VIEWpoint 新观点

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Risks to food security in China under climate change

Briefing Note

A briefing on research from the Climate Science for Service Partnership (CSSP) China for decision-makers in China No. 03

The CSSP China project is investigating how climate change will affect agricultural systems in Northeast China. This research will be used to create accessible climate information which can be used to help Chinese government officials, industry and the public to make climate-informed decisions in the near and long-term future.

Drought is the dominant climate-related hazard affecting agriculture in Northeast China. China produces 30% of the global maize supply, and 30% of this is grown in the Northeast Farming Region (NFR), making it a critically important region for national production. Assessing drought characteristics over recent decades can help to improve our understanding of the large-scale climate drivers of drought and the relationship between drought and maize yield. Understanding these processes will enable the impacts of drought events to be better understood in the future.

How can this work on food security help to support decision-makers?

The China Meteorological Administration (CMA) and the Met Office are investigating climate-related risks to food security. This information will help those making decisions about agricultural and food systems in China to plan on annual to decadal timescales. For example, understanding the current and future risk of drought in the NFR will help local government and farmers determine what measures could be taken during times of water shortages to prevent a poor harvest.

This work supports the agricultural risk management priority outlined in the China Framework for Climate Services (CFCS). Ultimately, understanding the links between climate and crop yield will help inform decisions, creating a more productive and resilient agricultural industry in China.

New findings from CSSP China

The CSSP China project has provided a platform for scientists in the UK and China to develop models and scientific tools to understand the impact of climate change on life in China and worldwide. There are three main areas of research being developed for food security:

1. **Modelling extreme weather events** - Using the latest climate models, extreme weather events can be simulated that could feasibly occur in reality but have not yet been observed. This new method is called UNSEEN (UNprecedented Simulation of Extremes with ENsemble) and creates a collection of virtual observations using state-of-the-art climate models. This information can help communities build climate-resilient agriculture and food systems.
2. **Crop responses to extreme weather** - Observations and climate models are used to understand how crops are affected by changes in temperature and rainfall. Research has found that changes in the strength of the jet stream affect growing conditions for maize across North and Northeast China (Kent et al. 2019). This research could be used to develop a seasonal maize forecast which could help implement strategies for maximising crop yield.
3. **Satellite mapping of crop risks** – Crop stress can be monitored using images from the Copernicus Sentinel satellite data. This information can be used in combination with observational weather data to develop crop warning systems, potentially in the form of a mobile app.

Figure 1: Droughts affecting maize in Liaoning Province, 2020 (sina.com)

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Produced by VIEWpoint, a CSSP China project from the Institute for Environmental Analytics, highlighting research and improving the uptake of climate services developed in the partnership, through accessible resources.

Institute for Environmental Analytics

SUSTAINABLE DEVELOPMENT GOALS

China is the world's largest agricultural economy and one of the top global food producers, accounting for ~18% of the world's cereal grains, ~29% of the world's meat and ~50% of the world's vegetables (Ghose. 2014). Food security is one of the main goals of China's agricultural policy (Huang and Rozelle. 2009). Understanding the risks facing the food and agriculture system can help decision-makers develop long-term plans.

The following questions are important to consider when assessing climate risks to the agricultural system:

- What are the key climate hazards that affect the food system?
- How might these hazards change in the future?
- How can information about present and future climate help decision-makers to build a more resilient food system?

Why focus on the Northeast Farming Region?

The NFR accounts for ~30% of Chinese maize production yet maize grown there is particularly sensitive to climate-driven hazards, such as drought, because it is predominately rain-fed.

Drought is the dominant cause of climate-related disasters in the region leading to a loss of agricultural production (Figure 3). Unexpected decreases in maize yield will not only cause huge economic losses, but will have negative impacts on prices, trade and national and global food security.

Collaboration between the Met Office and CMA has demonstrated the need for adaptation and mitigation measures to reduce the impact of climate change on the NFR. CSSP China aims to co-develop climate services with decision makers in the NFR to help them manage risk.

What are risks to food security?

Drought is a major risk to agriculture in Northeast China (Boxes 1&2), the impact on crops can be devastating and depends on a range of factors such as severity, duration, area and frequency, as well the crop type and stage of growth.

Severe droughts, as seen in 2014, (Box 1) have had large-scale impacts on agriculture and on the livelihoods of people in China. Research in CSSP China aims to build on existing knowledge to improve the understanding of droughts and drought risk in China.

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Box 1: CASE STUDY - Severe drought in Liaoning, July and August 2014

In July and August 2014, seven provinces in North China experienced a severe drought. For some areas, it was the most serious drought since 1951 (Wang and He, 2015).

Northeast China had considerably less rainfall during these summer months, affecting Jilin and Liaoning. Figure 2 shows how total water resources in Liaoning (grey) were significantly lower in 2014 than in previous years.

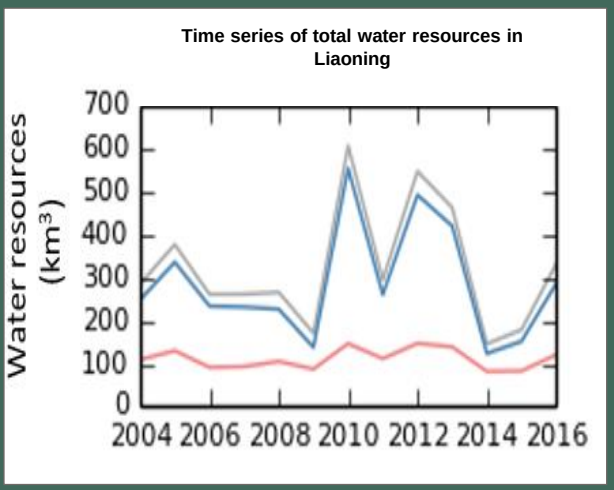

Figure 2: Time series of total water resources by province (grey, km³), and the contribution from surface water (blue, km³) and groundwater (red, km³). Source: National Bureau of Statistics in China.

News articles reported that Liaoning authorities had 'mobilized more than two million people' and 'invested 592 million yuan' in response. A national drought relief emergency response was triggered by the National Committee for Disaster Reduction and the Ministry of Civil Affairs. The local government started emergency water projects, including dispatching water tankers, cloud seeding to induce rain and digging wells to find alternative sources of water. Despite this, the 2014 drought caused maize production to decrease by ~4 million tons (approximately 5% of total maize production) (Wang et al. 2020).

It demonstrated how severe weather events can impact food security and livelihoods. Information and knowledge gained from collaborative research and partnerships are vital to help inform decisions and prepare for future climate change.

Under current climatic conditions, there is a 5% chance each year of a drought occurring (Kent et al. 2019) which is larger in area than any previously observed event (Box 2). Agriculture accounts for nearly 65% of all water usage in China, including both surface and groundwater sources (Pope. 2017). Research conducted by CMA and the Met Office predicts there could be an increased water requirement for maize irrigation by the middle of the century which will increase the risk of extreme water shortages in the NFR (Xu et al. 2019). These water shortages are projected to occur mid-season, an important developmental time for the maize crop. Improving irrigation in the region will be crucial to sustain current maize yields.

How can the region adapt?

Using the latest research findings from CSSP China, farmers, policymakers, scientists and the agricultural industry are creating tools to deliver relevant climate information. These tools will be tailored to decision-makers and will help advanced planning for actions such as irrigation and adjusting the crop calendar.

Maize Harvest
Pixabay.com

“Understanding the climate risk to food production is a vital part of building resilient and sustainable food systems. We are working with partners in China to understand how maize production can be affected by drought and flood conditions both now and in the future. The aim is to develop a skilful seasonal forecast system which will give early warnings, allowing farmers and decision-makers to better prepare for these hazardous events.”

- Dr Edward Pope

CSSP China Scientist, Met Office

Box 2: Unprecedented Events in the Current Climate

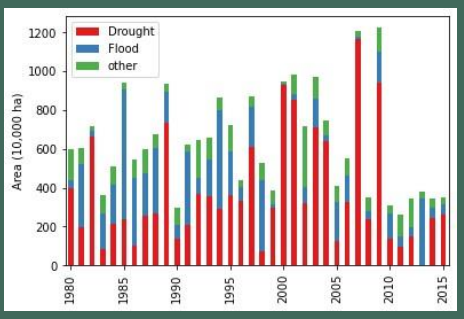

Figure 3: Reported area affected by drought, floods, and other hazards across cropland in the NFR where droughts are the main hazard.

Droughts are the dominant hazard in the Northeast Farming Region (Figure 3), a key area for maize growth.

CSSP China researchers used a number of climate models, with slightly different starting conditions, to generate a dataset of thousands of simulations of the current climate (Figure 4 – grey lines). These model runs produce 80 times as much data as the equivalent observational dataset (1981-2010) (blue line). This helps scientists understand the variability of the current climate and improves knowledge of extreme climate events, such as droughts (red dots).

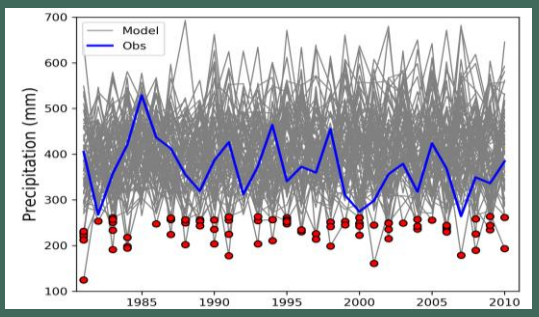

Figure 4: Climate model runs of precipitation (grey lines) compared to precipitation observations (blue line) over the NFR 1981-2010. Red dots highlight results that showed a record low precipitation. In total the model produced 81 record dry events (Kent et al. 2019).

This research shows there is a 5% annual chance of a drought occurring which is greater in area than any previously observed (Kent et al. 2019). It suggests the expected risk of a major drought is significantly underestimated if based only on the observational record.

The results from these model simulations are also being used to identify key large-scale atmospheric circulation patterns associated with NFR rainfall variability and maize yield. This information could be used to create a climate service which delivers seasonal information to farmers about potential drought risk.

By understanding the current and future risks of record drought events, decision-makers can initiate plans to make the agricultural industry in China more resilient to climate change and create a more food-secure future.

Implications and recommendations for the Northeast Farming Region

Without effective adaptation, the warming climate in the NFR could lead to a reduction in maize yield. Government, the agricultural industry and local farmers need to take action to reduce risk to crops from extreme climate events. These include:

- Engaging in and directing **the development of climate services**, e.g., a seasonal forecast of adverse growing conditions for maize, with users specifying their needs to allow for a more tailored service.
- Assessing current drought exposure and identifying areas with **different levels of droughts risk**.
- Strengthening **intersectoral collaboration** among the emergency management, water, agriculture, and climate sectors for the design of **long-term** irrigation infrastructures, and **short-range** mitigation strategies.
- Issuing guidance for farmers to **benefit from the increasing heat** in a warming climate.
- Estimating crop water requirement **at different growth stages** to optimise irrigation and guarantee water resource amid drought events.
- Developing **more efficient irrigation technologies** and **motivating more efficient use of water resources** by adopting incentive-based approaches, e.g., water rights transaction across different households and sectors (Di et al.2020; DRCMWR, 2018).

Next steps

Working with agricultural experts in China, the Met Office can design tools to deliver the information users need to make climate-conscious decisions. The Met Office wants to learn about the choices that are made about crops, farming and food sales, and will share information about current and projected future climate in the Northeast Farming Region. By working together, the Met Office, CMA, businesses, and local communities can help to create a more resilient and food secure future for China. Scan the top QR code (below right) to contact the Met Office on WeChat.

"The drought events will not only directly impact the productivity but could also harm the agriculture by inducing pest disasters, etc. An advanced seasonal forecast of drought events could benefit mitigation strategy planning, as emergency supplies are needed in response to such disasters."

- Yanhua Wang
Agricultural expert, CIECC

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