AIRCURRENTS

INTRODUCING A CROP LOSS MODEL FOR CHINA

Editor's Note: AIR has applied its award-winning Agriculture Weather Index (AWI) technology to develop a multiple peril crop insurance (MPCI) model for mainland China that will be available in the fall of 2011. This article explains the need for such a model and how AIR's innovative approach overcomes some of the challenges in the objective assessment of the impact of weather on crop yields.

10.2011

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INTRODUCTION

Last winter, large portions of mainland China were in the grips of a prolonged drought, one of the worst in decades. Beginning in October 2010, the North China Plain, the main production region for wheat, suffered from significantly below average precipitation, which affected more than 5 million hectares of cropland across eight provinces. The drought threatened both winter wheat harvest and spring wheat planting, and commodity futures responded sharply to the possibility that China—self-sufficient in wheat in normal years—would need to import from global markets in 2011.

Fortunately, decent amounts of rain and snow in late February and early March, which—along with a massive irrigation effort undertaken by the government—largely eased fears of a wheat crisis. However, later in the year, drought conditions returned, this time to southern China in the middle and lower reaches of the Yangtze River valley. Complicating matters further, these conditions were followed by deadly floods. How final crop yields will be affected remains to be seen.

Numerous other adverse weather episodes in recent years—including a severe drought in 2007 and massive floods in 2008—highlight not only the potential global ramifications of an output shortage from one of the world's largest agricultural producers, but also the intense vulnerability of rural households. In the past five years, the government has sought to dramatically increase the availability of insurance protection to China's 300 million farmers.

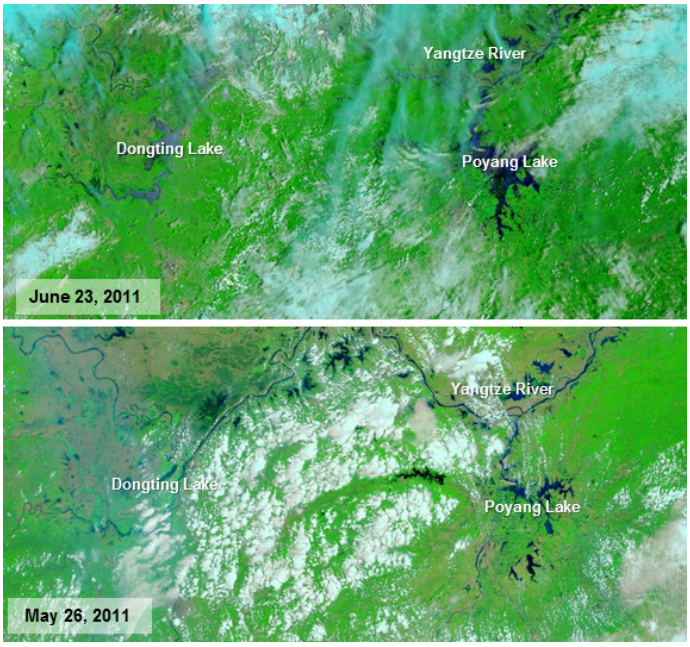

Figure 1. In June 2011, deadly flooding on the Yangtze River came after months of devastating drought. These satellite images show significant flooding (top panel) on two lakes along the Yangtze compared to the same view one month earlier (bottom panel), before the floods began. (Source: NASA Earth Observatory)

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FLOODS, DROUGHTS, AND TYPHOONS MAKE CROP PRODUCTION UNCERTAIN

China's vast expanse and complex topography result in extremely diverse climates, ranging from subtropical to subarctic. Temperature and precipitation levels vary widely from region to region, as do farming practices and crop types. One factor in common across all of China is susceptibility to natural hazards. The massive basins of the Yangtze and Yellow Rivers in the central and southern regions are subject to devastating floods that have caused much misery and loss of life for centuries. In the southeast, crops flourish in the warm humid air and fertile soil, but landfalling typhoons here can bring torrential rainfall hundreds of kilometers inland. And in the semi-arid northeast, precipitation is uncertain and droughts can be long and severe.

Despite its large size, only about 15% of the total land area in China can be cultivated. An overwhelming majority of farming operations are small entities, with average holdings of less than a hectare. Add to this the reliance on natural precipitation and agriculture's multi-season production cycle, China's farmers are extremely vulnerable to weather variability.

Weather variability is responsible for most of the overall variability in crop production. From 2003–2009, losses to grains from natural disasters totaled more than 300 million tons according to the Chinese Academy of Agricultural Sciences (CAAS). Drought and flood, the top two hazards (see Table 1), cause an annual loss of approximately 125 billion CNY.

Table 1. Share of losses by peril (Source: World Bank 2007)

Weather Event	% Crop Loss
Drought	52%
Floods	28%
Hail	10%
Cold, Frost & Freeze	6%
Typhoons (tropical cyclones)	4%

China ranks first in the world in the production of 45 agricultural commodities, including paddy rice, wheat, and cottonseed. With a population of 1.3 billion, it is also the top consumer, and food security has always been a great concern—a situation made more salient by rapid urbanization since the 1980s, which created a sizeable gap in wealth between cities and the countryside. Inconsistent crop production can create income instability and civil unrest in the countryside, mass influx of migrant workers into industrialized areas, as well as the possibility of food shortages nationwide.

Recognizing the importance of more balanced growth and social welfare, the government has shifted focus to rural development since 2004. One primary goal—espoused in numerous directives, including the government's 12th Five Year Plan that guides China's economic development from 2011 to 2015—is to improve rural incomes by increasing the affordability and availability of crop insurance.

DRAMATIC GROWTH OF THE INDUSTRY IN RECENT YEARS

Crop insurance has been in existence since the 1930s in mainland China, but it was not until the last decade that it started to gain traction with the significant support from the government. Following the success of pilot programs in several provinces that began in 2004, the government has accelerated its commitment to building a sustainable agriculture insurance infrastructure by providing substantial premium subsidies, improving the legislative and regulatory framework, and establishing risk diversification mechanisms.

As a result, participation has risen dramatically in the past few years and agriculture insurance has become the fastest growing sector in China's insurance industry. Premiums in 2010 totaled more than 13 billion CNY, up from less than 1 billion CNY in 2006 (see Figure 2).

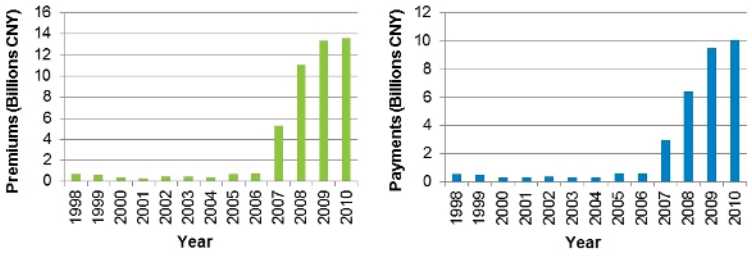

Figure 2. Dramatic growth in both agricultural insurance premiums and payments over the last decade. (Source: CIRC)

While crop insurance is now offered across all provinces and for many crop types, participation remains relatively low because many challenges remain in the pricing and administration of insurance products and in effective risk diversification. Risk management awareness among farmers is still limited, and there is much room for growth and innovation.

CHALLENGES IN MODELING CROP LOSS IN CHINA

Because droughts, floods, and typhoons can affect vast areas of farmland, there is an ever-present potential for catastrophic losses and thus a strong need for a robust risk transfer system. The China Insurance Regulatory Commission (CIRC) requires insurers to pay claims quickly, so insurers need ready access to large capital reserves that are usually supplied through reinsurance. However, objective assessment of weather risk—a primary concern of prospective and existing participants in the Chinese crop insurance market—presents many challenges.

One such challenge is the lack of high-resolution data on agricultural production, weather and yield, and the very short record of loss experience data. Even were such information available, constantly changing exposures and the still evolving nature of crop insurance programs limit the applicability of using historical data for estimating potential future losses.

In addition, China's diverse climate zones mean that regions are becoming increasingly specialized in certain crops. Unlike the multiple peril crop insurance (MPCI) program in the United States, which is centrally regulated and priced by the government, crop insurance policies in China can differ by province depending on crop types, farming methods, and regional perils. And whereas crop loss in the U.S. is determined solely based on yield (and price, for revenue-based policies) at harvest time, regardless of what weather factors contributed to the yield, indemnity in China can vary based on stage of plant growth and even by peril. Thus, policy conditions require explicit modeling of individual events, rather than just yield outcomes.

APPLYING AIR'S INNOVATIVE APPROACH

Drawing on experience in modeling crop loss in the United States, AIR has developed an MPCI model for China that leverages AIR's award-winning Agricultural Weather Index (AWI) to overcome the challenges mentioned above. The index takes into account weather variables (like precipitation and temperature), soil conditions (like available water capacity, surface moisture, and runoff) and crop-specific parameters (like requirements at critical stages of crop growth, planting and harvesting dates, and resiliency to adverse weather conditions). These variables are used in a water balance model that correlates the amount of water available to crops during the growing season with how much water the particular crop requires.

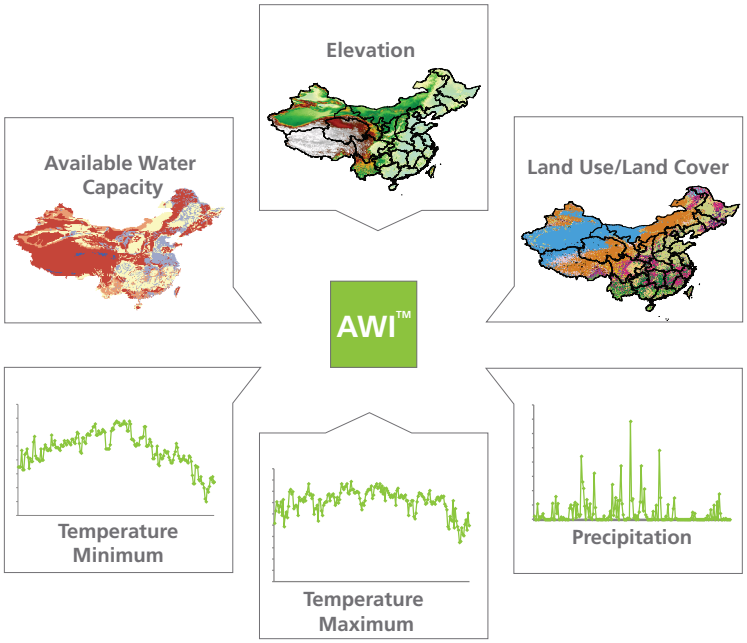

Figure 3. The AWI takes into account high-resolution temperature, precipitation, and land use/land cover data, along with crop-specific agronomic data.

The AIR MPCI Model for China also incorporates a run-off routing model that accounts for precipitation from large-scale systems, severe localized convective storms and typhoon-induced precipitation. The model leverages AIR's Asia-Pacific Typhoon Model to simulate wind damage from typhoons. No country in the world experiences more tropical cyclones than China, with an average of nine landfalls per year. Even typhoons with relatively low wind speeds can be accompanied by catastrophic flooding. Rainfall can persist for several days after landfall and farmland hundreds of kilometers inland can be inundated as typhoons transition into extratropical systems.

To route precipitation run-off and snowmelt through China's river networks and basins, the model uses a high-resolution digital elevation model and takes into account the soil water balance and seasonal variations in river water levels. This run-off calculation indicates where losses can occur, both within the floodplain as well as off the floodplain.

The AWI is used to generate a large stochastic catalog of loss-causing droughts, floods, and typhoons that accurately reflects the severity, frequency and location of potential events. The catalog also correctly preserves the timing of events during the season as well as geographical correlations in losses. While some events may not cause catastrophic losses across the country, regional losses at the province level—at which most insurance programs are administered—can be very severe.

TYPHOON WINNIE

In 1997, Winnie—one of the most damaging storms in China's recent history—came ashore along the southeastern coast as a weak typhoon and dissipated the following day. However, torrential rainfall continued for several days as the storm's remnants continued moving north. The storm killed more than 300 people, destroyed tens of thousands of homes, and inundated 1.5 million hectares of cropland. Crop losses in Zhejiang, the worst affected province, were estimated at more than 2 billion CNY (in 1997 currency).

ANTICIPATING FUTURE LOSSES

AIR's model gives insurers and reinsurers insight into the severity of potential future events, without relying on inadequate historical loss data. In 2007, a prolonged drought in northeastern China caused devastating crop damage in several provinces. Reported insured losses in Jilin province, one of the worst affected, were 160% of premiums.

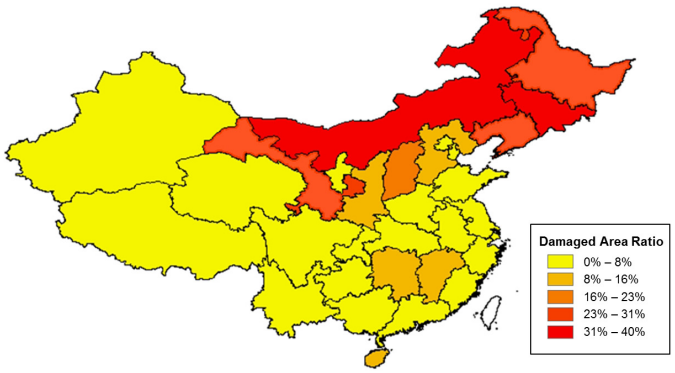

Figure 4. The drought in 2007 caused extensive crop damage to many provinces, especially in the northeast. (Source: National Bureau of Statistics)

AIR's MPCI model not only can provide estimates of what a recurrence of such an event would cause to present day crop exposures, but also can put past events in the context of what can be expected in the future. A repeat of 2007's drought today would incur estimated modeled insurable losses of 1.8 billion CNY in Jilin, a loss ratio of 150%. Based on AIR's model, this level of loss has an annual exceedance probability of 10% (representing a return period of 10 years). While it was a severe event, greater losses are expected to occur in the future. For example, a drought event with an exceedance probability of 5% (representing a 20-year return period)—similar to the drought that occurred in 2000—is expected to cause more than 3 billion CNY of insurable losses in Jilin. Only a fully probabilistic model can consider the impact of severe events with limited historical precedence on current crop exposures and insurance policy conditions.

CLOSING THOUGHTS

The AIR MPCI Model for China leverages industry-leading crop loss modeling experience, in-depth knowledge of China's geography, farming practices, and insurance system, and a thorough grasp of the frequency and severity of potential adverse weather events and resulting crop losses. The model will be updated regularly to include new AWI values based on the latest crop exposure data and loss information, and to reflect the latest changes to China's crop insurance program and policies. Still in its infancy, the market structure for agriculture insurance in China continues to evolve and improve, presenting potentially lucrative opportunities to companies that can achieve an objective understanding of this complex risk.

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 90 countries. More than 400 insurance, reinsurance, financial, corporate, and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, agricultural risk management, and property replacement-cost valuation. AIR is a member of the Verisk Insurance Solutions group at Verisk Analytics and is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www. air-worldwide.com.