



# Impacts of Climate Change on Chinese Agriculture – Phase II

## Adaptation Framework and Strategy Part 1: A Framework for Adaptation

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## Project Background

The project *Impacts of Climate Change on Chinese Agriculture (ICCCA)* was funded by the UK Government's Department for Environment, Food and Rural Affairs (Defra – transferred to the Department of Energy and Climate Change, DECC, in October 2008) and Department for International Development (DFID), conducted in partnership with China's Ministry of Science and Technology (MOST).

Since 2001, the project has led the way in understanding how climate change can be expected to affect rural China.

The project was rolled out in two phases: Phase I (2001 to 2004) applied regional climate modelling to construct several possible future climate scenarios for China. These were subsequently fed into a suite of regional crop models adapted by the Institute of Environment and Sustainable Development in Agriculture (previously the Agrometeorology Institute) of the Chinese Academy of Agricultural Sciences (CAAS), in collaboration with UK climate-change researchers, to determine the potential impacts of climate change on crop yields in China up to 2100.

Building on Phase I, Phase II (2005 to 2008) refined and widened the national level analysis. CAAS also worked in collaboration with major regional implementers such as the Clean Development Mechanism Service Centre (Ningxia) and Meteorological Study Institute (Ningxia), and engaged a range of stakeholders to assess the impact of climate change on rural livelihoods. This led to the development of the first regional adaptation framework in China – for the northern province of Ningxia.

The key findings and approaches for the project are summarised in six pamphlets. These are:

- *Overall summary of results*
- *Understanding how China's climate may change in the future*
- *Modelling the impacts of climate change on cereal production in China*
- *Modelling the interaction of climate change - water availability and socio-economic scenarios on cereal production*
- *Rural livelihoods and vulnerability to climate hazards in Ningxia*
- *An adaptation framework and strategy for Ningxia*

The full technical reports from the project can be found at [www.china-climate-adapt.org](http://www.china-climate-adapt.org). These are:

- *National Level Study: The Impacts of Climate Change on Cereal Production in China*
- *Future Cereal Production in China: Modelling the Interaction of Climate Change, Water Availability and Socio-Economic Scenarios*
- *Climate and Livelihoods in Rural Ningxia*
- *Climate Change in Ningxia: Scenarios and Impacts. Technical Report.*
- *Adaptation Framework and Strategy:*
  - Part 1 – A Framework for Adaptation*
  - Part 2 – Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China*
  - Part 3 – An Adaptation Strategy for Agriculture in Ningxia, Northwest China*

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## Project Team

The project team comprised the Institute of Environment and Sustainable Development in Agriculture of the Chinese Academy of Agricultural Sciences (CAAS), AEA Group, who managed the project and provided technical input, and Dr. Declan Conway of the University of East Anglia as Scientific Advisor. The project has benefited from the contribution of numerous partners and stakeholders in both China and the UK. Collaborative research links have been forged resulting in new insights into the scientific and policy challenges posed by climate change in China over the next century.

## Acknowledgments

### Key collaborators

#### China

- Chinese Ministry of Science and Technology
- National Development and Reform Commission
- China Meteorology Administration
- Chinese Ministry of Agriculture
- Chinese Academy of Social Sciences
- Ningxia Department of Science and Technology
- Ningxia Bureau of Meteorology
- Ningxia Agriculture and Livestock Department
- Office of Environmental Protection, Ningxia
- Office for Poverty Alleviation, Ningxia
- Clean Development Mechanism Centre, Ningxia

#### UK

- Cranfield University
- Environment Agency
- Met Office Hadley Centre
- The Tyndall Centre for Climate Change Research, University of East Anglia
- UK Climate Impacts Programme (UKCIP)
- University of Reading

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- Environmental Change Institute, Oxford University, UK
- Forestry Commission, UK
- Greater London Authority, UK
- Institute of Arable Crops Research, Rothamsted Research, UK
- Institute of Grassland and Environmental Research, UK
- John Innes Centre, UK
- JSC/CLIVAR Working Group on Coupled Modelling (WGCM), UK
- Programme for Climate Model Diagnosis and Intercomparison (PCMDI), USA
- School of Earth, Environmental and Geographical Sciences, University of Edinburgh, UK
- Unit for Landscape Modelling, Cambridge University, UK

[www.china-climate-adapt.org](http://www.china-climate-adapt.org)

## Executive Summary

ICCCA Phase II developed the first framework for adaptation to climate change in China. This is a generic and transferable tool to help decision-makers develop a comprehensive and strategic approach to adaptation policy which can inform action on the ground. Although local conditions will vary, the framework identifies a number of key actions that should be undertaken in the development of an adaptation strategy and represents a useful means for decision-makers to structure their approach to climate change impacts and adaptation. ICCCA successfully applied its framework to the agricultural sector in the autonomous region of Ningxia Hui (northwest China) to produce the first regional adaptation strategy in China but the generic framework should be applicable to different areas and sectors.

ICCCA's research on adaptation during Phase II is presented in three reports:

- **Part 1: A Framework for Adaptation.** This part outlines the generic, transferable tool developed by ICCCA to help decision-makers to structure their thinking about adaptation and to start develop their own adaptation strategy.
- **Part 2: Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China.** This part illustrates the practical application of ICCCA's framework to generate prioritised adaptation options – the first step towards the development of an adaptation strategy. It covers the methodology, results and lessons learnt from applying the framework, as well as the outcomes from the exercise.
- **Part 3: An Adaptation Strategy for Agriculture in Ningxia, Northwest China.** This part concentrates on the outcomes of applying the adaptation framework to the agricultural sector in Ningxia by presenting the adaptation strategy arrived at through application of the framework.

This report is **Part 1** of ICCCA's research on adaptation and sets out ICCCA's framework for adaptation.

The key features of ICCCA's adaptation framework are as follows:

- The framework consists of six steps or phases:
  1. Assessing the climate risk
  2. Integrating regional development goals and adaptation goals
  3. Identifying adaptation options
  4. Prioritising options
  5. Implementing and demonstrating
  6. Monitoring and evaluation
- The framework is iterative (represented diagrammatically as a closed circle) and this encourages learning from implementation of adaptation in the field (Stages 4 to 6) by using feedback to review and adjust adaptation options and priorities;
- Its iterative nature also encourages continual engagement of relevant local stakeholders to help identify and monitor adaptation activities;
- Through its encouragement of continual engagement of local stakeholders and institutions, the framework helps enhance understanding and awareness about climate change, and to build capacity for adaptation implementation;
- The successful application of the framework relies on certain information being made available. This includes, *inter alia*, climate projections for the jurisdiction under consideration and a basic understanding of local vulnerabilities to weather events;
- Following the process outlined by the framework should enable decision-makers to identify what information is needed to develop an adaptation strategy, which can be subsequently refined at implementation.

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# 1 Introduction

Adaptation has become increasingly important to many government departments in China. In 2006 the Chinese government published its National Climate Change Program that outlined detailed plans and arrangements for adaptation. At a regional level development plans are also starting to address the issue of climate change impacts and adaptation. Ningxia's Eleventh Five-year Development Plan and the National Government Report have both clearly mentioned that adaptation abilities need to be improved to help face climate change.

Adaptation is a future-oriented and location-specific activity, and adaptive capacity is closely related to the development level of the society that needs to adapt. Decision-makers face a number of difficult questions when considering adaptation: How to identify, prioritise and implement practical adaptation measures? How and when should adaptation measures be phased in?

Phase II of ICCCA developed a regional framework for adaptation to climate change in China, which was found to be a useful means of addressing some of these difficult questions for the region of Ningxia. The framework and the subsequent adaptation strategy were developed by engaging a range of stakeholders from a variety of government agencies and farming communities. Scientists, policy-makers and rural communities have all contributed to developing an appropriate framework for adaptation to climate change in Ningxia – an approach that is intended to inform future adaptation policies in other Chinese regions.

Ningxia is an interesting region to examine because it suffers from many of the agricultural problems experienced currently more widely across rural China including: water scarcity, desertification, aridity, and a high reliance on irrigation. The region is also experiencing one of the driest spells in its history.

This report is the first of a series of three project reports on adaptation presenting ICCCA's work on adaptation:

- **Part 1: A Framework for Adaptation.** This part outlines the generic, transferable tool developed by ICCCA to help decision makers to structure their thinking about adaptation and to start develop their own adaptation strategy;
- **Part 2: Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China.** This part illustrates the practical application of ICCCA's framework to generate prioritised adaptation options – the first step towards the development of an adaptation strategy It covers the methodology, results and lessons learnt from applying the framework, as well as the actual outcome from the exercise;
- **Part 3: An Adaptation Strategy for Agriculture in Ningxia, Northwest China.** This part concentrates on the outcomes of applying the adaptation framework to the agricultural sector in Ningxia by presenting the adaptation strategy arrived at through application of the framework.

This report is Part 1 of the series, and sets out the framework used by ICCCA's research team to devise an adaptation strategy for Ningxia's agricultural sector. This framework was developed in light of the increasing strategic emphasis placed on adaptation at a national and regional level, and to help address the many questions that remain about how to carry out effective measures on the ground.

There are a number of adaptation frameworks in existence. ICCCA has drawn on, for example, work undertaken by the UK Climate Impacts Programme (UKCIP) and AEA; the ORCHID approach developed by the Institute for Development Studies (IDS) and UEA; and the OECD's *Stocktaking of progress on integrating adaptation to climate change into development co-operation activities*.<sup>2</sup> These existing frameworks tend to have similar features and are usually presented as being generic and applicable in any context. The project team drew on these frameworks and in consultation with numerous stakeholder organisations developed a framework more suitable for the task at hand – the development of an adaptation strategy for agriculture in the region of Ningxia. However the process described here should be a suitable means to help decision-makers in other parts of China structure their thinking about adaptation and to start to develop their own adaptation strategies.

Following the framework described in this document will not lead directly to the implementation of adaptation actions, but the framework identifies a number of necessary key stages and highlights the likely resources needed at each stage of the process.

<sup>2</sup> See also: "Climate adaptation: Risk, uncertainty and decision-making" (Willows & Connell, 2003).

The stages are:

- Stage 1: Assessing the climate risk
- Stage 2: Integrating regional development goals and adaptation goals
- Stage 3: Identifying adaptation options
- Stage 4: Prioritising options
- Stage 5: Implementing and demonstrating
- Stage 6: Monitoring and evaluation

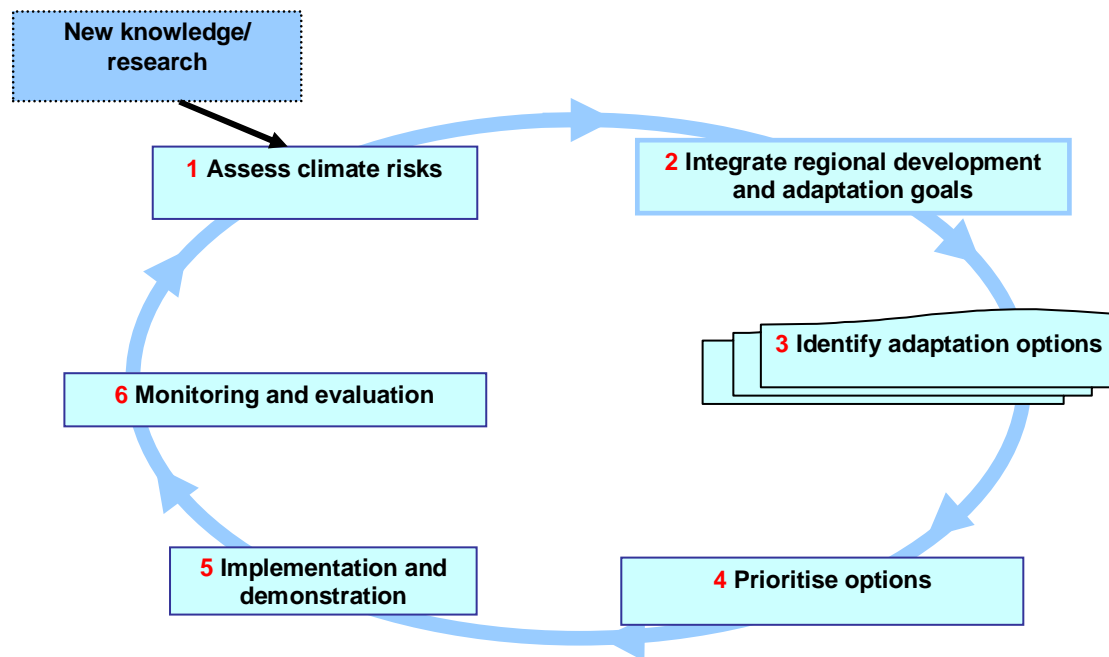
The framework does not prescribe a time frame as resources and requirements will differ from case to case. The framework also does not necessarily have to be followed in sequential order as different organisations may be at different stages in their consideration of vulnerability and adaptation.

## 2 ICCCA's Adaptation Framework

The key features of ICCCA's framework on adaptation to climate change are as follows:

- The framework consists of six steps or phases;
- The framework is iterative (represented diagrammatically as a closed circle) and this encourages learning from implementation of adaptation in the field (Stages 4 to 6) by using feedback to review and adjust adaptation options and priorities;
- Its iterative nature also encourages continual engagement of relevant local stakeholders to help identify and monitor adaptation activities;
- Through its encouragement of continual engagement of local stakeholders and institutions, the framework helps enhance understanding and awareness about climate change, and to build capacity for adaptation implementation;
- The successful application of the framework relies on certain information being made available. This includes, *inter alia*, climate projections for the jurisdiction under consideration and a basic understanding of local vulnerabilities to weather events;
- Following the process outlined by the framework should enable decision-makers to identify what information is needed to develop an adaptation strategy, which can be subsequently refined at implementation.

Figure 2.1 ICCCA's adaptation framework



### Stage 1: Assess the climate risk

Before developing an adaptation strategy, it is necessary to identify the climatic features of the region under consideration and assess how these might change under projections of climate change. This can help decision-makers to start to understand the potential impacts of climate change. There are many ways this can be achieved. A risk-based approach (which focuses on the risks from the projected impacts of climate change in the future) may be complemented by a vulnerability-based approach (which focuses on how systems are currently vulnerable to weather events and increasing climatic variability). This can give individuals and organisations a means of thinking about future climate change impacts through a consideration of how they are currently affected by climate and weather events.

There are a number of ways to assess climate change risks and current vulnerabilities. The most appropriate method depends on the needs and availability of resources in each particular case. The case study for Ningxia (See the ICCCA report *Part 2: Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China*, Ju Hui et al., 2008d) used a combination of vulnerability approaches and risk-based approaches: vulnerability was examined by interviewing stakeholders (rural communities and government departments) about how they are affected by climatic variability and weather extremes; future climate risks were assessed by reviewing climate change scenarios and potential impacts.

### Stage 2: Integrate regional development and adaptation goals

Every sector or region has its own mid- to long-term development plans, many of which will be inevitably related to the weather and climate. Development plans may influence the prospect for adaptation in a positive or negative fashion. Once current vulnerabilities and potential impacts from climate change are assessed, it is important to clarify the goals that adaptation seeks to achieve: what is the aim of adaptation in this region and sector? This will be closely related to the aims of the institution(s) concerned, and will inform the suitability of measures for implementation. For instance, joint consideration of near or mid-term development goals and climate change projections may enable an analysis of what the impacts of climate change might be on the ability to achieve development targets in a specific region or area.

The criteria for identifying and defining the adaptation strategy's objectives should be developed in consultation with the stakeholders who will be responsible for the strategy and its implementation; organisations and communities may be more inclined to take a strategy forward if they have been involved in its development. It is quite likely that different stakeholders will identify different objectives for different regions and sectors.

### **Stage 3: Identify adaptation options**

This stage of the process looks at identifying potential adaptation options that will address the risks identified at Stage 1. Initially, this may include a wide range of options, some of which may already be in place for reasons other than adaptation to climate change. Certain measures, however, may rely on new technologies. This step will require consultation with relevant stakeholders and expert guidance on how to interpret climate risks and identify relevant adaptation options.

### **Stage 4: Prioritise options**

The wide range of possible adaptation options is narrowed down to a set of options that are practical. Here, using the objectives and criteria identified in Stage 2, consideration should be given to which options best meet the needs of the strategy.

In practice, this stage may be conducted simultaneously with the identification of options (Stage 3): as options are identified, they will generally be discarded, taken forward or shelved for future consideration. However it is important to fully document and justify why particular options have been prioritised above other. The relevant stakeholders should be involved in this assessment and approve of the outcomes.

Different stakeholders may have different perspectives on what is appropriate. Similarly, implementation capacities may vary from one stakeholder to the next. Option appraisal will depend strongly on the institutional context. One possible way of proceeding is to consider options in light of whether they are 'win-win' (i.e. multiple benefits), 'no regrets' (i.e. options whose benefits outweigh the costs irrespective of the magnitude of climate change) or 'low regrets' (i.e. options that have a low cost now but might provide considerable benefits in the future).

In the particular case of Ningxia (see *Part 2: Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China*, Ju Hui et al., 2008d), Multi Criteria Analysis (MCA) was used to rank different options. The analysis considered a range of factors such as win-win options, cost effectiveness and adaptive flexibility. These criteria – or indeed, this level of detail – may not be appropriate for all situations: the exact details will need to be adjusted to suit the particular jurisdiction and sector under consideration. For more details on ICCCA's case study in Ningxia, please refer to Part 2.

Stages 1 to 4 are primarily about developing a strategy for action.

### **Stage 5: Implementation and demonstration**

Once adaptation options have been identified and prioritised, then implementation can begin. The timing of implementation will depend on the nature of the organisation, the type of adaptation required and the nature of existing plans, policies and strategies.

Certain techniques and methods of adaptation may require a degree of trial-and-error or experimentation and in such cases demonstration projects can be a useful means of (1) evaluating performance and (2) giving local stakeholders a sense of what adaptation might look like on the ground and in practice. However, this may not be applicable to 'softer' adaptation initiatives such as new policies or regulation.

**Stage 6: Monitoring and evaluation**

Evaluating and reviewing the adaptation strategy are crucial activities. The exact time when monitoring and evaluation is to be carried out depends on the planning model and system used by the institutions involved. This could, for instance, be made to coincide with existing planning horizons. Certain activities should be undertaken in addition to any evaluation or review of options. For example, consideration should be given to any scientific advances as they occur and to new and/or updated datasets as they become available. The review process should include all relevant stakeholder organisations to ensure that both the strategy designers and implementers participate in the process.

### 3 Conclusions

ICCCA's adaptation framework presented has much in common with other frameworks of a similar kind. They all share a common ambition: making it easier for decision-makers to consider the impacts of climate change on their area of responsibility and present a means for identifying and prioritising action.

Drawing on a number of frameworks from different contexts the project team developed a tailored approach to help guide the development of a regional and sectoral adaptation strategy in Ningxia. The experience of the project team was that the framework was a very useful method for raising awareness amongst stakeholders and it provided a structured approach to a complex and in many ways novel problem for regional decision-makers in Ningxia.

While local conditions will vary, at a strategic level the framework provides a straightforward, flexible and useful model that should be easily transferable to other sectors or jurisdictions both within China and elsewhere.

The purpose of presenting a framework is not to be prescriptive (the approach presented here is by no means the only possible way of developing an adaptation strategy) but rather to illustrate how ICCCA structured its approach to adaptation and to suggest the steps and resources required in order to develop a strategy and to move towards implementation.

For further details about how the framework was used to address adaptation in Ningxia's agricultural sector, please see ICCCA's report *Part 2: Application of the Adaptation Framework: A Case Study of Ningxia, Northwest China*.

For the particular details of the adaptation strategy designed through the application of the framework, please see *Part 3: An Adaptation Strategy for Agriculture in Ningxia, Northwest China*.







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