



# The Verisk Agriculture Model for China





Participation in China's multiple peril crop insurance (MPCI) program has dramatically increased since 2007, when government-funded premium subsidies were expanded. This growth in insurance penetration, combined with complex and evolving policy conditions, means that insurers can no longer rely solely on historical losses to understand the risk of future losses.

A primary distinction between agricultural insurance and most other insurance lines is the strong geographic correlation of losses to large-scale adverse weather events: in mainland China, extreme weather is to blame for 90% of crop losses. The financial impact is significant; we estimate that a repeat of the 2000 drought would cost crop insurers more than CNY 20 billion (USD 3 billion) today. Thus, to quantify the potential gains and losses to a crop insurance portfolio, we must quantify the impact of weather.

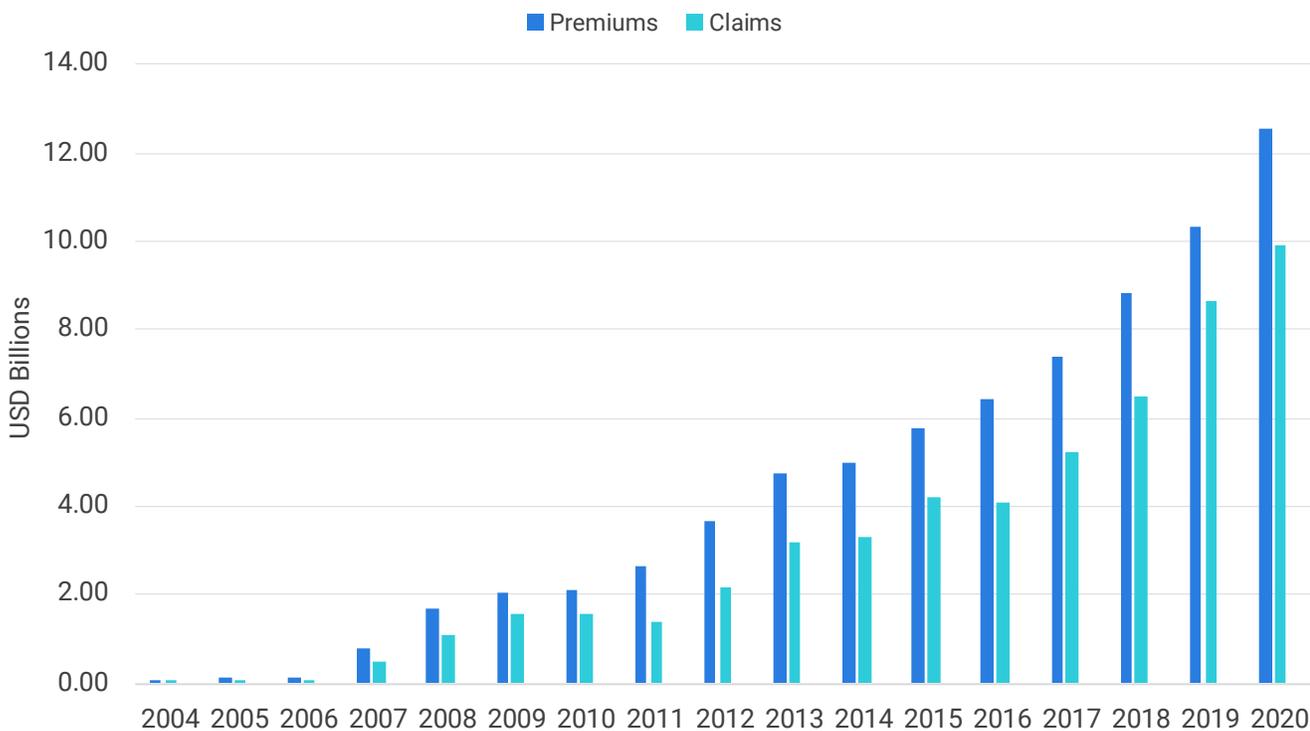
Of course, agriculture goes beyond crop farming. China is a leading global producer of wood and paper products. Policies for livestock (including poultry) now make up nearly 40% of the country's agricultural premiums and have a large potential for losses. Companies must consider the risk to crops, forests, and livestock to get a comprehensive view of agricultural risk in China.

The model captures both abiotic and biotic stresses, including the effects of drought, flood, wind, cold, and heat stress on crops; the effects of fire and other perils (wind, pests, disease, and rodents) on forests; and the effects of weather (drought, flood, wind, cold, snow, and heat) and disease on livestock.

## The Verisk Agriculture Model for China

In 2011, Verisk leveraged its considerable experience and success in modeling MPCl portfolios in the United States to develop its first model for mainland China. The Verisk Agriculture Model for China captures the severity, frequency, and location of drought, flood, wind, cold, and heat events nationwide, covering over 90% of weather-related crop losses. In addition, it models forest losses due to fire, wind, pests, disease, and rodents, as well as livestock losses due to weather and disease.

Regular model updates ensure that the latest available weather, exposure, and policy condition information are reflected. Verisk incorporates new exposure data from the China Statistical Yearbook and new policy condition information from the industry into each update. The most recent version of the model provides a 10,000-year stochastic event catalog and a historical event set from 1981 to 2021.



**The growth in both premiums and claims arising from China's agriculture insurance program highlights the importance of modeling the impact of adverse weather events on China's agriculture. (Source: National Bureau of Statistics of China, China Banking and Insurance Regulatory Commissions)**

## Applications for the Verisk Agriculture Model for China

Agricultural insurance and reinsurance evaluations are performed in Verisk's Touchstone Re™ software. Users can generate custom results by applying peril and line-of-business filters and adjusting premium rates and sum insured per mu. Agriculture insurers can evaluate alternative strategies regarding expected profit versus potential risk. Reinsurers can price excess-of-loss and quota-share programs and manage their entire portfolio.

Agriculture programs are evaluated by applying each of the 10,000-year catalog outcomes and determining the insured retained loss. The probability distribution of total losses across the 10,000 simulated outcomes measures the risk of loss. The result is expressed in terms of an exceedance probability distribution, characterized by the average (expected) annual gain/loss and losses at selected exceedance probability (EP) levels, such as 10% (10-year return period), 5% (20-year return period), 1% (100-year return period), and 0.4% (250-year return period) exceedance probabilities.

The average annual loss (AAL) in the exceedance probability (EP) curve reflects historical loss ratios in China's agriculture insurance market. "Tail" events with large return periods, such as major droughts, flood, or wind events, can produce losses that far exceed the average, especially when a single province or locality is evaluated.



## Model coverage

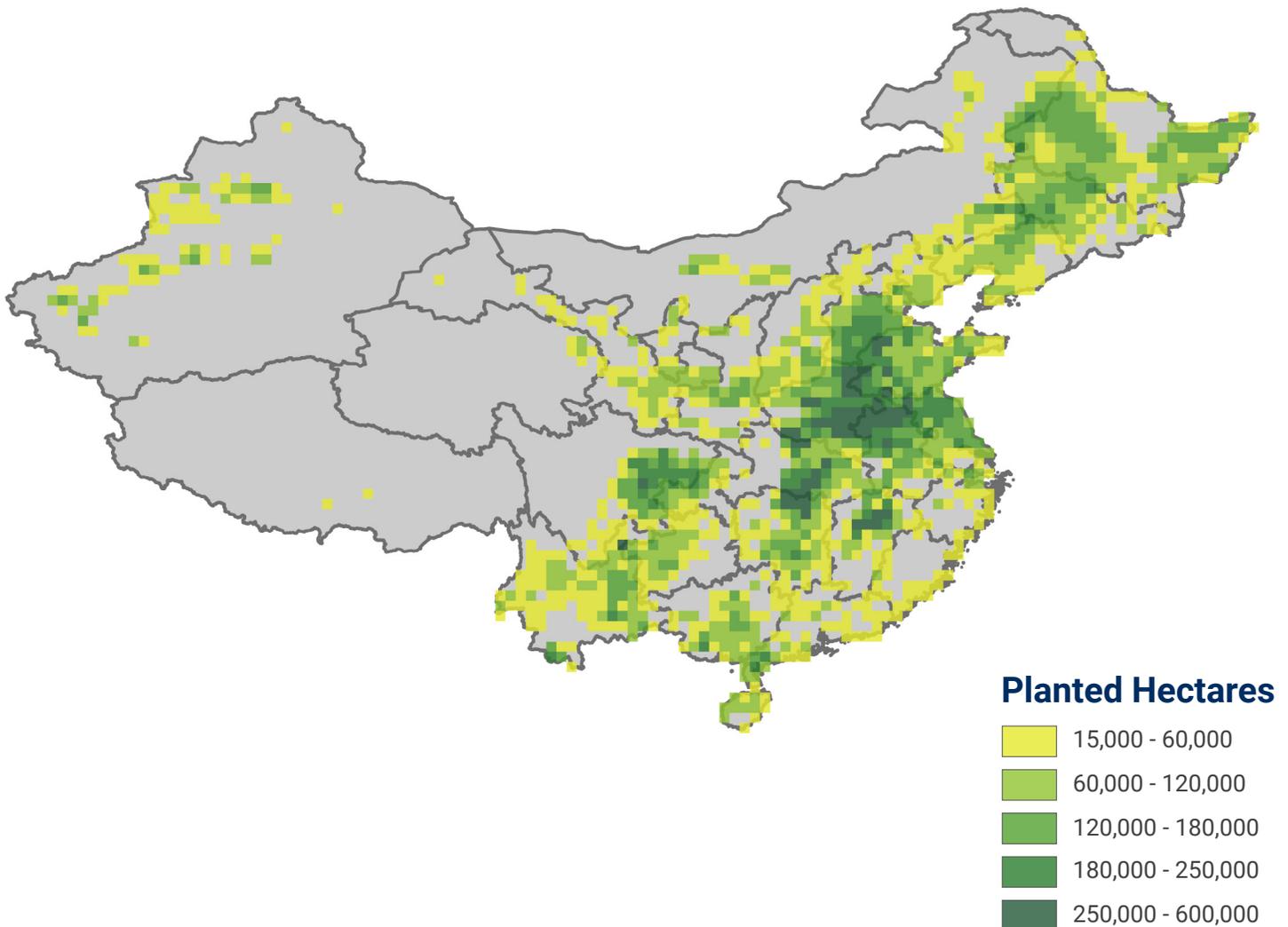
### Crop

The Verisk Agriculture Model for China estimates damage to all crops with federal subsidies for insurance premiums and includes barley, corn, cotton, fruit, peanut, potato, rapeseed, rice, rubber, soybean, sugar (cane and beet), tobacco, and wheat – the country's major crops.

The severity of crop damage and the resulting insured losses can vary depending on which phase in the growing season an extreme weather event occurs. Insurance policy conditions in China cover crop production costs up to the time of damage; thus, payouts are directly correlated to the crop's stage of development. Farmers have invested limited time and money at the start of a crop's growing season, so if an extreme weather event occurs in the early stages, the potential losses to the insurer are limited. As the season continues, the potential for insured losses increases.

Policy conditions vary depending on crop type, peril, and province; the Verisk Agriculture Model for China was built to accommodate these complex policy conditions.

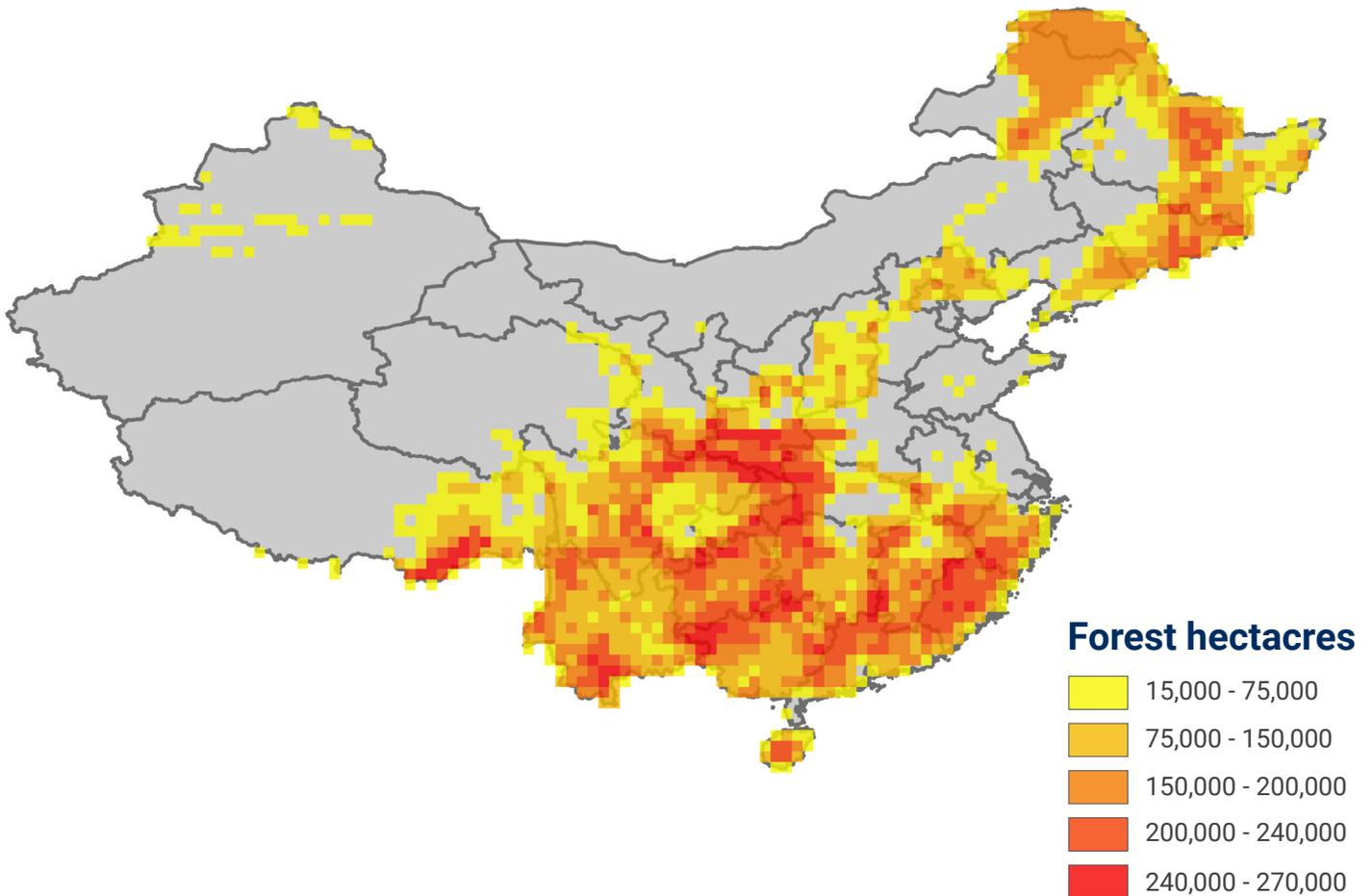
### Planted area in hectares in the model domain:



## Forest

Nearly 23% of China is forested (220 million hectares), producing 102,570,000 cubic meters of timber. While forested land is present in all regions of China, most forest exposure can be generalized into categories. Forests in northeastern China are boreal, dominated by conifers and deciduous hardwood, and mostly native species. In contrast, forests in southern China are sub-tropical and dominated by non-native monoculture farms (mostly eucalyptus) planted for commercial purposes. The Verisk Agriculture Model for China estimates damage to all forest types from biotic (pests/disease/rodents) and abiotic causes (fire, wind).

### Forest exposure in hectares in the model domain:

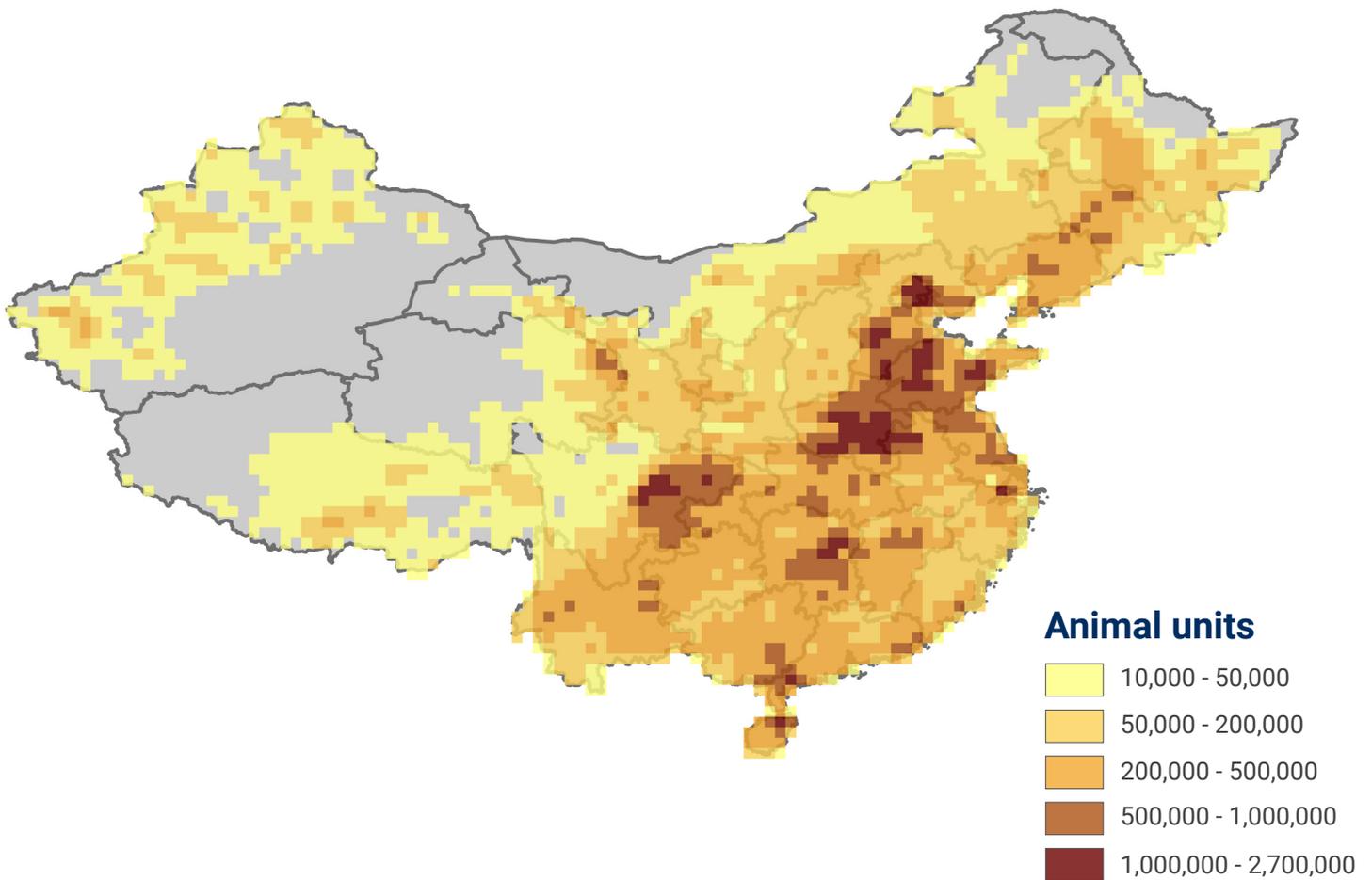


## Livestock

The Verisk Agriculture Model for China estimates weather and disease losses to livestock, including all livestock types with federal subsidies for insurance premiums: dairy cattle, other cattle, breeding sows, other pigs, poultry, and sheep/goats. Livestock death rates due to extreme weather are estimated by leveraging the model's weather events that impact crops and forests. The frequency and severity of disease outbreaks for livestock (including poultry) in China are modeled from data from the World Organization for Animal Health and recent historical events.

Because China is the world's leading producer of chickens, pigs, goats, ducks, and sheep, and the fourth-largest producer of cattle in the world by head, the potential for livestock losses is considerable. For example, an outbreak of African swine fever—a highly infectious and deadly disease—that began in 2018 in China resulted in a loss of half of China's 400 million pigs, or 40% of the world's total agricultural pig population, as of the first half of 2020.

### Animal exposure in units in the model domain:



## Leveraging local data amid a highly variable climate

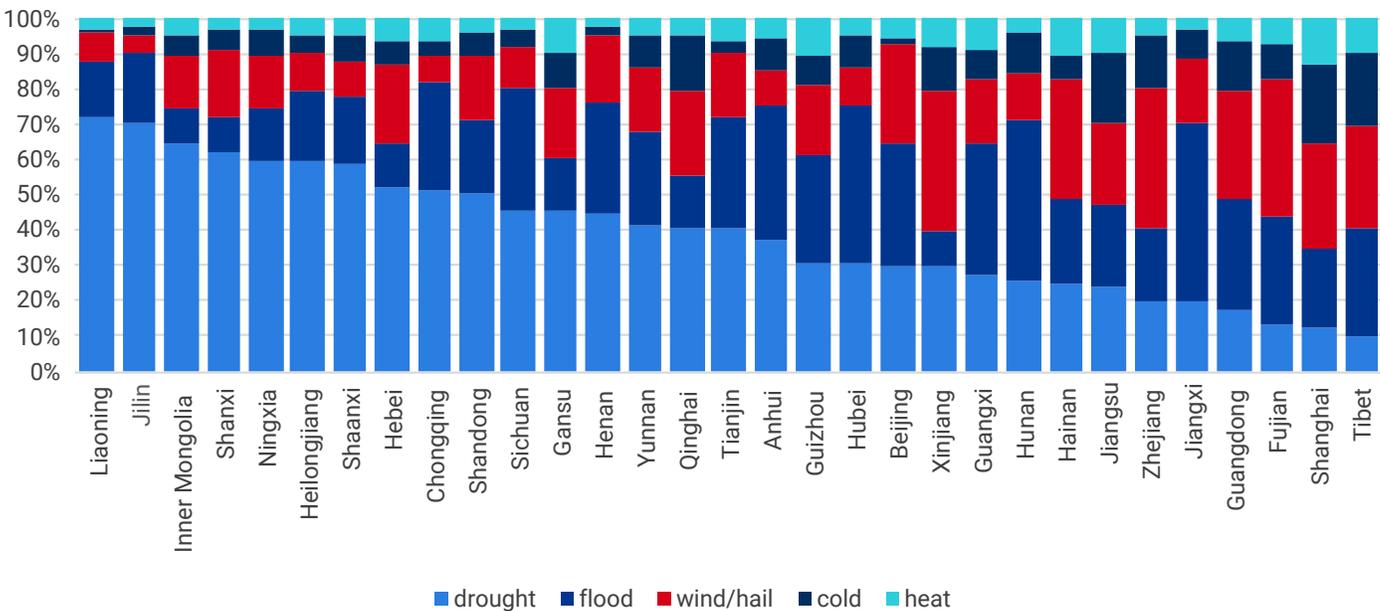
Mainland China has multiple climatic zones, ranging from subtropical to subarctic. The land is also subject to a wide range of weather events that the Verisk Agriculture Model for China covers:

- Crop – drought, flood (due to excessive local precipitation, the runoff from more remote precipitation, and/or snowmelt), wind, cold, and heat
- Forest – fire, wind, and pest/disease/rodent
- Livestock – weather and disease

The model also captures the geographic variation in weather (for example, drought is more common in the arid north and west) and their different impacts (such as dehydration in case of drought or crop rot in case of flood). Figure below shows the degree to which the importance of different perils to crop loss varies across the model domain.

Because perils can be correlated in complex and non-linear ways, the model uses a single, unified weather catalog for all modeled lines of business and weather-based perils. To create a comprehensive 10,000-year catalog of simulated weather events, Verisk scientists collected data on historical weather and disease events from various agencies, such as the U.S. National Oceanic and Atmospheric Administration and the National Bureau of Statistics of China. Daily temperature, precipitation, and wind speed data at high spatial resolution were also analyzed, and all this information was coupled with data on soils, terrain/elevation, and the spatial distribution of land cover types.

**Average (1981-2020) Verisk-modeled percentage of crop losses due to individual perils by province:**



## Creating new scenarios from historical data

Historical flood, drought, snow, wind, cold, and heat events form the basis for generating the events in the model’s catalog of simulated events. By perturbing the growing conditions experienced during the historical years, a catalog representing a wide range of outcomes is produced—each equally likely but with potentially very different implications for insured losses.

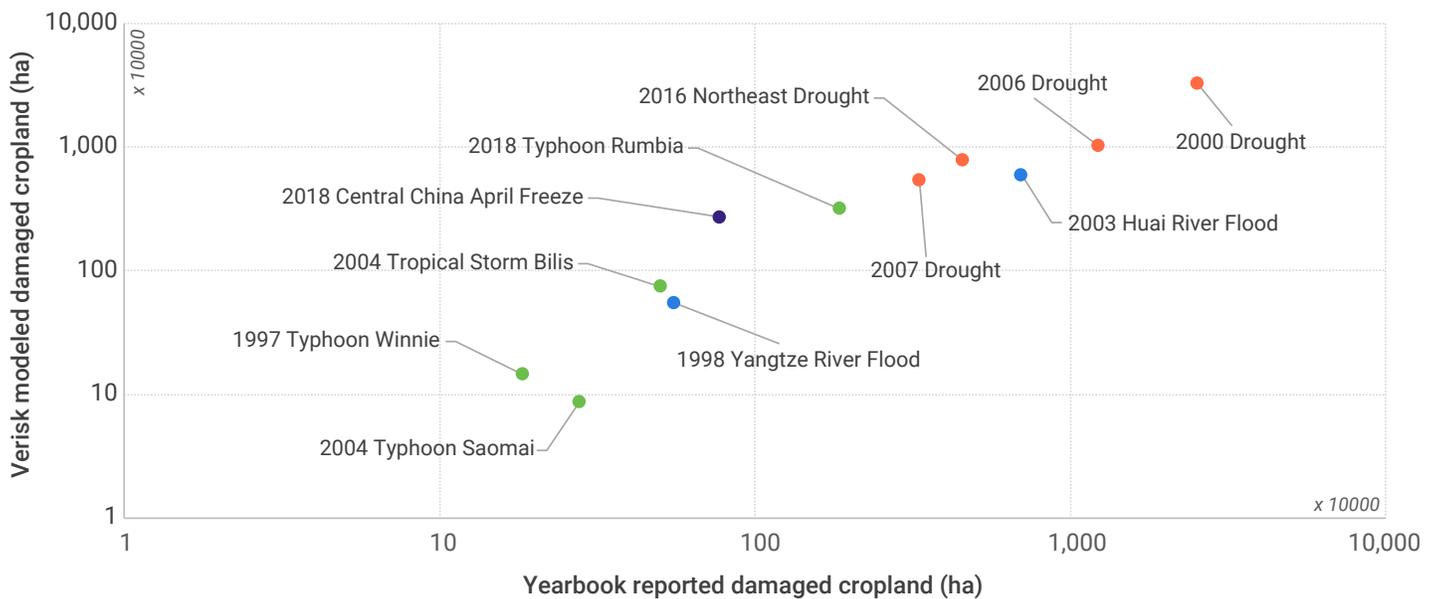
The model’s event generation process carefully maintains correlations in growing conditions in both space and time. These correlations are extremely important from a risk management perspective, as they are the basis of any risk protection available from a well-diversified crop insurance portfolio.

## Modeled losses are validated against historical losses

Damaged areas for crops and forests and death rates for livestock (including poultry) are validated using historical data. The Verisk Agriculture Model for China calculates insured losses by applying agricultural insurance policy conditions to the model’s catalog of simulated events. To ensure the most reliable modeled loss estimates, losses from the Verisk Agriculture Model for China are carefully validated against actual loss experience.

For example, the graph below shows how closely Verisk modeled damage matched the observed damage.

### Verisk-modeled damaged areas compare well to the observed damaged areas:



## Model at a glance

### Perils

- Crop: Drought, flood, wind, cold, heat
- Forest: Fire, wind, pests, disease, rodents
- Livestock: Drought, flood, wind, cold, snow, heat, disease

### Domain and resolution

- Mainland China
- County level

### Vulnerability

- Varies by farming practice, peril, and crop developmental stage

### Covered lines of business

- Crop: Barley, corn, cotton, fruit, peanut, potato, rapeseed, rice, rubber, soybean, sugar (cane and beet), tobacco, wheat
- Forest: All forest types
- Livestock: Dairy cattle, other cattle, breeding sow, other pig, poultry, sheep/goat

### Catalog

- Historical losses based on current exposure and coverage terms recast for 1981 through 2021
- 10,0000-year catalog of simulated events

### Output options

- Can be adjusted for sum insured per mu and premium rate
- Can be differentiated by peril and line of business

## Highlights

- Supports all central government-sponsored lines of business for agricultural insurance in China
- Provides a probabilistic catalog reflecting spatial and temporal correlations of losses
- Isolates the impacts of extreme weather on crops, forests, and livestock at the county and province levels
- Captures the variability of plant vulnerability to environmental stress throughout the plant life cycle
- Includes the first probabilistic approach for determining the likelihood of insured losses to China's forests
- Provides a view of livestock risk that considers the impacts of both disease and extreme weather
- Reflects the differences in individual insurance programs, which can vary by province



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