

- elimination of old energy intensive automobiles and development of diesel automobile, heavy-duty and special vehicle;

- implementation of national standard on vehicle fuel consumption limit;

- acceleration of the development of electrified railway, AC-DC-AC high efficient electric locomotive and locomotive supplying power to passenger carriage;

- improvement of fuel oil efficiency and oil consumption reduction;

- acceleration of old ships elimination through the formulation of new technical standards and the introduction of new types of ships with advanced power systems;

- adoption of energy saving airplanes, improvement of the transportation capability.

Source: Elaboration of data from China's National Climate Change Plan (2007)

Besides all these actions, the Medium-and-Long-Term Energy Conservation Plan, formulated by the National Development and Reform Commission in 2004, and which already lists the 10 key energy conservation priority programmes, needs to be further promoted. The ten programmes listed in the Plan include:

- Upgrading of Low-efficiency Coal-fired Industrial Boilers (Kiln)
- District Heat and Power Cogeneration
- Recovery of Residual Heat and Pressure
- Oil Saving and Substitution
- Energy Conservation of Motor System
- Optimization of Energy System
- Energy Conservation in Buildings
- Green Lighting
- Energy Conservation in Government Agencies
- Building the Energy Conservation Monitoring
- Technological Support System.

Through the implementation of these ten programmes, it is estimated that 240 Mtce can be conserved during the 11th five-year plan period (2005-2010), equivalent to 550 Mt CO₂ reductions.

Industrial processes.

“According to the principle of “reduction, reuse and recycle of waste” and the requirements of new industrialization, China will take various effective actions and measures to further promote the development of clean production and circular economy in industrial sector, to accelerate the building-up of a resource-conserving and environmentally-friendly society. In order to reduce greenhouse gas emissions from the production and use of industrial products, China will work hard to save the use of cement, lime, iron and steel, calcium carbide and other raw materials to the uttermost while satisfying the necessary demand of these industrial products for the legitimate social and economic development” (NDRC, 2007). Furthermore, China aims to actively seek necessary financial resources and technical assistance to reduce and control emissions of nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

Agriculture.

The plan foresees the gradual establishment and improvement of the system of laws and regulations on the basis of the Law of Agriculture, Law of Grassland and Law on Land Management. These, together with administrative rules and regulations should lead to an improvement in agricultural production and an increase in the agricultural ecosystem carbon storage capacity. Some of the actions that could be adopted are the development of plans to protect farmland and pastures from new

constructions, the prohibition of any destruction of pastures or waste of land, and the intensification of ecological agriculture in highly-intensive production areas.

Forestry.

As in other fields, forestation also needs improvement and the implementation of laws and regulations, namely, the plan to develop regulations on forest transfer rights, forest products, and forest land use. In order to increase forest resources and therefore, carbon sequestration, policies to promote the voluntary planting and afforestation by local governments will be established.

As many forestry programs are already in place, the aim is to continuously strengthen their results so as to protect existing forest carbon stock and enhance carbon sequestration. Some of these programs are: the Natural Forest Protection Program (NFPP), the Conversion of Cropland to Forest Program (CCFP), the Sandification Control Program for Areas in the Vicinity of Beijing & Tianjin, Key Shelterbelt Development Program in Such Regions as the Three North & the Middle and Lower Reaches of the Yangtze River, and the Wildlife Conservation & Nature Reserve Development Program.

Municipal Waste.

Management of municipal waste should shift its focus to the entire process, with the aim of reducing wastes from source, then increasing recovery and utilization, and finally reducing non-hazardous disposal. The revision and implementation of current, valid sectoral standards so as to improve the recovery and utilization of combustible gas and to reduce the emissions of methane from landfills is one of the actions presented by the NCCP.

The recovery and utilization of landfill gas seems to be a very important topic in China's plans. Firms will be encouraged to construct and operate landfill gas collection and utilization facilities through the support of incentive policies, which will include an increase of waste disposal fees, a favourable feed-in tariff for landfill gas power and waste incineration power projects and income tax relief and reduction within a certain period of time.

Where waste is incinerated the aim will be to use advanced technologies, and thus, their development needs to be reinforced.

Adaptation

In the field of adaptation numerous interventions have been already put in place over the years. Agriculture, forests and natural ecosystems, water resources, coastal zones and regions are, as seen before, the areas where the impacts of climate change are more significant, thus inducing social and economical problems.

With regards to agriculture and forests, China has formulated and enforced a series of relevant laws and regulations, as under-

lined in the CPACC; “the state has strengthened construction of agricultural infrastructure and capital construction of farmland water conservancy, enlarged irrigation areas, improved farm-land irrigation and drainage efficiency and capability, and promoted dry farming and water-saving technologies, making agriculture better able to deter and mitigate natural disasters and increasing overall agricultural productivity”.

Other tools adopted in order to reduce the impacts of climate change on water resources and coastal zones are: programs on flood control and water usage, and studies on the marine environment and air-sea interactions in order to improve the capability to predict marine disaster. The State Council Information Office of P.R. of China, 2008 writes. “China has enhanced its capability of monitoring and issuing early warning over extreme climate events, and basically established mechanisms to deal with extreme meteorological emergencies, including their derivative and secondary effects. Great progress has been made in countering the effects of extreme climate phenomena like typhoons, regional intense thunderstorms and floods, and a comprehensive monitoring system for climate and climate change has taken initial shape” .

However, China is aiming to continue its efforts in order to improve its capability in adapting to climate change. These are the planned actions to be adopted for each area of intervention.

Agriculture:

to further improve the agricultural infrastructure and cropping system, to select and cultivate stress-resistant varieties, to prevent the aggravation of grassland desertification and to strengthen research and develop new technologies.

Forests and other natural ecosystems:

to formulate and implement laws and regulations relevant to climate change adaptation, such as the Forest Law and the Law on the Protection of Wildlife, to strengthen the effective protection of existing forest resources and other natural ecosystems and technology development (i.e. fire control, forest insect and disease control).

Water resources:

to enhance a unified management of water resources through basin-wide integration of water resource planning, allocation and management, to convert the water resource allocation approach from a demand-based supply to a supply-based demand by establishing national initial water rights allocation and water rights transfer systems, to strengthen infrastructure planning and construction, by also speeding up the creation of the South-to-North Water Diversion Project and to promote the development and extension of technologies for water allocation, water saving, and sea water utilization.

Coastal areas:

to formulate regional management regulations and detailed rules in accordance with the existing laws and characteristics of the specific localities in the coastal areas, to establish integrated coastal zone management (ICZM) systems, to strengthen research and development of technologies for protection and restoration of the marine ecosystems, to further improve the marine environmental monitoring and early-warning capacity.

Public Awareness

All governmental levels should consider the raising of public awareness as an important issue when addressing climate change. For this purpose, China aims to take various measures to promote climate change awareness in the government, enterprises and institutions, with the objective to build a high-quality leadership team with strong awareness of global climate change.

The reinforcement of advertisements, education and training on climate change will rely on mass media (e.g. books, newspapers, periodicals, audio and video products), the support of sustainable life-style actions (e.g. electricity-saving, water-saving, waste separation, reduction, recycling and reuse), the incorporation of climate change awareness into the framework of lower, higher and adult education as an important component of China's overall education system, the setting up of thematic training seminars and workshops targeted at different audiences and focused on both popular and professional climate change science, and updating the government's climate change information websites to transform them into real, quick-response and effective platforms for information dissemination and communication.

International experience on climate change is also seen as a very important resource to promote public awareness. International cooperation on climate change is also strongly supported in order to ensure the exchange of information and best practices, not only between governments but also between research institutions, as well as schools and universities.

Clean Development Mechanism

One of the means through which China could develop advanced technologies which reduce emissions is the Clean Development Mechanism provided by the Kyoto Protocol, and specifically addressed to developing countries.

The aim of the Mechanism is to involve these countries in the global actions against climate change without imposing any binding commitments on them, as opposed to the developed countries, whilst at the same time, enabling developing countries access to high and advanced technologies and investments, as well as revenues from the selling of Certified Emission Reductions (CERs).

In 2005, China drafted its “Measures for Operation and Management of Clean Development Mechanism Projects”, a way for the country to “strengthen the effective management of CDM projects, protecting China’s rights and interests, and ensuring the proper operation of CDM project activities”.

In this document the priority areas for project development have been identified, and include energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization.

It also states that the Designated National Authority, in charge of approving any proposed project, is the National Development and Reform Commission. The NDRC takes its decision with the help of the National CDM Board, whose main functions include reviewing and assessing CDM projects.

This Board is co-chaired by the NDRC and the Ministry of Science and Technology (MOST), and vice-chaired by the Ministry of Foreign Affairs (MOFA). Other members include the Ministry of

Finance (MOF), the Ministry of Agriculture (MOA), the Ministry of Environmental Protection (MEP) and China Meteorological Administration (CMA).

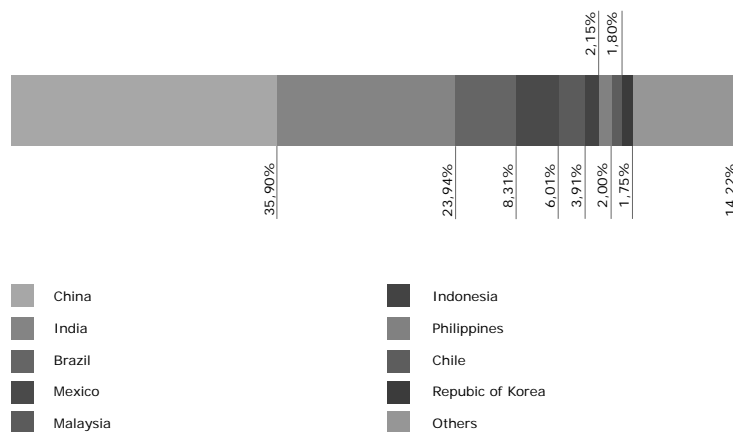
The National Climate Change Coordination Committee (NCCCC) is responsible for reviewing and coordinating CDM measures such as national policies, criteria, and standards on CDM project activity and approving the National CDM Board members.

It should also be noted that China subjects this project to some restrictions such as: it should be consistent with China's laws and regulations, sustainable development strategies and policies and the overall requirements for national economic and social development planning; that funding for CDM projects from developed countries, shall be additional to their current official development assistance and their financial obligations under the Convention (UNFCCC); project activities should promote the transfer of environmentally sound technology to China.

Another specific requirement, stated by art. 11 of the Measures, is that only Chinese funded or Chinese-held enterprises (meaning that at least 51 % of the equity share is owned by Chinese entities or citizens) within the territory of China are eligible to carry out CDM projects with foreign partners.

China has been active in the CDM market from the start and is currently the country with the greatest number of CDM projects (716 as of December 2009), accounting for nearly 36% of the total (1779), as shown in Figure 2.

Fig. 2:
CDM registered
project activities



The following figure shows the geographical distribution of all the registered CDM projects in the world and in China.

Source:
CDM Statistics,
UNFCCC, as of
December 2009.

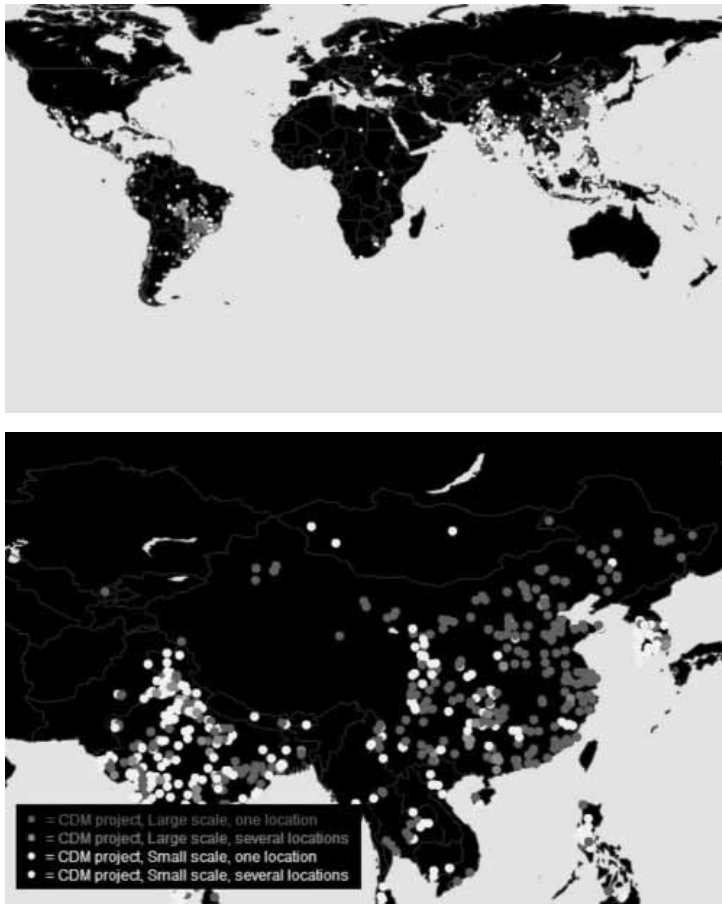


Fig. 3:
CDM Registered
Projects in the World
and in China

As seen above, each proposed project needs to be approved by the NDRC, but in order for the CERs to be issued it must also be registered by the CDM Executive Board. In the following table the projects approved, registered and the CERs issued by the end of 2009 are represented.

Source:
CDM Interactive
Map, UNFCCC, as of
December 2009.

Tables 4 and 5 show how China is also the leader in the number of CERs issued, reaching nearly half of all the greenhouse gas emission reductions available through CDM projects globally. This also is consistent with the situation depicted in Figure 3, which clearly demonstrates how most of the registered projects developed in the country are on a larger scale and therefore, able to reduce a significant amount of greenhouse gases.

Table 4. Carbon reduction programs (December 2009)

	CDM projects approved by NDRC	CDM projects registered by the CDM Executive Board	CERs issued
China	2279	716	173,926,805
World Total		1994	363,782,239

Tab. 5. Carbon trading: Top Five CER issuers (metric ton)

Country	CERs issues	% share
China	173,926,805	47,81%
India	72,920,819	20,05%
Republic of Korea	47,664,437	13,10%
Brazil	37,311,190	10,26%
Mexico	6,084,525	1,67%
Other Countries	25,874,463	7,11%
World Total	363,782,239	

The Central Government has stated that revenues from the transfer of CERs shall be owned jointly by the Government and the project owner with different levy rates: 65% from HFC and PFC projects, 30% from N₂O projects, 2% from the priority areas and forestation projects.

These revenues will be used to establish the Clean Development Mechanism Fund to support the country's activities on climate change such as, climate change related science and technology research, and raising national adaptation and mitigation capacity.

Source:
Clean Development
Mechanism in China;
CDM Statistics, UNFCCC

Conclusions

The rapid growth of both economy and population are two of the most evident aspects in China today. The country wants to play a big part in the world economy, but has also realised its development is limited if it doesn't take into consideration the side effects which could threaten the results of its efforts.

According to China's white paper on Policies and Actions for Addressing Climate Change (CPACC), as a developing country with a large population, a relatively low level of economic development, a complex climate and a fragile eco-environment, China is vulnerable to the adverse effects of climate change. This has brought about substantial threats to the natural ecosystems as well as the economic and social development of the country which are particularly pressing in agriculture and live-stock breeding, forestry, natural ecosystems and water resources, and in coastal and eco-fragile zones.

China is fully aware of the importance and urgency of addressing climate change and must consider the economic development and ecological construction, domestic situation and international situation, both in the present and future. The country has, therefore, formulated and is implementing a national plan for coping with climate change, and adopted a series of policies and measures in this regard. Taking economic development as the core objective, and placing emphasis on energy conservation, optimization of the energy mix, reinforcement of ecological protection and construction, and scientific and technological progress as backup, China is striving to control and mitigate the emission of greenhouse gases and continuously enhancing the capability of

adapting to climate change. (State Council Information Office of P.R. of China, 2008).

To achieve these results many policies and laws should undergo complete restyling or revision in order to establish stricter targets, especially in the field of energy efficiency, and to promote cleaner energy sources.

International cooperation can be seen as a great resource, as the country is, without a doubt, a magnet for foreign investments. For this reason China, is taking advantage as much as possible from the Clean Development Mechanism, as it represents an important means of clean technology transfer.

Bibliography

Clean Development Mechanism in China website (<http://cdm.ccchina.gov.cn/english>)

National Bureau of Statistic of China website (<http://www.stats.gov.cn/english>)

NCCCC (National Climate Change Coordination Committee), 2005. *Measures for Operation and Management of Clean Development Mechanism Projects*

NDRC (National Development and Reform Commission), 2007. *China's National Climate Change Program*

State Council Information Office of P.R. of China, 2008. *China's Policies and Actions for Addressing Climate Change*

UN (United Nations), 1992. *United Nations Framework Convention on Climate Change*

UNEP *Collaborating Centre on Energy and Environment. Introduction to the CDM*, Roskilde, Risø National Laboratory

UNFCCC website (<http://www.unfccc.int>)

