辩论

Discussion Paper

CLIMATE CHANGE RISK AND RESPONSE:

DROUGHTS AS EXTREME WEATHER EVENTS IN CHINA

Harrie Esterhuyse

Stellenbosch | October 2012 5/2012

UNIVERSITEIT STELLENBOSCH UNIVERSITY

CENTRE FOR CHINESE STUDIES
STELLENBOSCH · SOUTH AFRICA

ABSTRACT

Climate change is leading to an increase in extreme weather events globally. Different communities and different ecosystems are impacted in various ways by these events. The study evaluates the effectiveness of drought response at the level of both the national climate change policy and region specific response. The paper makes use of the IPCC Special Report on Managing the Risk of Extreme Events and Disaster to Advance Climate Change Adaption's (SREX) to create two frameworks: one for determining extreme weather event risk, and one that evaluates the effectiveness of risk mitigation strategies.

This study contributes to enriching the area specific knowledge of extreme weather event risks, taking into account local conditions. China's National Climate Change Programme (CNCCP) overall, is adequate in mitigating and adapting to climate change and thus extreme weather events. However it is also found that deficits exist with regard to health related issues, and to urban planning. Finally the paper finds that implementation of the plan appears to be a weak spot: implementation of the CNCCP in the two case studies is too incoherent to conclude that the CNCCP is actually being followed. Future studies should research the reasons for the policy gap between mitigation plan and implementation.

This study illuminates some ways in which developing countries, especially relevant in the China – Africa relationship, can learn from each other; both from successes and mistakes.

The author is a research analyst at the Centre for Chinese Studies, Stellenbosch University, working on environmental aspects in China-Africa relations.

E-mail: hesterhuyse@sun.ac.za

CCS discussion papers aim to contribute to the academic debate on China's global rise and the consequences thereof for African development. The CCS therefore explicitly invites scholars from Africa, China, or elsewhere, to use this format for advanced papers that are ready for an initial publication, not least to obtain input from other colleagues in the field. Discussion papers should thus be seen as work in progress, exposed to (and ideally stimulating) policy-relevant discussion based on academic standards.

The views expressed in this paper are those of the author.

Contents

1. INTRODUCTION 5

2. THE CURRENT CHALLENGE: EXTREME CLIMATE DROUGHT EVENTS IN CHINA 7

2.1 Droughts in China: a reoccurring phenomenon throughout history 7
2.2 The South China drought 8
2.3 North China Drought 10

3. THE FUTURE RISKS: ASSESSING CLIMATE CHANGE IN CHINA 11

3.1 Projections of climate change in China 11
3.2 China's response to climate change 13
3.3 IPCC: Managing the risks of extreme weather events 15
Vulnerability and exposure 15
IPCC Adaption and Disaster Risk Management 16

4. THE RESPONSE: DETERMINING RISKS AND ASSESSING THE CHINESE POLICY 18

4.1. Extreme weather event risks in China's drought areas 18
South China drought 18
North China drought 19
4.2 Assessing Chinese climate change policy 20
Natural ecosystems and forestry 20
Agriculture and food security 21
Coastal zones and fisheries 21
Water resources 22
Infrastructure, housing, cities, transportation and energy 22
Health 23
Overall assessment of the policy 23
4.3 Extreme weather drought response: Implementing the CNCCP? 24
Natural ecosystems and forestry 24
Agriculture and food security 25
Water resources 26
Summary of findings 27

5. CONCLUSION 28

ENDNOTES 29

APPENDIX 33

List of Tables and Figures

Box 3.1 Basic data on China and climate change 11

Box 3.2 Measuring Vulnerability 16

Box 3.3 The Low regrets framework 17

List of Acronyms and Abbreviations

CNA Report	: China's National Assessment Report on Climate Change
CNCCP	: China's National Climate Change Programme
CO_2	: Carbon dioxide
GHG	: Greenhouse gasses
IPCC	: Intergovernmental Panel on Climate Change
MEP	: Ministry of Environmental Protection of the People's Republic of China
NCCCC	: National Coordination Committee on Climate Change
NDRC	: National Development and Reform Commission
OECD	: Organisation for Economic Co-operation and Development
SFA	: State Forest Administration
SREX	: Special Report on Managing the Risk of Extreme Events and Disaster to Advance Climate Change Adaption
US	: United States/United States of America (applicable as clear in context)

1. INTRODUCTION

The fact that the global climate is changing has become an accepted phenomenon, even though there are still wide-ranging opinions on the degree of anthropogenic causes and what the effects of climate change will be on the planet, different regions and their unique ecosystems. The Intergovernmental Panel on Climate Change (IPCC) has done much in establishing consensus on what the agreed upon effects of climate change are to be in all likelihood - and what the effects have been thus far. According to this consensus, China will be strongly affected by climate change. According to *China's National Climate Change Programme* China's annual temperature has increased by between 0.5-0.8 degrees Celsius in the last 100 years (NDRC, 2007:4). It is also forecast that cases of extreme weather in the country will increase. Rivers such as for example the Yangtze River are expected to experience more flooding, glaciers are predicted to melt and sea level on the coast is expected to rise. The arid regions of the country are also said to be at risk of desertification and increased droughts are expected in northern and north eastern China (NDRC, 2007:5-6).

The IPCC has corroborated some of these findings. Other studies found that precipitation over semi-arid regions, such as northern China, will decrease and this will have an impact on food security, since less precipitation will probably reduce the yields of wheat, corn and rice (Brown and Funk, 2008:580). It is estimated that 79 per cent of China's dry lands are affected by desertification. China's approach in the past was described as trying to subjugate nature to man with the effect of environmental degradation in large parts of the country (Jiang, 2010: 14). Considering that China has a very large population with rapidly rising living standards and a related increase in demand for resources and food, it becomes clear that China has to take climate change very seriously to prevent the possibility of future instability.

Extreme weather events are not new phenomena only to be found during climate change or global warming. The term refers to events such as floods and droughts that have a serious effect or impact on the area in which they occur. Extreme weather events are caused by changes in weather patterns. Weather patterns again are influenced by both naturogenic (nature related) and anthropogenic (human related) factors. These extreme weather events create a risk for so called "exposed" societies and ecosystems (IPCC, 2011:1). There are many factors that play into the risk factor, or exposure of ecosystems and societies. A large part of the risk is determined by how communities and areas develop as this has an impact on vulnerability. The IPCC further found that risk mitigation strategies work best when fitted to local circumstances (IPCC, 2011:1-2).

Both adaption and mitigation are important endeavours in climate change. Adaption strategies are strategies that change local, regional or other factors to make a community or environment more resistant to climate change. This can for example include planting more drought resistant crops and increasing water productivity (how effectively water is managed). Mitigation strategies are strategies that are used to reduce the drivers of climate change. This includes the planting of trees to increase carbon dioxide absorption or reducing emissions of greenhouse gasses. In the *IPCC Special Report on Managing the Risk of Extreme Events and Disaster to Advance Climate Change Adaption's* (SREX) the IPCC set out two basic principles of risk management with regards to extreme weather events: firstly, determining vulnerability of a community or an environment and secondly the application of a coherent "adaption and disaster risk management" strategy (Field et al, 2012a:2,4). Different societies will experience the effects of climate change to different degrees. Even though extreme weather events are not new, we know that climate change will have an impact on the intensity and frequency of these events. Societies that begin

to implement risk reduction policies by applying adaption and mitigation strategies will be more prepared for both the depth, impact and lasting effect of extreme climate events. Extreme weather events encompass a wide array of incidents, droughts being the focus of this paper, are but one example of extreme weather events.

China has a well-documented history of extreme weather events. This study will show what the risks involved with extreme weather events in combination with climate change are in China, using two incidents of drought experienced in recent years as case studies. Further it will be looked at how effective responses to these extreme weather drought events have been and what can be improved in the national risk mitigation strategy, involving both adaption and mitigation. From effective risk response and from lapses it is possible to improve understanding of how an effective risk response should look or how effective a current one is. Thus there is much to be learned from China's example, both positively and negatively. These lessons might in time be used to help Africa with its own climate change challenges. However the main focus is determining whether China's climate change policy, also meant as a measure against extreme weather events, is effective when studied on a smaller scale with a focus on droughts.

The study will begin by sketching a general overview of recent modern droughts in China. It will then look at the two drought cases, the first will focus on the prolonged drought experienced in South West China during 2009/2010, and the second on the continuing drought in the north of China. These two droughts will act as case studies for applied climate change and extreme weather event responses in China. Consequently the study will look at the general projected effects of climate change on China and the government's general climate change policy.

Looking at the effects of climate change is important because it must be determined to what extent climate change is likely to increase extreme weather event risks in China, once more with the focus on droughts. This will provide a solid footing in understanding the droughts, as extreme weather events and with the exacerbating factor of climate change and drought response in the broader context of national climate change vulnerability risk and federal Chinese climate change policy. Having established this contextual base, the study will draw on the SREX to create a basic framework for vulnerability and exposure assessment. This framework offers an understanding of how exposure and vulnerability to weather and extreme climate events can be determined. The framework allows the evaluation of risks faced by the drought ridden areas of China. Secondly the paper, by drawing on the SREX National Systems for Managing the Risks from Climate Extremes and Disasters, chapter 6, will adapt a second basic framework based on the "no regrets" and "low regrets" national disaster risk reduction and adaption policy. This will serve as the general basis for analysing the effectiveness of Chinese climate change vulnerability risk reduction and extreme weather response policies. The focus will be on national risk mitigation and adaption strategies.

In the final part of the paper the framework for vulnerability and exposure will be applied to the two drought case studies to determine what some of the extreme weather event risks are and were in the two cases of drought. Secondly, by using the "no regrets" and "low regrets" risk response as a framework guideline (from here on referred to as the Low regrets framework) the paper will conduct a desk-based evaluation of the general Chinese climate change policy to determine if there are any areas that need to be improved in dealing with a climate change and an extreme weather event reality within China. And finally the Low regrets framework will be used to evaluate the Chinese response in each of the drought cases. This will indicate whether there were any lapses in the response in light of the risks faced by the drought hit areas. It will also shed light on the active benefits or application of Chinese climate change policies. Thus, determining whether the Chinese national climate policy is conceptually equipped to deal with

extreme weather events such as droughts, and whether these findings still hold true when introduced into a "real life" scenario, namely: in the two drought cases.

Beyond the primary aims of the research, this study is also meant as a contribution to the discussion on China/Africa relations. The paper provides country specific climate change risk analysis with policy improvements for China. It combines knowledge of climate change impacts on areas with a sound adaption and mitigation strategy. The IPCC provides a general overview of climate change and risks faced by regions, but it cannot evaluate each region in detail. Thus area specific studies such as this contribute to our knowledge and understanding of how different areas will be affected and need to respond to climate change. In this regard it would be important for any region to have a case specific analysis to determine local vulnerability, both in terms of local conditions and policy. This study acknowledges and accepts that the applied IPCC frameworks do not cover all variables; this is a limitation often faced with frameworks. It is even more specifically to be expected with frameworks that determine risk in something as large as climate change, where identified factors will always only be part of a bigger picture. The aim is to improve and evaluate the policies. Identifying areas of excellence in the Chinese case is of value to African governments who are often faced with the same environmental problems as China, in a developing country context. There are, it is hoped, lessons to be learned for African policies. This study also acknowledges that there are further limitations, discussed in the text. This study is for example limited also in being a desk-based study, relying exclusively on the scientific and academic literature.

2. The current challenge: Extreme climate drought events in China

2.1 Droughts in China: a reoccurring phenomenon throughout history

Droughts are a serious ecological condition with problematic consequences for human livelihood and the global economy. It is estimated that the cost of droughts to the world economy is between US$6 billion and US$8 billion per year. China has a history of severe droughts hitting the country periodically in the last century (Cui et al, 2011:1534). Even before modern times, droughts have been recorded throughout written history, especially on the plains of northern China (Cohen, 1978:244). In ancient China, droughts were more than mere natural events, and the breaking of a drought was done by praying to deities. If the drought was not broken through prayer, deities were even coerced. A deity could have his/her temples closed, titles revoked or could even be banished to a "secluded place". If this still did not have the desired results the coercion was increased, as happened in a drought during the reign of Emperor Wenxuan (also written Wen Hsuan or Wen Xuan) between 550 to 559 A.D. When a deity did not answer the Emperors prayers for rain, he ordered that the deity's shrine be demolished as punishment (Cohen, 1978:248-249).

In modern China droughts are still a common phenomenon. China experienced severe droughts long before the effects of climate change and the risks of extreme weather events were known or understood. The country had suffered intense drought in the 1960's, again late in the 1970's, early in the 1980's and once more late in the 1990's (Cui et al, 2011:1534). Northern China also experienced a major drought from 1921 into the 1930's. That drought caused the deaths of over 4 million people, almost the size of the entire modern Norwegian population (Chen et al, 2009:129). Since the drought in 1921 there has been a clear increase of droughts in northern

China (Chen et al, 2009:134). In a recent study by Shan, Qian and Zhu (2011:310) it was found that when one analyses China during the last fifty years, south China has had a moderate frequency of drought, at between 0.6 and 0.9 droughts a year, whilst northern China during the same period has had a high frequency of drought with between 0.9 and 1.3 droughts a year. The study agreed that there has been an increase in droughts in northern China, but added that there was also an increase in temperature over the period measured (Shan et al, 2011:320). Lin, et al. (2011:1879) found that drought likelihood in China in general has increased since 1951. In northern China drought likelihood has increased by 30 per cent and in southern China it has increased by between 10 and 17 per cent. They also found that droughts in China since 1978 have shown a concentration in the east and an increasing likelihood of drought the further north measurements are taken (Lin et al, 2011:1878).

In southern China there has been a decrease in precipitation in late spring since the 1970's. This has become known in scientific circles as the South China drought (Wang et al, 2006:3204). This will be the phenomenon first looked at. However as shown above, drought has been an ever more common phenomenon in China, especially measured in the last fifty years. Studies have found that there has even been a decrease in China's total water reserves (water resources available for exploitation) in recent times (Gang, 2009:8). Between 1997 and 2004, water reserves decreased from 2785.5 billion cubic metres to 2413 billion cubic meters, a drop of 372.5 billion cubic metres, or of 13.37 per cent in only seven years (Ibid, 2009:8). Thus China seems to be experiencing a general dryer period or "drought" of sorts. Gang also referred to China's rapidly increasing Carbon dioxide (CO_2) emissions. Even though China is not the world's largest emitter of greenhouse gasses (GHG), it became the largest emitter of CO_2 in 2007, predominantly due to its large reliance on coal power which satisfies 70 per cent of its energy needs (Gang, 2009:11). CO_2 is a gas accepted by the IPCC to be related to climate change and global warming, which in turn are processes generally accepted to cause increases in temperature and the possibility of extreme weather events such as droughts and floods. Although there is a difference between droughts and areas that are naturally dry, or between areas that are water scarce and areas that are drought hit, water scarcity and drought can often go hand in hand. Water planning and water management are strongly influenced by the probability of drought and by drought events, or extreme weather drought events themselves (Cui et al, 2011:1534).

2.2 The South China drought

Southern China has seen a decrease in its late spring precipitation over the last 40 years, the so called South China drought (Wang et al, 2006:3204). This has correlated with a ten to 17 per cent increase in drought likelihood in the region since 1951 as mentioned above (Lu et al, 2011:1878). The focus for studies on drought in China has naturally been on the dry north; the south is becoming increasingly more relevant however. This section of the paper will focus predominantly on the drought of 2009/2010 that hit Yunnan and surrounding areas.

Southwest China was hit by a spring drought in 2005 and by a summer drought in 2006 (Wang *et* al, 2012:173). The drought of 2009/2010 caused severe water shortages[1]. In Yunnan alone a total of 18 per cent of the population, or 8.1 million people were left without an adequate supply of drinking water. The drought also threatened the failure of crops worth US$2.5 billion (Qui, 2010:142). The value of possible crop failure is remarkably high if one remembers that droughts in general cause between US$6 billion and US$8 billion worth of damage to the world economy on average each year (Cui et al, 2011:1534). The drought, which lasted from the autumn of 2009 until the spring of 2010, was finally estimated to have caused total economic losses exceeding

US$30 billion. The Chinese Ministry of Civil Affairs also estimated that in total, in both Yunnan and surrounding areas, the drought had left 21 million people short of drinking water (Gong et al, 2012:173).

The drought was caused by a combination of factors, including processes such as climate change, but also more immediate factors such as poor environmental practices. Scientists in China have said that the 2009/2010 drought is the clearest example yet of how the combination of climate change and poor environmental practice can cause serious disasters (Qui, 2010:142). It was the extreme drought event that has been the driest, with the lowest rainfall, and the longest, with longest period of non-rainy days, in the last 50 years. It has also been found to be the severest drought with the lowest overall rainfall over the same period of time since 1880 (Gong et al, 2012:173). The 2009/10 drought saw a reduction of rainfall of 70 per cent (Gong *et al*, 2012:172). The drop in rainfall was so severe that the water storage facilities in the affected provinces were inadequate and unable to provide enough stored water to remain operational through the drought. By April 2010, reservoirs such as Degehaizi, which has a storage capacity of 1.6 million cubic meters (m^3) of water, had dried-up completely (Greenpeace, 2011). In general, there has been an increase in the occurrence of extreme weather events such as torrential rain and droughts in southwest China, where extreme weather events have occurred less frequently than in the rest of China. Nonetheless, whilst Yunnan has experienced droughts before, usually once in a few decades, it has never been hit by a drought of the severity of the 2009/2010 drought (Qui, 2010:142). Yunnan itself does not generally have a problem with water scarcity, in contrast to the rest of China which is increasingly becoming a more water scarce country.

A major exacerbating factor in the case of Yunnan has been deforestation. During the economic expansion of China during the last decades, Yunnan's forests like so many other natural resources in China have been severely over-exploited. In the prefecture of Xishuangbanna in Yunnan, only 3.6 per cent of natural forests still remain when compared to forestation levels of 1976. Rubber trees have been planted in the place of the natural forest cover and in areas that are too cold for rubber trees to survive, eucalyptus trees have been planted. Both of these tree species are invasive and are so called "thirsty" trees, because of the vast volume of water absorbed by them. Where the indigenous trees have not been replaced by rubber and eucalyptus trees, the forests have been cleared by logging or for mining, quarrying and increasingly also for human settlement (Qui, 2010:142).

Deforestation has led to water loss as a consequence. Forests have an ability to store water and prevent run-off and erosion, thus preventing both the loss of water and soil nutrition. The layer of organic matter under trees can absorb up to seven times their mass in water, keeping the ground wet and retaining soil moisture by preventing evaporation. The loss of tree cover does not only increase the risk of droughts, but also has an impact on other extreme weather events. With the reduction of tree cover there is an increased risk of landslides, as the soil is no longer anchored by the roots of trees. Consequently there is an increased risk of flash floods, since the cutting down of trees removes the absorbing and containing ability of forests (Qui, 2010:142).

After the 2009/2010 drought, Yunnan and surrounding areas have repeatedly experienced periods of insufficient rainfall. The New York Times reported that a drought starting in July 2011, and predominantly affecting Yunnan, the Guizhou provinces, the Guangxi Autonomous Region and the municipality of Chongqing, had left 12.6 million people short of drinking water. The drought also affected 14 million hectares of farmland (Wong, 2011a). In April 2012, the news agency Reuters reported on repeating droughts in southwest China. The worst hit province was once again Yunnan, but it also affected Hebei, Shanxi and Gansu. The droughts

caused the drying up of reservoirs, threatened spring planting and left 7.8 million people and 4.6 million livestock without adequate drinking water. The droughts in south China preceding the 2012 droughts had been so severe as to force the closure of hydroelectric dams in 2011. Drought was thus also negatively affecting energy production (Qing, 2012).

In addition to the droughts and subsequent water scarcity caused by them, Yunnan has a problem with existing surface water due to severe water pollution. Many lakes and rivers in Yunnan are extremely polluted (Qui, 2010:143). Water that could have been used to alleviate drought is made unusable. This is a problem that has not received enough attention. The Chinese government, especially local government, are reluctant to do anything that might reduce their competitiveness or that might slowdown economic production (Esterhuyse, 2012b).

2.3 North China Drought

Northern China as a naturally drier region has experienced many droughts throughout China's long history. The region is classified as a water-stressed basin with less than 1000m^3 of rain per year (Bates et al, 2008:8). The drought of the 1920s and 1930s, which caused the deaths of four million people, is the most severe example in living memory (Chen et al, 2009:129). Northern China has been experiencing a general increase in drought frequency since 1921 (with a high frequency of 0.9 to 1.3 droughts a year), an increase in temperature in the last two decades and water scarcity (Chen et al, 2009:134 & Shan et al, 2011:310,320). Desertification and drought currently endangers over 200 million livelihoods in northern China (Dong et al, 2010:13). Northern China at the same time is also increasing in importance as a grain producing region as the south continues to develop and usable farmland is taken up by processes such as urbanisation. Even without climate change and drought China is experiencing the start of a water shortage. This is due to the overuse of local resources, poor water management, wasteful irrigation practices, rapid industrialisation, urbanisation and water pollution (Yu, 2011:307).

The dry lands of northern China receive less than 380mm of rainfall in a year. Over 27.5 per cent of China's land already suffers from land degradation, and the most of this is to be found in the north. In addition to this another 79 per cent of China's dry lands, concentrated in the north and northwest are affected by desertification (Jiang, 2010:14). Similar to southern China, the drought exposure risk and drought risk in north China is affected by both natural processes such as global warming, further exacerbated by immediate local human activity. In northern China, misdirected government policy has negatively impacted on an already bad situation. The Central government has increased its willingness to prioritise environmental issues, but have had a problem in readjusting incentives so that they encourage local governments to become more environmentally conscious (Esterhuyse, 2012b). 'Privatisation' of grassland in Inner Mongolia, with the aim of increased agricultural output from livestock and subsequent increases in tax incomes, has caused large scale overgrazing and land degradation. Local governments are faced with a choice of either increasing taxes through large scale farming, especially husbandry in northern China, or environmental protection. At present most opt for increased taxes (Jiang, 2010:20-22).

The United Nations reported that a winter drought in northern China, on the North China plain in 2010/2011, had a severe impact on grain production. The winter wheat harvest was endangered by low rainfall and by reduced snow cover leaving the crops vulnerable. The region affected is responsible for two thirds of China's wheat production, and included the provinces of Shandong, Jiangsu and Henan. It was estimated that roughly 5.16 million hectares of the 14 million hectares of winter wheat had been affected. More than 2.5 million people and 2.8 million livestock were also being affected by a lack of drinking water (UN News, 2011).

Due to environmental factors, but also exacerbated by over-exploitation, some rivers and lakes in the north of China have dried up in recent years. The large Yellow River, also called 'the mother river', has been affected so severely that sections of it, especially in the lower flow, have been known to completely dry up. Rivers are often exploited upstream, leaving areas downstream either with reduced access to water, or – in the extreme event – completely without water. This in turn leads to people beginning to use ground water for example, which in turn can lead to the over exploitation of ground water and the damaging of ecosystems and biodiversity (MacBeath & MacBeath, 2010:98). Even though these processes do not directly increase the likelihood of a drought, they significantly reduce the capacity of local populations to respond to a drought when it occurs.

As an additional problem – and similarly to southern China – northern China also has a large problem with (water) pollution. Pollution does not increase drought likelihood but it does increase drought risk by reducing available water resources (MacBeath & MacBeath, 2010:100).

3. The future risks: Assessing Climate Change in China

3.1 Projections of climate change in China

The previous section looked at two case studies of drought, or extreme weather drought events. The following section will look at the forecast effects of climate change on China. Since climate change is expected to increase extreme weather events globally, there is a need to determine what the effect will be on China. For this reason this section seeks to answer the question whether it is forecast that there will be an increase, decrease or no change in extreme events in the following decades.

Box 3.1 Basic data on China and climate change

According to a Worldwatch Report (2010:8), China's rapid economic growth is causing environmental problems and is leading to air pollution and climate change. China is the world's largest consumer of coal, consuming 2.7 billion tons in 2008. At that stage it represented 43 per cent of the world's total coal consumption, or two and a half times the volume used by the United States of America (Worldwatch, 2010:8). China's need for energy has made it the world's largest emitter of carbon dioxide, a GHG accepted by the IPCC to directly exacerbate the effects of climate change (Gang, 2009:11 & Mark, 2010:971). China uses 16 per cent of the world's energy and has doubled its generation capacity between 2000 and 2008, however even though there has been an increase in renewable energy sources being used the scope is too limited to have a significant impact. Some forecasts show that China could be producing as much carbon dioxide as double all Organisation for Economic Co-operation and Development (OECD) countries combined during the period between 2004 and 2030 if the Chinese government does not begin to take action (Marks, 2010:971-972). A large reason for the high carbon emissions is the fact that 70 per cent of Chinese energy is generated from coal. Coal is a very "dirty" energy source and can have effects such as acid rain and lead to respiratory and other health problems for citizens. Energy generation from coal also involves very high GHG emissions (Gang, 2009:11 & Mark, 2010:973). Per capita, however, China does have a very low energy consumption of 2.1 tons coal equivalent (tce), compared to an OECD average of 6.6tce and an USA average of 11.1tce (Worldwatch, 2010:8).

In light of global climate change, the Ministry of Science and Technology of the People's Republic of China, the China Meteorological Society and the Chinese Academy of Sciences conducted a national climate change assessment, reported on in three volumes as *China's National Assessment Report on Climate Change (CNA Report)* (2007). These documents list the different effects that climate change could have and has had on China, based on the available scientific research and available models. In 2010 the *Report on the State of the Environment in China* was also released by the Ministry of Environment Protection of the People's Republic of China. This report is useful in giving estimates for more recent statistics, but is less useful for trends due to its lack of climate change focus. The report looked at trends in the past and made some forecasts for the future. It was found that Mainland China saw a rise in mean surface temperature of 1.1 degrees Celsius in the last 50 years (before 2007), which means a warming rate of 0.22 degrees Celsius per decade. With this average, China has thus experienced a faster warming rate than the world or northern hemisphere averages during the time after 1950 to the present. In general, winter and spring temperatures increased the highest, with northeast-, north-, and northwest- China experiencing the highest increases in annual mean temperatures. The effect of average warming, however, does not mean that all areas get warmer. Even though the average mean temperature in mainland China has increased in the last half century, some areas of the country did experience cooling. Southwest China, for instance, experienced a general cooling, and summer mean temperatures in the middle and lower Yangtze River have also shown a decrease (Chen *et al*, 2007:2).

Looking at past trends, it has become clear that sunshine duration and wind speed have decreased in most areas in the last 50 years. In some parts of the North China Plain annual hours of sunshine have been reduce by as much as 500 hours. The CNA report agrees that some of the climate change effects seem to be stemming from greenhouse gas emissions, of which China has become a major source in recent years (see Box 3.1). Although factors such as solar activity could not be ruled out completely, the changes of the last 50 years were found to be mostly due to greenhouse gas emissions. The noted reduction in sunlight and solar radiation has also been linked to increased emissions and air pollution (Chen et al, 2007:2-3).

Projections indicate that China will experience significant warming in the 21st century. The CNA report looked at varied emission scenarios based on the levels of GHG emissions. According to these models China would be experiencing temperature increases of between 1.3-2.1 degrees Celsius by 2020, of 2.3-3.3 degrees Celsius by 2050 and a massive 3.9-6.0 degrees Celsius increase by 2100 (Chen et al, 2007:4). These numbers are very high, as even a change of one or two degrees in temperature can have devastating effects on crops, ecosystems and biodiversity. The highest increase of 6 degrees would leave the Chinese landscape completely unrecognizable, changing the country's ecosystems almost completely.

- Not all parts of China will be experiencing trends of dryer climate. On a whole precipitation is forecast to increase by between 10 and 12 per cent by 2100. The highest increases in precipitation (in relative terms) is expected to be in northeast and northwest China, this whilst central China is expected to experience drying (Chen et al, 2007:4). More water in some areas can also have negative effects. There will be an increase in 40 per cent of the population threatened by plagues (Mark, 2010:972). Some of these increases will be due to wetter climate allowing for water born disease to take hold. The likelihood of disease incidence and transmission after flood events increase especially for waterborne diseases such as diarrhoea and cholera (Ju et al, 2007:7).
- Coastal areas will be affected. There have already been noted increases in sea level on the Chinese coast. The sea level is rising by between 1.4 and 3.2mm each year (Ju et al, 2007:7). Sea

level rise could displace 67 million people in the next decades (Mark, 2010:972). There are also negative processes observed in marine ecosystems. In recent years, coral bleaching has been noted in the coastal waters of Hainan and Guangxi[2] (Ju et al, 2007:7).

- Since the time of the Little Ice Age[3] (as documented and experienced in China), the glacier areas of northwest China have decreased by 21 per cent (Ju et al, 2007:7). Research has found that in time the Tibetan and Tianshen glaciers will melt (Marks, 2010:972). Perma frost in Tibet has been slowly decreasing and has already been reduced by between 4 and 5 meters (Ju et al, 2007:7).

China at present can feed its own enormous population; it still produces 95 per cent of its own staple foods (MacBeath and MacBeath, 2010:86). In the NCA study it was found that agricultural production is becoming more unstable as heat waves become more intense and as spring damage from frost worsens. Nonetheless, some agricultural sectors have benefitted. In northeast China winter wheat can now be planted ever further north and westward as the climate changes. In some maize varieties there has been an increase in productivity along with an increase in the areas where it can be grown. It is however forecast that Chinese crop production overall will drop by between 5 and 10 per cent by 2030 and that the rice and maize crop will ultimately be reduced by 37 per cent, if current trends continue or if nothing is done to remedy the problem (Ju et al, 2007:7-8).

Water in the north of China, even with expected precipitation increases, is relatively scarce. And yet this is the region where 40 per cent of the grain harvest is produced (MacBeath and MacBeath, 2010:97). Runoff from six of China's largest rivers has decreased. Some of the rivers are even experiencing intermitted flow (Ju et al, 2007:8). China has the world's fifth largest supply of fresh water but only 25 per cent of the world average per capita (MacBeath and MacBeath, 2010:97). Future climate change will most likely not change the distribution of water in China, with water in the north remaining relatively scarce and relatively abundant in the south. However, even with "unchanged" distribution, water resources are expected to come under increasing pressure due to changing precipitation and increased demand. This can lead to the price of food increasing causing long-term food insecurity (Ju et al, 2007:8). China's large population and its increase in development is leading to a reduction in arable land and available water resources (MacBeath and MacBeath, 2010:86). The expectation is that there will be an increase in droughts, storms, floods and a rise in the occurrence of natural disasters due to extreme weather events (Marks, 2010:972). One example of a reason for this is that climate change will lead to increased river runoff in the south and reduced runoff in the north; this will increase both the likelihood of droughts and of floods, thus the likelihood of extreme weather events (Ju et al, 2007:88-9).

Overall, climate change will impact the frequency, ferocity and scope of extreme weather events in China. Due to the correlation between climate change and extreme weather events, the next section will look at China's official response and policy with regards to climate change.

3.2 China's response to climate change

The National Development and Reform Commission (NDRC) of China in 2007 published *China's National Climate Change Programme* (CNCCP). This national strategy for sustainable development was drafted by the National Coordination Committee on Climate Change (NCCCC). Their aim was to find ways to mitigate and adapt to climate change in China. The 2007 national programme was originally meant to be in implementation until 2010 (NDRC, 2007:2). While there is work on a new plan, it has not been completed at the time of writing.

The CNCCP reiterates that China is a developing country and that it aims to be "a developing country of responsibility" (NDRC, 2007:2). It also confirms that climate change is an accepted reality and thus a priority, for China. The report continues to detail some effects that climate change is having and will have on the country, including warming trends with significant increases in winter temperatures, an increase in extreme weather events, increased droughts in the north and the risk of arid regions suffering desertification amongst others. This summary of climate change however ends with a rather politically defensive note that it should be remembered that China has historically been a low emitter of GHG even though emissions have been increasing in recent years (NDRC, 2007:4-6). This is a reminder that China does not see itself as responsible for climate change, but much rather shifts the blame to the so called developed world.

The CNCCP sets out a long list of what China has done and achieved in the past regarding the mitigation of climate change. These listed achievements include the promotion and improvement of energy efficiency, the development of low carbon renewable energy, enhancing ecological restoration and protection, the launch of afforestation campaigns, population control, climate change research and capacity building and fostering knowledge and public awareness of climate change (NDRC, 2007:7-13). The validity of these claims will not be tested here. It is sufficient to note that China has, even though not always very enthusiastically, been aware of the future risks posed by especially environmental destruction and more recently climate change.

The CNCCP states that in the drafting of the 2007 plan, it made use of eight guidelines:

- To give full effect to the scientific approach of development (a phrasing of President Hu Jintao);
- To promote the construction of socialist harmonious society (as a second overall guiding term used during Hu Jintao's presidency);
- To advance the fundamental national policy of resources conservation and environmental protection;
- To control GHG emission and enhance sustainable development capacity;
- To secure economic development;
- To conserve energy, to optimize energy structure, and to strengthen ecological preservation and construction;
- To rely on the advancement of science and technology;
- To enhance the capacity to address climate change.
  (NDRC, 2007:23)

Based on these guidelines, the objectives for the CNCCP were drawn up. The four objectives of the CNCCP are in the area of mitigation of GHG emissions, adaptation, fundamental research and the increase of public awareness in order to improve the management of climate change. (NDRC, 2007:26-29). The main action part of *China's National Climate Change Programme* (CNCCP) is found on pages 30 to 57, under *China's Policies and Measures to Address Climate Change*, which is divided into two sections, the first part looking at mitigation strategies and the second at adaption strategies[4].

CNCCP mitigation categories:	**CNCCP adaption categories:**
-Energy production and transformation -Energy efficiency improvement and energy	-Agriculture -Forests and other natural ecosystems

conservation -Industrial processes -Agriculture -Forestry -Municipal waste	-Water resources -Coastal zones and coastal regions

(NDRC, 2007)

3.3 IPCC: MANAGING THE RISKS OF EXTREME WEATHER EVENTS

The impact that an extreme climate event will have is not only influenced by the event itself, but also by the risks associated with specific communities and environments. Risk is measured by evaluating vulnerability and exposure (discussed below). Since it is hardly possible to completely remove risk, disaster risk management does not completely remove, but reduces risk. Disaster risk management in terms of the environment often makes use of a combination of mitigation and adoption strategies, as these are complementary (Field et al, 2012b:2). Some definitions for terms used will be discussed in the following section, but the IPCC definitions provided in the SREX (Field et al, 2012b:3), should generally be accepted as the assumed definition for this section.

VULNERABILITY AND EXPOSURE

Vulnerability and exposure during or after an extreme weather event is not only influenced by the extreme event itself. According to the IPCC SREX (Field et al, 2012b:65-108) vulnerability and exposure also depend on economic-, social-, geographic-, demographic-, cultural-, institutional, governance and other environmental factors. Vulnerability and exposure have been found to be high when there is skewed development, environmental mismanagement, demographic changes, rapid unplanned urbanization, failed governance and scarcity (referring to poverty and a scarcity of essential life sustaining resources).

Risk in this study will be qualitatively determined by looking at whether there is or is not risk, based on the presence of exposure and vulnerability. Exposure and vulnerability are two very different terms. Exposure is the collection of circumstances and elements in an area that create a certain environment. Exposure is the "inventory of elements" that creates the potential for disaster (IPCC, 2012b:69). Thus a certain community with the same traits situated in two different locations, one on a flood plain and one on a hillside have different exposures: while the hillside village might be exposed to mudslides, the floodplain village might be exposed to flash floods. To stay with the example: if the houses on the flood plain were built on stilts, they would still be exposed, but much less vulnerable to flash floods. Thus the possibility exists that one is exposed, but not vulnerable.

Exposure is determined by looking at the circumstances creating an environment, and in the case of this study, by looking at environmental circumstances and elements in the two drought hit areas of China. In determining exposure, both future forecasts and evidence from the past is used.

When considering vulnerability, the focus is not on the possible extreme weather events as much as it is on the "state" of the community affected, or what weaknesses are present. Vulnerability is "directly related, in context of climate change, to susceptibility, sensitivity, and lack of resilience or capacities of the exposed system to cope with and adapt to extremes" (Field et al, 2012b:69-70). Further a lack of resilience to climate events are caused when there are

"limitations in access to and mobilization of resources of human beings and their institutions, and the incapacity to anticipate, adapt, and respond in absorbing the socio-ecological and economic impact" (Field et al, 2012b:72). Thus the question is, what conditions expose a community to the possible impacts of an extreme event, and also what are the conditions that will prevent it from reducing vulnerability in the future.

Measuring vulnerability and exposure can become very complex, as the list of variables that need to be taken into account can be very long. However, for the aims of this research an extremely detailed analyses is not feasible. The IPCC SREX report will rather be used to combine some variables that are accepted with certainty by the IPCC to contribute to vulnerability and exposure to create a basic framework for risk analyses.

Box 3.2 Measuring Vulnerability

In combination with exposure, vulnerability will be qualitatively evaluated. This is done by looking at the economic-, governance (as in actions of government)- and social situations in each case study.

Governance looks at government actions and the areas of environmental mismanagement (if applicable). Government action can thus either be supportive of the community and local environment or detrimental in essence, these also include the looking at the rules that guide society, for example land management and resource extraction.

The social variable looks at urbanisation and demographic changes. Vulnerability is high when urbanisation happens too quickly and leads to poorly planned cities, with inadequate infrastructure for the high densities of people. Demography causes vulnerability when there is an increase, especially a rapid increase in the population. It also looks at the population age break-up. An older averaged population would for example be more at risk in situations of heat waves compared to a younger population. The last variable looks at the economic, which includes skewed development and scarcity. Scarcity includes the basic concept of poverty in an area, but also the increased economic pressure of acquiring needed resources.

By combining the findings on vulnerability and exposure it is possible to determine whether the drought hit areas of China suffer from environmental risk.

IPCC Adaption and Disaster Risk Management

This paper makes use of the Low regrets framework as adapted from the "'no regrets' and 'low regrets' actions for current and future risk" presented in the SREX table 6-1 (Field et al, 2012b, 352-354, 376-377). No and low regret strategies focus predominantly on the reduction of vulnerability to known risks and the improvement of coping mechanisms. Some of these strategies would include flood-proofing villages, better agricultural management in drought hit areas and improved forecasting and early warning systems (Field et al, 2012b:351).

The benefit of making use of so called low regret and no regret options is that they are not specified to a situation or to just one risk factor; they provide possible general benefits in a wide range of challenges and future forecasts. Scientists in general recommend the use of low and no regret options when the uncertainty factor is high in regards to data on future forecasts. The lack of specificity means that there are options better suited for some scenarios than others. Yet, looking at a national mitigation and adaption plan, this lack of specificity is a benefit.

Low and no regret options and strategies provide a general standard for the basic components of a national climate change risk strategy. The Low regrets framework is divided into six categories. Each of the categories include strategies that can be employed to improve "no and low regret" outcome of a general reduction in environmental vulnerability. Thus, if a national adaption and mitigation strategy for extreme weather shares many traits as found in the Low regrets framework it can be said with relative certainty that this shows a plan that at the least is of general benefit.

Box 3.3 The Low regrets framework

Categories	**Strategies**
Natural ecosystems and forestry	Adaptive forest management
	Reduced forest degradation
	Use of ecosystem based adaption
Agriculture and food security	Sustainable land and water management
	Climate monitoring
Coastal zones and fisheries	Use integrated coastal zone management
	Strengthen institutional, regulatory and legal instruments
	Establish marine protected areas
	Climate risk reduction planning
Water resources	Implement integrated water resource management
	Establish effective surveillance, prediction, warning and emergency response
	Ensure adequate funding is available
Infrastructure, housing, cities, transportation, Energy	Strong building codes
	Urban planning
	Diversified energy systems
	Energy security
Health	Strengthen surveillance for disease control
	Early warning systems, heat/cold alerts
	Monitor air and water quality
	Improve land and water use management for reduced health risk

(Field et al, 2012b:352-354)

4. THE RESPONSE: DETERMINING RISKS AND ASSESSING THE CHINESE POLICY

4.1. EXTREME WEATHER EVENT RISKS IN CHINA'S DROUGHT AREAS

The aim of this section is to determine whether there are future risks of extreme weather events in the form of droughts in southern and northern China. The aim is not to determine the exact degree of risk, but rather whether it is significant enough to be an important policy consideration or not. The South China Drought will be discussed first, followed by the North China drought. In both cases the exposure and vulnerability of the areas are analysed.

SOUTH CHINA DROUGHT

As established above, southern China and the area of focus, Yunnan, have not traditionally been frequently hit by droughts. The area in general suffered one drought every few decades, but these were not as harsh as recent droughts or repetitive enough to have a severe impact on the region in the long term. This has however changed with Yunnan repeatedly suffering drought in the last decade. These droughts are not only much more severe than in the past but have also become a frequent event. The drought of 2009/2010 was not only severe by southern drought standards, but it was the driest, severest and longest in the last 50 years in China. These events can be accepted as proof of current and past climate extreme events in the south of China, whilst the recent trend, although not long enough to be regarded as permanent, seems to indicate an increase in extreme weather drought events in the south.

It is interesting that south China is expected to get "wetter", contrary to what one would expect of a drought hit area, based on the expectation of increased river run-off in the south. An increase in precipitation during one time of the year, leading to a general increase, but with reduced precipitation during another part of the year, can lead to water shortages and drought. Increased river run-off, can also lead to increased risk of other extreme weather events such as floods. Changing weather patterns can likewise indicate possible unexpected increased weather events. A study by Lin *et al* (2011:1879), confirms the expectation that drought in China in general, including in the south, has shown an increase in the last 50 years, with a reported increase of between 10 and 17 per cent in southern China in the last half century. Spring time in south China has shown a reported drop in precipitation, leading to the South China drought. Since climate change in China during the last 50 years can to some certainty be explained by anthropogenic causes, it can be expected that current trends will continue due to continued greenhouse gas emissions. Thus it can be deduced that southern China at present does have significant exposure to extreme weather drought events and that this will most likely remain true in the foreseeable future.

The South China drought, especially in Yunnan, is a clear example of poor resource governance with excessive resource exploitation. Poorly managed logging and forest destruction has been found to have strongly contributed to vulnerability to climate change in the region. By cutting down the forests, the softening effect of these forests on climate extremes, were destroyed. There are noted attempts at improving environmental sustainability in Yunnan and there are attempts at improving the water infrastructure and farming practices of Yunnan (Qui, 2010:142). Nonetheless, recent actions such as government led well digging, done without surveying the ground or doing environmental impact studies can result in increased vulnerability. Thus governance at present needs attention, as it is creating possible future vulnerability.

Yunnan is one of the lesser developed provinces of China, rating as one of the three poorest provinces in China, along with Guangxi and Guizhou (Glauben et al, 2012:784). It has also been found that poverty duration (time until escaping poverty) is the highest in Yunnan of the three provinces, thus indicating that the problem of poverty is not diminishing (Glauben et al, 2012:788). If the international poverty line (of under US$1 per day in this study) is applied, over 40 per cent of Yunnan's population have lived in poverty for five years or more[5] (Glauben et al, 2012:789). Even with government led poverty alleviation plans, poverty remains present. Poverty reduces the resources available to people to withstand the effects of climate extremes and extreme climate events. Poverty also destroys people's ability to prepare for future uncertainty, as they are unable to produce and store surplus.

Water scarcity, as seen by the drying up of reservoirs, lakes and dams, similarly to poverty, removes a community's ability to withstand climate shocks and changes. Lack of water creates severe vulnerability to drought. Lack of adequate water storage infrastructure and enough water reserves also contribute to vulnerability. In summary then, Yunnan will continue to experience exposure to extreme weather drought events along with vulnerability, leading to the conclusion that Yunnan is definitely exposed to policy relevant extreme weather risk.

NORTH CHINA DROUGHT

Northern China is a drought prone area with a frequency of 0.9 to 1.3 droughts a year. The region has been hit by droughts at regular intervals and some with devastating effects. Extreme weather drought events were recorded in the 1960s, 1970s, 1980s and in the 1990s. In the last 50 years droughts and temperatures have increased in northern China (Shan et al, 2011:320), which meant that the likelihood of drought has increased by 30 per cent since 1951 (Lin et al, 2011:1879). With temperatures in northern China expected to continue rising and precipitation and river runoff expected to decrease, it is clear that northern China has extreme weather drought exposure, this will continue to be the case and it might even increase.

The expansion of agricultural activity in northern China is creating future vulnerability and exposure to climate change effects. The area is suffering from skewed growth, given the decreasing precipitation forecast for northern China and the already visible impact of drought and water scarcity. More crops are planted in an area that is now temperate enough for crops, but still suffering from water scarcity. A failure of governance is apparent in this case, as land management and resource extraction leads to increasing vulnerability in an area already exposed to drought. Planting trees as a way of reclaiming land (Three-North China Shelterbelt programme) might benefit an area, but it can also contribute to the problem if the area is not suitable for forests and if the planted trees require more water in an already water scarce area. Forestation, under these circumstances, creates further skewed development.

The land in northern China is not as productive as in the south, neither with regard to farming nor husbandry. Consequently, if government wants to increase tax revenues, radical measures have to be taken, as was seen in the case of fencing areas in Inner Mongolia. Grasslands were fenced and intense husbandry was established, leading to overgrazing (over-exploitation) and soil degradation. This was an example of poor resource governance and skewed development. Northern China, similar to other parts of China faces the problem of rapid urbanisation. Urbanisation in itself is not necessarily negative, but the influx of millions of migrants into ecologically fragile areas puts further stress on the local resources. In addition to the increase in absolute numbers, this migration is also a matter of vulnerability. Ever more vulnerable (poor) migrants make their way to the north. So called "blind-migrants", who travel to anywhere they

might make a better life, live in conditions of extreme vulnerability in shanty towns on the edges of cities.

Northern China is an area that has been and will increasingly be exposed to extreme climate events, especially extreme weather drought events. Due to skewed development and poor resource governance, the vulnerability of the north is, in fact, increasing. With an increase in population numbers and an increase in vulnerable migrants into the north, the vulnerability of the population overall is further increased. Both exposure and vulnerability in northern China can be seen to be at a policy relevant extreme weather drought risk level.

4.2 Assessing Chinese climate change policy

This section aims to evaluate *China's National Climate Change Programme* (CNCCP) by applying the Low regrets framework as adapted from the IPCC SREX. The different categories in the Low regrets framework will be compared to the CNCCP, determining if the plan makes provision for these. Logically the more of these or similar aspects of the CNCCP correlates with the six general categories of the Low regrets framework, the more effective the CNCCP can be assumed to be (NDRC, 2007:30-57).

Natural ecosystems and forestry

The first category of the Low regrets framework is *natural ecosystems and forestry*. This variable or category is measured making use of three indicators, namely: adaptive forest management, reduced forest degradation and use of ecosystem based adaption. Since not all the indicators are always self-explanatory, some will be discussed in more detail. An example in this case would be that the indicator of reduced forest degradation is self-explanatory, but adaptive forest management in contrast is a less accessible term. It is important to know what each indicator means, as the CNCCP will not necessarily explicitly use the same terminology as the Low regrets framework. Thus understanding the indicator is essential in determining whether the CNCCP touches on it. Indeed, all three indicators are present in the CNCCP, with reduced forest degradation being the most prominent.

Adaptive forest management is a style of management that makes use of continuous research and is informed on changes in the forest environment. Thereby, forest management can modify to be effective, allowing adaption to changes in a dynamic manner. Planning and monitoring along with reporting and a culture of accountability allows for all stakeholders in a forest to be actively involved in the open process of managing the forest. The CNCCP does not explicitly make use of the term adaptive forest management. Yet, there is a clear understanding of planning, monitoring, early warning and forecasting in section 4.2.2 of the CNCCP. There is also provision for fostering research into not only conservation but also forest management.

Looking at the second indicator, there further is a clear focus on reduced forest degradation in the CNCCP. In section 4.1.5 afforestation, including running programmes such as the *Natural Forest Protection Program* and voluntary tree planting is to be promoted. In section 4.2.2 strict regulation of logging and implementation of logging bans are to be enforced.

The third indicator for ecosystems and forestry is making "use of ecosystem based adaption". Ecosystem based adaption accepts that an ecosystem that is healthy and operating in its optimal natural state, will be less vulnerable to climate change, thus including extreme weather drought events. Ecosystem based adaption promotes biodiversity, and allows communities to be better adapted to climate change and extreme drought events, in that the resources of the environment can be sustainably enjoyed. The CNCCP once more does not directly mention ecosystem based adaption, but it does nonetheless have references to it. Through examples such as the *Conversion*

of Cropland to Forest Program, there is the possibility of improving and re-establishing local ecosystems; whether the actual outcome in fact achieves this will only be dealt with in the next section. There is, nonetheless, a focus in the CNCCP on "enhancing comprehensive control, and enlarging biological control" in forests, in this case referring predominantly to pest and disease control. These aims are to some extent in contrast to allowing and fostering a natural ecosystem. Controlling and enhancing by "natural" means are two very different approaches. Human interference especially when controlling an ecosystem can have negative impacts on the system. Control of re-established ecosystems is essential, as these are indeed not real natural systems in the real sense of the word, but should be approached carefully.

AGRICULTURE AND FOOD SECURITY

The second category is *agriculture and food security*. In analysing this category use is made of two variables; sustainable land and water management, and climate monitoring. It is surprising that sustainable land management and water management are not more explicit in the CNCCP. There is however mention of both.

In section 4.1.4 of the CNCCP for example states that sustainable land management is to be promoted. It also calls for semi-dry rice cultivation and "scientific" irrigation, both ways that improve water resource sustainability. The implementation of a "new round of (the) fertile soil programme" (NDRC:2007:45), weakly points to sustainable land management. In section 4.2.1 of the CNCCP the prevention of grassland desertification and the breeding of drought resistant crop varieties are mentioned. Further the recovery of vegetation and increasing the vegetation cover in grasslands is to be promoted. In section 4.2.3 of the CNCCP (NDRC, 2007:50), water resources and their management is discussed. In this there is clear evidence of sustainable water management, with the idea that water is not an inexhaustible resource but something that needs to be managed. The second variable, climate monitoring, is also very prominent in the CNCCP. Section 4.3 in the CNCCP is dedicated to "climate change science and technology" (NDRC, 2007:52). This section deals with everything from training and fostering climate change expertise to funding research in the field.

COASTAL ZONES AND FISHERIES

The third category is *coastal zones and fisheries*. There are four indicators for this variable, the use of integrated coastal zone management (ICZM), the strengthening of institutional, regularly and legal instruments, the establishment of marine protected areas and lastly climate risk reduction planning. Integrated coastal zone management is a way of managing coastal environments in a sustainable way. It involves the use of many interlocking disciplines and stakeholders, all working together in a process that is monitored and includes the sustainable use of coastal zones for all purposes to the extent of its capacity.

The CNCCP makes clear provision for the establishing of ICZM, referred to as "the comprehensive decision-making mechanism and effective coordination mechanism". The second indicator is also present. In section 4.2.4 of the CNCCP provision is made for the improvement and establishing of relevant laws and regulations for the management and the protection of marine areas. Thirdly the CNCCP, also in section 4.2.4, calls for the establishment of marine protected areas. And finally there are also measures for implementing adaption strategies to reduce the impacts of climate change, such as adaption to sea level rise. Although climate change reduction is not explicit in section 4.2.4 *Coastal zones and coastal regions* of the CNCCP, it is explicit in the first half of the plan which is entirely devoted to mitigation. Thus all four indicators for the category *coastal zones and fisheries* are present in the CNCCP.

WATER RESOURCES

The fourth category is *water resources*. The three indicators for the category are: the implementation of integrated water resource management, the establishing of effective surveillance, prediction, warning and emergency response, and the ensuring of adequate funding. Integrated water (resource) management is a "management style" that promotes sustainable and equitable development of finite water resources for all its uses, along with land and other similar resources. With the *water resources* category, the variables are not all explicitly present, and there is some vagueness in relation to monitoring of risk events, but it can nonetheless be said that all three indicators of water resources are found in the CNCCP.

The CNCCP in 4.2.3 proposes the adoption of principles in water management that creates "harmony" between humans and nature. It also wishes to establish "enhanced unified management of water resources". In terms of prediction and warning responses the CNCCP in the section on water resources, section 4.2.3, is lacking in any detail. However in section 4.3, a section devoted to research on climate change, there is proof of possible surveillance and predictions (NDRC, 2007:52). There are also government reports such as "China's National Assessment Report on Climate Change", published in three volumes in 2007 that look at forecasts for climate change. The third indicator, adequate funding, is addressed in section 4.2.3. The development of "investment and financing system(s)" for water conservancy projects are planned for.

INFRASTRUCTURE, HOUSING, CITIES, TRANSPORTATION AND ENERGY

The fifth category is *infrastructure, housing, cities, transportation and energy*. This category has four indicators; strong building codes, urban planning, diversified energy systems and energy security. In terms of this broader infrastructure category, two indicators are clearly and strongly present (diversified energy systems and energy security), whilst a third, strong building codes, has some very limited presence. Urban planning in essence receives no mention.

In the CNCCP there is a lack of a clear process of improving building codes. Building codes are very important especially in areas with exposure, to reduce vulnerability. "Stronger" buildings are more resistant to the pressures of extreme weather events. There are other examples, such as prohibiting the construction of buildings on flood plains, which logically reduces possible exposure of a population. The CNCCP does however have regulations for buildings, in other areas, which it wishes to improve. In section 4.1.2 priority is given to implementation of energy-saving standards for buildings, thus acting as possible adaption and mitigation. Buildings are also to become greener and more land-efficient, using less space. Indirectly in section 4.1.2, point 4, attention is also given to producing and using building materials that are more resistant to the effects of climate change and extreme weather events. However this indicator is generally not present. Urban planning is another of the indicators that is lacking in the CNCCP. It is not really discussed.

The third indicator, diversified energy systems, is however discussed in meticulous detail and with high priority attached to it. The energy sections do not only mention aspects such as the development of green energy technologies for increased variety and greening but also show a move to try and establish energy security, based on higher energy yields from resources, but also by improving sustainability. In section 4.1.1, point 3, bio-energy along with solar-, wind-, geothermal- and tide- energy is mentioned.

HEALTH

The sixth and last category is *health*. Health is measured by looking at four indicators; strengthening of surveillance for disease control, early warning systems for heat and cold alerts, the monitoring of air and water quality and lastly the improvement of land and water use management for reduced health risks. The fourth indicator, the improvement of land and water use management, has already been shown to be present in the CNCCP. Only this indicator, improving land and water use management for reduced health risk, is present in the CNCCP. The other three indicators are lacking, as is the case with surveillance and disease control, or completely absent, as in the case with early warning for extreme warm and cold conditions.

In terms of air quality monitoring, in section 4.1.6, *Municipal waste*, there is the promotion of waste incineration, a process known to be extremely hazardous to air quality (NDRC, 2007:47). There is also no specifications or proposed improvements to air monitoring. With water monitoring and pollution control there is also clear lapses. In section 5.2.1 importance is attached to the development of water treatment technology for household and industrial water. Further however the CNCCP mostly only looks at water-saving, an important indicator for *water resources*, but not for water pollution or managing waterborne diseases.

In terms of disease control, there is acknowledgement of increased risk for animal diseases and tree diseases (NDRC, 2007:17). On page 19 of the CNCCP there is mention of possible increases in disease due to higher temperatures, and other medical conditions such as "cardiovascular diseases, malaria, dengue fever, and heatstroke" due to climate change (NDRC, 2007:19). Section 2.3.5 of the CNCCP prioritises the control of plant diseases, and section 4.2.2 the prevention of tree diseases. This section amongst others proposes the development of forecasting systems for forest disease control along with technologies to combat these diseases. However there is no plan or proposed action for human disease control, monitoring or prevention. Thus this indicator is somewhat present but strongly lacking in depth. It thus cannot be said to be present in the CNCCP.

OVERALL ASSESSMENT OF THE POLICY

From the analyses it can be said that the CNCCP as measured by the Low regrets framework is overall adequate. *Natural ecosystems and forestry, agriculture and food security, coastal zones and fisheries* and *water resources* are all present in the CNCCP. *Infrastructure, housing, cities, transportation and energy* and *health* are however inadequate.

Even though being on the right track as such, the CNCCP does have gaping lapses, which should most definitely be addressed in any new plan(s) on climate change and extreme drought events. With no clear warning or planning for the outbreak of diseases associated with climate change and extreme weather events the population is left at risk. Of course there is the possibility to include disease control in other government plans, but with so little focus of disease in the context of climate change and extreme weather events there is a risk of misunderstanding diseases associated with extreme weather events. If it becomes clear that a certain area will become hotter, heatstroke and the treating of dehydration and other symptoms should receive focus, not least so with a view to an overall rapidly aging population of China. If this is not done it will lead to a situation where action becomes a retrospective event. Instead of preparing for risk, communities will first suffer from an event and be helped only after suffering. This increases risk to an unnecessary level in situations where risk could have been mitigated.

4.3 Extreme weather drought response: Implementing the CNCCP?

The previous section has found that in most regards, *China's National Climate Change Programme* can be regarded as adequate, even though it has some areas which need to be addressed in more detail. However, having a national plan to mitigate and adapt to climate change, is just a first step; a good policy is only as good as its implementation. Thus it is important to also analyse the two cases of extreme drought events and establish whether *China's National Climate Change Programme* is only good policy on paper, or an actual plan that has seen implementation. In this regard the research is benefitted by the fact that the CNCCP was meant to run until 2010, thus it should be possible to see whether the plan was implemented. For this purpose, it is irrelevant that a new plan has not been released.

Making use of the two extreme drought events in southern and northern China, this section will analyse whether there is any evidence of the CNCCP being implemented. It is not the aim of this paper to determine the complete extent of the CNCCP nationally across China. Rather, it will determine its reach in the two case studies. These two extreme events were and are some of the largest drought events and thus climate events to hit China in the last 50 years. Consequently, if the CNCCP was not visible in these two cases it can be assumed that the extent of implementation of the plan has not been significant in climate events.

In assessing the implementation of the CNCCP in the drought cases, a similar methodology will be used as in the previous section, using the drought relevant sections of the CNCCP instead of the previously applied Low regrets framework. The variables that will receive the most focus are; *natural ecosystems and forestry, agriculture and food security* and *water resources*. *Health* and *infrastructure, housing, transportation and energy* will receive little attention in the analyses, as they are not well represented in the CNCCP and can thus not be used to assess implementation. *Coastal zones and fisheries* will also not be touched on, since it does not have a clear enough direct impact on the two mainly inland drought cases.

As a limitation, it must be noted that this desk-based assessment cannot differentiate between coincidence and wilful action. If the different variables are found to be present, it is not necessarily possible to determine whether this is due to concerted efforts to implement the CNCCP or due to other factors. It must thus be accepted that their presence do nonetheless indicate a positive trend. This section will conclude with a short discussion on general findings with regards to China's environmental policies.

Natural ecosystems and forestry

Ecosystems and forestry are of great importance in the case of Yunnan. Lack of effective forest management led to the destruction of much if not most of Yunnan's forests. The forests of Yunnan are sometimes referred to as mountain reservoirs. Moist air travelling inland from the ocean is caught against the forested mountains of Yunnan and water is trapped in the forest, in a way similar to how water is trapped by a sponge. When the trees are cut down, this effect is lost. Over centuries the forests of Yunnan have weathered many droughts and always continued to provide a constant water supply. The forests in the region have evolved over the centuries, with weaker plants dying, resulting in a forest system that effectively traps water (RTCC, 2012).

The importance of forests in Yunnan are clearest illustrated by the example of the city of Gejiu. Unlike many other cities in Yunnan, Gejiu, never had to implement water rationing. Research has shown this is most likely due to the presence and health of forests in the vicinity of Gejiu. The forest provided the city with forest water resources. A study by the Shan Shui Conservation

Centre of Beijing found that in the 2009/2010 drought, that most areas that were hardest hit by the drought were areas where forest cover had been reduced. In areas where the forests still remained, a steady supply of forest water sustained water supplies. (RTCC, 2012).

The destruction of Yunnan's forests has led to a sever increase in vulnerability and risk to extreme weather events such as drought (Qui, 2010:142). It is in many regards too late to "reduce forest degradation" since the situation has escalated too far already. With little forest cover left in Yunnan, compared to earlier levels, the water trapping effects of the forests have been removed. The replacement of local environments with alien species such as rubber trees and eucalyptus forests, logging and quarrying have all thus had a negative effect on Yunnan (Qiu, 2010:142). Thus far no large scale effective reforestation programmes or attempts to recreate the local ecosystems have been launched. There are projects by NGOs in Yunnan that are trying to educate communities on the importance of forests. Cities, such as Gejiu, have seen the health of their local forests increase since the 1990s. However the CNCCP does not seem to have been effectively implemented in the province of Yunnan with regards to *Natural ecosystems and forestry*.

In the north of China, the implementation of systems that are supportive to *natural ecosystems and forestry* are clearly visible. Forest cover in northern China has been increased from 5.05 per cent to over 10.51 per cent (Jiang, 2010:23). This is however a process that has been on-going for the largest part of the last half century. Nonetheless, forest cover is increasing and bans have been put in place for the preservation of local forests. The problem, however, lies with ecosystem based adaption; dryland tree planting often fails because of the constraints of the local environmental conditions (Jiang, 2010:24). And in this regard the government has not effectively begun restoring local environments, but rather establishing "foreign environments" on degraded soil. What is meant by this is, that instead of adopting grassland planting, making use of local shrubs and grasses (which have been shown to be more effective than trees), tree planting remains the major government supported policy (Jiang, 2010:25). Some scientists claim that the government is making an error in not restoring original environments (Jiang, 2010:32). The Three North's Shelterbelt programme at present remains the most ambitious environmental project in China and is, at least to some extent, increasing forestation (Dong *et al*, 2010:14). Yet when planting trees in areas that do not receive enough rainfall to sustain the trees, there is a risk of further damaging a degraded environment. Trees absorb even more water from the ground, leading to a drop in the water table, which can have detrimental effects on the local natural environments that still exist. Thus, while *Natural ecosystems and forestry* as found in the CNCCP is clearly visible in northern China, it might not be as positive a sign as expected. The un-adapted implementation of this policy is probably creating new problems, especially in long term sustainability. What can be deduced from the two examples seems to be that some of the elements in the CNCCP are found in the two drought cases with regards to *natural ecosystems and forestry*, but that it is by far to incoherent and at times unsustainable to be seen as an effective implementation of the CNCCP.

AGRICULTURE AND FOOD SECURITY

When researching the topic of sustainable land management, it seems that it is a high priority for the Chinese government, given the emphasis put on it in the CNCCP. A recent application to the Asian Development Bank, for example requests US$400 000 (with an approval date beyond the time of this research for November 2012) for the launching of an environmental sustainability capacity development project. The project is described as "a ten-year development strategy for SLM of dryland ecosystems endorsed (by the Chinese) government" (SLM stands for sustainable land management) (Asian Development Bank, 2012).

In Yunnan, after the 2009/2010 drought, more than 80 per cent of croplands were converted to make use of intercropping, an indication of more sustainable farming (Qiu, 2010:142). Yet when looking at the larger picture, there does not seem to be concerted effort in making agriculture in general more environmentally friendly. The environmental intention comes across in many policy documents, not only in the CNCCP, but political will seems to be lacking. In northern China with the grain-to-green project, there are, indeed, cases of cropland being converted into grassland, and steep slopes in Yunnan were turned back into natural environments (Qiu, 2010:143).These projects show increases in sustainable land management practices.

In other areas, the government has implemented projects that are presented as improving sustainability. Yet, to increase food security is different from sustainability. A study by McBeath and McBeath (2010) identified six main projects stated by the government that aim at sustainability. These projects are; (1) restrictions on land convergence, this allows for a minimum amount of land being identified as critical for sustained food security, (2) China's one child policy, this reduces environmental pressure by the growing population, (3) state investment in irrigation, in 2000 the government spent 30 per cent of the budget on agricultural irrigation (this however does not seem to apply to water infrastructure in general, with Yunnan suffering from inefficient water infrastructure), (4) the South-North Diversion Project, and (5) afforestation programmes as well as (6) the restoration of grasslands (MacBeath & MacBeath, 2010:102-107). In recent years (since increased interest in 1997) the Chinese government has also become one of the biggest global investors in biotechnological (BT) development. More than 70 per cent of China's cotton crop has already been converted to BT cultivars by 2008. The use of BT cotton has seen a decrease in the use of pesticides for cotton of over two-thirds in recent years (MacBeath & MacBeath, 2010:109-110).

WATER RESOURCES

The severity of the 2009/2010 Yunnan drought forced officials to focus on the state of water management and infrastructure development, in Yunnan. Upgrades are being done to the 50 year old infrastructure. The age of infrastructure is a general problem in China. On average China loses 25 per cent of water transmitted through pipes due to leakage (MacBeath & MacBeath, 2010:98). However some other government actions seem to completely disregard the CNCCP. During the 2009/2010 drought the government reactively sent 2000 government relief workers to Yunnan to dig water wells to relieve the drought. As much as infrastructure development will improve water management, the digging of wells by government relief workers risked the sustainability of many natural environments in Yunnan. The central government did not do enough research before starting the well digging projects. The government only surveyed 10 per cent of the entire area in which wells were drilled. Studies on sustainability, environmental impact studies and studies on the quality of groundwater were either not done or were grossly inefficient (Qiu, 2010:143). It is highly recommended that these studies be done before further developing already fragile environments. In an area already suffering from drought and environmental destruction, such as the reduction in natural forest cover in Yunnan, the use of groundwater, can be devastating. The drilling of wells as a reaction to the drought cannot be seen as a positive action in any light, the risks which have been and are involved in the drilling, far outweighs any possible benefit.

With regard to water management projects in the north, the main focus for the government has been on an enormous water divergence project. The north of China, which is regularly hit by drought, currently produces over 40 per cent of China's grain crop (McBeath and McBeath, 2010:97). However due to a lack of sustainable water management, rivers are over exploited and the lower reaches of some rivers have run dry. Groundwater in the north has also not been

sustainably managed, leading to severe and dangerous drops in the water table (McBeath and McBeath, 2010:98). Large cities have also been using natural underground aquifers as sources of water and these are beginning to dry up (Wong, 2011).

The government, as a solution to water scarcity in the north, has decided on a plan that sees the pumping of 23 trillion litres of water from the south to the north each year; this project will serve the needs of 440 million residents in the north. It is estimated that the project will cost around US$62 billion (McBeath and McBeath, 2010:105 & Wong, 2011). However, this project has been severely criticised in China, as being to destructive. Not only does the project require the relocation of over 300 000 people (150 000 have already been moved), but scientists are worried about the effects that the project will have on ecosystems in the south. A study focussing on the Han River found that the loss of water from the Han (as a result of its water being pumped north), will cause a noticeable drop in the flow of the river in the middle and lower stretches. This drop in flow will increase the risk of pollution of the river, and can lead to ecological disaster (Wong, 2011).

When the two cases are assessed, it once more seems as if, even though there are actions being taken to remedy drought risk and water scarcity, that the CNCCP as a more ecologically "friendly" (or sustainable) document, is not being implemented. Correlation between the CNCCP and response on the ground, seem to be by chance. When the degraded state of water infrastructure in Yunnan is highlighted by a drought, actions are taken to remedy the situation. However what would have been expected, is that water infrastructure would have been upgraded (at least in the last 50 years) before a drought hit, thus proactive and not reactive solutions are needed. The conclusion is thus, that the CNCCP has not been effectively implemented with regards to *water resources*.

SUMMARY OF FINDINGS

The findings of this paper are threefold. First, the two regions in the case studies are at risk of future extreme events such as drought. Secondly, it can be said that the CNCCP is an adequate extreme event mitigation and adaption plan. And thirdly, the CNCCP is seemingly not being implemented adequately. With regards to the implementation of the CNCCP, two conclusions are possible. Either the government is not truly motivated and lacks the political will to implement the CNCCP, only implementing parts of it by coincidence or when it suits its own needs. Or, possibly, the central government does indeed see the importance of the CNCCP, but the goodwill of the central government does not transfer through to reality, due to inhibiting factors that would require further (field) research.

China is often seen as a powerful state with a government that is all powerful within its borders. The reality however is far from this picture of an "all controlling" central government (Gang, 2009:16). Officials who work at local environmental protection bureaus, are dependent on local government for their budgets, promotions and even for the allocation of housing and cars. High-speed economic development is often more important for local governments, than the implementation of strict environmental policies promoted or even made law by the central government (Gang, 2009:22). At the local level entrepreneurs and other possible polluters or people in industries that are environmentally destructive, can often rely on what is known as *guanxi*, or social connections. With the right *guanxi*, ensured through payments, invitations to events and presents, it is possible to skip compliance with environmental standards (Esterhuyse, 2012b & Gang, 2009:18). Thus there are 'loop-holes' in the governance system, that can prevent the effective implementation of policy.

5. CONCLUSION

In coming years, China will most likely see an increase in extreme weather events, including droughts. Drought likelihood is to remain a constant risk for both Yunnan and north China. With both exposure and vulnerability in the two regions, it is essential that long term mitigation and adaption policies are implemented. Making use of central policy documents and plans is an important step. However with the lapses in the current CNCCP the risk at present is still too high. Recent floods in Beijing, even though not situated in the study areas, showed how a lack of proper building regulations can lead to general chaos as the city was devastated by extreme weather. In the case of Beijing 37 people lost their lives and US$1.6 billion of damages were incurred. These casualties could most likely have been prevented had early warning systems and effective waste water networks been in place. The lack of healthcare preparation in the CNCCP is also exposed by the same incident. The flooding could very easily have led to outbreaks of waterborne diseases, which could have increased the death toll significantly. Preparations for (mitigating and adapting to) extreme weather events should be part of a coherent and integrated proactive plan.

The Chinese central government seems to be prioritising climate change adaption and mitigation as set out in the CNCCP. Yet, these effects do not convert into results on the ground. A possible reason for this is that local governments are crucial in the final application of environmental plans, and are able to slow down their implementation or even circumvent it. Thus it is important for China to not only improve its climate change plan, but to also find ways to incentivise local governments to actually implement the policies that Beijing promotes. Without focus on implementation, policies are paper tigers. Recently the Chinese central government has been redrafting legislation that can possibly reduce the policy gap by introducing incentives and disincentives, encouraging local governments to act more responsibly (for a discussion, see: Esterhuyse, 2012b). This area provides an important topic for future research to explore; to what extent are central policies considering local government dynamics and possible obstacles?

Lastly, and rather implicitly, the findings of this paper are of relevance to the China-Africa dialogue. This discussion paper aims at improving the understanding of policy dynamics in China which has indirect repercussions for China – Africa relations and for optimizing cooperation. Cooperation on environmental protection and policy is of critical importance in this relationship. In an international system with a changing climate and shifting power, truly mutually beneficial partnerships need to take effective climate change mitigation and adaption into account, and will thus have to prioritise cooperation and knowledge sharing in this topic area. By jointly addressing these challenges the Africa–China partnership can contribute to security on a national level by reducing climate induced risks, building understanding between states (thus securing peace), increasing knowledge sharing and ultimately improving sustainability and international economic competitiveness.

ENDNOTES

[1] The drought is referred to as the drought of 2009/2010 in most sources. Some refer to it as the Yunnan drought, but this is somewhat of a misnomer as it did not only affect Yunnan, however the focus of the study will predominantly be on Yunnan. Other areas affected include Sichuan and Guizhou (Gong et al, 2012:172)

[2] Coral bleaching is a phenomenon that occurs when the coral animals release the coloured algae that usually live within it. This release is a sign of stress and destroys the symbiotic relationship between the algae and the coral. The algae provide the coral with nutrients and are also responsible for the colour of the coral. When the algae are released the coral appears white or "bleached".

[3] The little Ice Age was a cooling period between 1550 and 1850, with increased cold spells following 1650, 1770 and 1850.

[4] For a concise version of the CNCCP, and more information on each of the categories, please see a brief summary in the Appendix of this paper.

[5] It is important when looking at statistics of poverty in Yunnan to be aware of the difference between the national poverty line (China) and the international poverty line. According to the measures of the national poverty line only four per cent of Yunnan's population fall into the category of having lived in poverty for five or more years, vastly different from the 40 per cent according to the US$1 per day measure.

BIBLIOGRAPHY

Asian Development Bank, 2012, Integrated Strategy for Sustainable Land Management in Dryland Ecosytems. Available at: <http://pid.adb.org/pid/TaView.htm?projNo=46084&seqNo=01&typeCd=2> [Accessed 18 July 2012]

Bates, B.C., Kundzewicz,Z.W., Wu, S. & Palutikof, J.P. (eds.). 2008. Climate Change and Water. Technical paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva.

Brown, E.M. & Funk, C.C. 2008. Food Security Under Climate Change. Science, 319:580-581.

Chen, D., Dai, X., Ding Y., Gao, X., Gong, P., Luo, Y., Ren, G., Shi, G., Wang, H., Wang, S., Zhai, P., Zhang, D., Zhao, Z. & Zheng, X. 2007. China's National Assessment Report on Climate Change (I): Climate change in China and the future trend. Advances in Climate Change Research, 3 (Supplement):1-5.

Chen, G. 2009. Politics of China's Environmental Protection: Problems and Progress, Series of Contemporary China. Volume 17. Singapore, B & Jo Enterprise Private Limited.

Chen, F., Fang, K., Gou, X., He, M., Li, J., Peng, J., Tian, Q., Yang, M. & Zhang, Y. 2009. Drought variations in the eastern part of northwest China over the past two centuries: evidence from tree rings. Climate Research, 38:129-135.

Cohen, A.P. 1978. Coercing the Rain Deities in Ancient China. Current Perspectives in the Study of Chinese Religions, 17(3/4):244-265

Cui, Y., Liu, C. Singh, V.P., & Qiang, Z. 2011. Copula-based evaluations of drought variations in Guangdon, South China. Natural Hazards, 59:1533-1546.

Dong, Z.B., Hasi, E., Wang, X.M. & Zhang, C.X. 2010. Has the Three North Forest Shelterbelt Program solved the desertification and dust storm problems in arid semiarid China?. Journal of Arid Environments, 74:13-22.

Esterhuyse, H.W. 2012a. Washing out the flaws in China's National Climate Change Policy [Online]. Available: http://www.ccs.org.za/wp-content/uploads/2012/08/HE-Heavy-Rain-Beijing.pdf. [Accessed 2 October 2012]

Esterhuyse, H.W. 2012b. Getting China's environmental policy moving stick by stick – now it is time for the carrot [Online]. Available: http://www.ccs.org.za/wp-content/uploads/2012/09/HE-FOCAC-Sustainable-Development.pdf. [Accessed 2 October 2012]

Glauben, T. Herzfeld, T. Rozelle, S. & Wang, X. 2012. Persistent Poverty in Rural China: Where, Why, and How to Escape?. World Development, 40(4):784-795.

Gong, D., Hu, M., Mao, R., Wang, W. & Yang, J. 2012. Extreme drought even of 2009/2010 over south-western China. Meteorology and Atmospheric Physics, 115:173-184.

Greenpeace. 2011. 'Severe Drought Hit Southern China'. Available at: <http://www.greenpeace.org/eastasia/multimedia/slideshow/climate-energy/scenes-climate-change-china/Severe-Drougth-Hit-Southern-China/> [Accessed 28 May 2012]

Hulme, M., Mahony, M. 2010. Climate change: What do we know about the IPCC? Progress in Physical Geography, 34(5):705-718.

Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G. K. Allen, M. Tignor, and P.M. Midgley (eds.). 2012a. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaption – Summary for Policymakers, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. World Meteorological Organization, Geneva.

Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.). 2012b. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, in A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Fang, J., Lu, C., Shen, Y. & Wang, X. 2007. Implications for development of grain-for-green policy based on cropland suitability evaluation in desertification-affected north China. Land Use Policy, 24: 417-424.

Jiang, H. 2010. Chapter 1 desertification in China: Problems with Policies and perceptions, in Kassiola, J.J. & Gua, S. (eds.). China's Environmental Crisis. Palgrave Macmillan. 13-40.

Ju H., Lin E., Ma, S., Xu, Y. & Wu S. 2007. China's National Assessment Report on Climate Change (II): Climate change impacts and adaptation. Advances in Climate Change Research. 3(Supplement):6-11.

Lin C.A., Lu, G.H., Wen, L. & Wu, Z.Y. 2011. Reconstructing and analyzing China's fifty-nine year (1951-2009) drought history using hydrological model simulation. Hydrology and Earth System Sciences Discussions, 8:1861–1893.

Marks, D. 2010. China's Climate Change Policy process: improved but still weak and fragmented. Journal of Contemporary China, 19(67):971-986.

McBeath J. & McBeath, J.H. 2010. Chapter 4 Environmental Degradation and Food Security Policies in China, in Kassiola, J.J. & Gua,S. (eds.). China's Environmental Crisis. Palgrave Macmillan. 85-119.

Ministry of Environmental Protection of the People's Republic of China (MEP) (2010). Report on the State of the Environment in China. Available at: <http://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CGgQFjAB&url=http%3A%2F%2Fenglish.mep.gov.cn%2Fdown_load%2FDocuments%2F201104%2FP020110411532104009882.pdf&ei=31YWUPCrAYPPhAfTrYHYBg&usg=AFQjCNGyKJTgUJt9dAqCvh2SpJr-Nn4Mmw&sig2=83rQC0a5-7JOLmmqVrbYtg> [Accessed 28 May 2012].

National Development and Reform Commission (NDRC) (2007). China's National Climate Change Programme. Available at: <http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File188.pdf.> [Accessed 28 April 2012]

Qiu, J. 2010. China drought highlights future climate threats. Nature, 465:142-143.

Responding to Climate Change (RTCC). 2012. Rio+20 Business Focus: Combating drought in south-west China. Available at: <http://www.rtcc.org/living/rio20-business-focus-combating-drought-in-south-west-china/> [Accessed 13 July 2012]

Qing, K.G. 2012. Focus: 'Drought hits 4 million hectares of China's crops- Xinhau'. Reuters, [online]. 5 April. Available at:

<http://www.reauters.com/assets/print?aid=USBRE8340QE20120405> [Accessed 28 May 2012].

Shan, X., Qian, W. & Zhu, Y. 2011. Ranking Regional Drought Events in China for 1960-2009. Advances in Atmospheric Sciences, 28(2):310-321.

Wong, E. 2011a. Focus: 'China: Drought leaves 14 Million Chinese and Farmland Parched'. The New York Times. [online]. Available at: <http://www.nytimes.com/2011/09/10/world/asia/10chinabrf.html> [Accessed 28 May 2012].

Wong, E. 2011b. Focus: 'Plan for China's Water Crisis Spurs Concern'. The New York Times. [online]. Available at: < http://www.nytimes.com/2011/06/02/world/asia/02water.html > [Accessed 13 July 2012].

UN News. 2011. Focus: 'Winter drought threatens wheat harvest in north China plain as prices soar'. United Nations. 8 February. Available at: <http://www.un.org/apps/news/printnewsAr.asp?nid=37485> [Accessed 22 May 2012]

Wang, B., Xin, X., Yu, R. & Zhou, T. 2006. Drought in Late Spring of South China in Recent Decades. Journal of Climate Change, 19:3197-3206.

Worldwatch Institute, 2010. Worldwatch Report 182. Renewable energy and Energy Efficiency in China: Current Status and Prospect for 2020, Mastney, L (ed).

Yu, C. 2011. China's water crisis needs more than words. Nature, 470:307.

APPENDIX

Summary of Chinas National Climate Change Programme (sic)
A. Greenhouse gas mitigation
a. Energy production and transformation "Formulate and implement relevant laws and regulations": The CNCCP aims to improve the strength of Chinese laws that deal with climate change. The new and improved legislation will aim to regulate the energy sector, and to establish the legal basis for proposed long and medium term energy programs. These laws will help to promote the mitigation of GHG emissions from energy production. "Strengthen institutional innovation and mechanism construction": This part of the plan aims to create a government supported promotion of renewable energy development. It also wishes to promote institutional reform in China's energy sector to ensure the greening of the sector by making use of mechanisms such as pricing and limiting or controlling the trade of energy intensive-, pollution intensive- and resource intensive product. "Intensify relevant policies and measures in energy industry": This sees a focus on the creating of hydroelectric power stations, nuclear power stations, improving thermal power generation and also an improvement of the Chinese coal power generation infrastructure. In general it is the promotion of more efficient energy sources and processes making the power supply network more efficient and less environmentally damaging. There is also a section on the strengthening and spreading of advanced technologies, which also promotes the improvement and the process of making the energy sector more sustainable. It includes new, old and renewable energy sources.
b. Energy efficiency improvement and energy conservation "Accelerate the formulation and implementation of related laws and regulations": this section calls for the implementation of laws that will assist in energy saving and efficiency. It also aims to formulate and improve the energy efficiency standards of the most important and the largest energy consuming products and industries. The rest of the section further details how to improve energy efficiency, including through the further implementation of the ten key energy conservation priority programs.
c. Industrial processes China will aim to develop its economy so as to be circular, making use of recycling, the reusing of products and the reduction of waste. Further China will aim to reduce the use of steel and to limit its imports, rather using substitute products. China also aims to develop new products that are high-performance, low-cost and low-consumption. China will reduce the use of bag cement and rather focus on making use of bulk cement and slag cement. This will be done through policies such as tax exemptions. China will also promote buildings that are more environmentally friendly.
d. Agriculture In the field of agriculture, laws protecting the environment will be strengthened and improved. Agricultural ecosystems are to improve their carbon storing capabilities. China also aims to improve protection of farmland and to monitor development in fragile environments. The country will intensify efforts to make agriculture more ecologically friendly, limiting chemical fertilizers and pesticides usage. Technology and knowledge transfer will be promoted, for example promoting the usage of semi-dry rice cultivation technology and the breeding of rice varieties with high yields and low GHG emissions.
e. Forestry Legislation will be implemented that will improve and speed up the process of enhancing China's forestry legislation. This process will also see the drafting of legislation for the protection of natural forest conservation areas. The CNCCP aims to improve the process of afforestation, both improving the government led afforestation and also promoting voluntary private afforestation.

f. Municipal Waste The Chinese government will strengthen legislation for the management of solid waste. Management of waste will be changed from a system that focuses on processing the end 'product', to a system where the whole process is managed. This will mean a reduction in waste at the source, the recovery and utilization of recyclable waste and ensuring that waste is disposed of in a non-hazardous manner. Incentives will be put in place for the capturing of landfill gasses.
B. Adaption to climate change
a. Agriculture In adapting to climate change the Chinese government will upgrade existing storage facilities and construct new water storage facilities for irrigation. The use of stress-resistant crop varieties is also to be promoted. Furthermore research needs to be conducted into new technologies that promote stress resistance, precision agriculture, bio-technology, nitrogen fixation and the prevention of diseases and pests.
b. Forests and other natural ecosystems The CNCCP first calls for the implementation of laws and regulations relevant to climate change adaption. Later this is rather vaguely specified to mean the strengthening of laws so as to provide legal guarantee "for improving the capacity of forests and other natural ecosystems to adapt to climate change". Further the CNCCP aims to vigorously counter logging in protected natural forests. Degraded forests are also to be rehabilitated. Once more the CNCCP calls for further research to support the adaption process, and in terms of forests looking at forest fire control and forest insect disease control amongst others.
c. Water resources Water resource management should be enhanced and a 'harmony' should be created between nature and humans. Some farm land is to be converted back into lakes and rivers, and polders are to be removed in some areas. Rivers with serious ecological problems are to be protected and rehabilitated and key water conservancy projects are to receive investment and financing. Further the CNCCP calls for the promotion of water-saving practices, waste water and rainfall utilisation and the improvement of agricultural water use efficiency.
d. Coastal zones and coastal regions Once more legislation is to be improved and implemented. Integrated coastal zone management systems are to be established. This is a management system in which a range of components are managed by a central actor, allowing all different objectives to contribute to the same end goals. Research will be done into the protection and restoration of marine areas. Early warning systems are also to be built to focus especially on changes in sea level rise. In areas where the sea level is rising, slope and shore protection strategies are to be implemented.
C. Research and development, awareness and mechanisms
China plans to conduct research into the improvement of macro-management of climate change related scientific research. China will also promote scientific research and technology development in areas that are related to climate change. There are also plans for increasing the research capacity of the climate change field and increasing general financial support. Public awareness of climate change is to be promoted in different ways, encouraging public participation in conservation and saving. Further the Chinese government aims to strengthen the leadership in areas of climate change. There is also hope to establish regional climate change coordination centers to implement and complete national programs in the different regions.

(NDRC, 2007:30-57).

Editorial Team
Sven Grimm
Harrie Esterhuyse
Matthew McDonald

Design & Layout
Centre for Chinese Studies

Contact Us

Centre for Chinese Studies
Stellenbosch University
T: +27 21 808 2840
F: +27 21 808 2841
E: ccsinfo@sun.ac.za
W: www.sun.ac.za/ccs