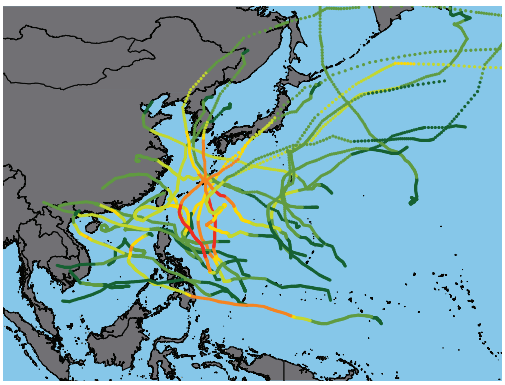
The AIR Typhoon Model for South Korea

Every year about 30 tropical cyclones develop in the Northwest Pacific Basin. On average, at least one makes landfall in South Korea. Others pass close enough offshore to cause wind damage and coastal and inland flooding. As the value and number of properties in South Korea's risk-prone areas increase every year, insurers need tools that can accurately assess and help manage this changing risk.

AIR

The AIR Typhoon Model for South Korea—part of AIR's Northwest Pacific Basinwide Typhoon Model—provides a fully probabilistic approach for determining the likelihood that losses will result from typhoon winds and precipitation-induced flooding. The model incorporates the current understanding of tropical cyclone activity in this basin and the latest engineering research concerning the response of local construction to damaging winds and precipitation. Model results are validated using extensive loss experience data—including data from two of South Korea's strongest historical typhoons, Maemi and Rusa—that represent about 25% of the market.



The majority of storms during the 2012 Northwest Pacific typhoon season impacted more than one country.

A COMPREHENSIVE APPROACH TO ASSESSING REGIONAL RISK

Insurers and reinsurers who operate globally need to be able to quantify catastrophe risk to policies and portfolios that span multiple countries—especially in the Northwest Pacific basin, where more than half of all landfalling typhoons affect more than one country.

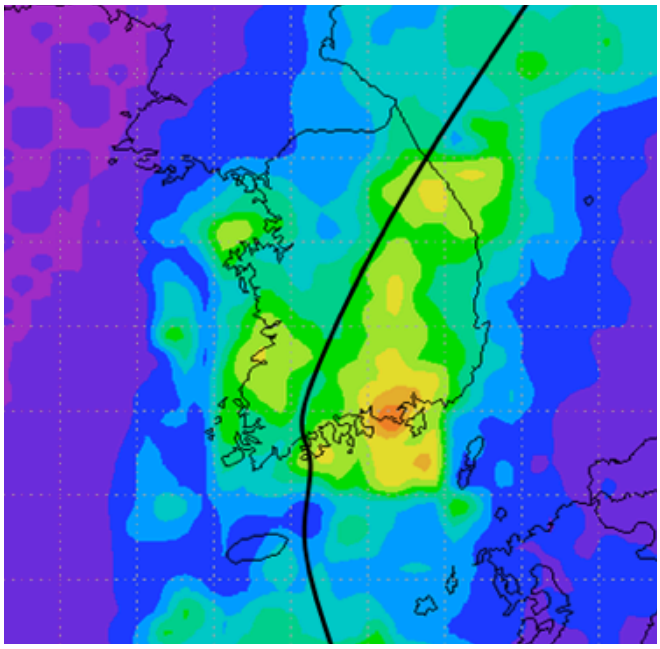
To provide a consistent and comprehensive view of risk to companies that have regional portfolios, AIR has developed a unified basinwide catalog shared by all modeled countries in the Northwest Pacific basin. The catalog enables seamless risk assessment for multi-country policies and portfolios, an approach of critical importance to global companies.

Robust Catalog Captures the Full Range of Potential Cyclone Activity

The basinwide model has a 10,000-year catalog consisting of 293,000 simulated events that realistically reflect the frequency, track, and other characteristics of storms in the Northwest Pacific. More than 17,600 of these cause loss in South Korea. To generate and validate the catalog, AIR scientists used data provided by the Korea Meteorological Agency, the Japan Meteorological Agency, the Shanghai Typhoon Institute, NOAA, and other similar organizations.

Wind Modeling Employs the Latest Research on Regional Typhoon Behavior

Satellite observations show that the relationship between a tropical cyclone's central pressure and its wind speeds is different in different ocean basins. For the same central pressure, for example, typhoons in the Northwest Pacific tend to have lower wind speeds than hurricanes have in the North Atlantic. The model's high (1km) resolution wind field therefore uses a central pressure–wind speed relationship developed from more than 30 years of data from the Northwest Pacific. Simulated winds are also informed by the latest information on the rate of decay of wind speeds after landfall. Overestimating this rate can significantly underestimate inland losses.



Accumulated precipitation in millimeters for Typhoon Rusa (the bold black line indicates its storm track) in 2002. Over four days Rusa dropped up to a meter of rain in some places, damaging 17,000 buildings and flooding crops widely.

Explicitly Captures Risk from Flooding

The model explicitly captures both wind and precipitation-induced flood risk and determines the combined losses—an important capability given that commercial policies can cover both perils. The intensity of typhoon-related precipitation can actually increase over land. South Korea's coastal mountains enhance precipitation on the north and east sides of typhoons that approach from the south, as most do. Also, precipitation footprints typically extend for hundreds of kilometers; thus, even storms far offshore can cause flooding.

The AIR model uses high-resolution data on soils, land use/land cover, and slope to determine the spatial distribution of accumulated runoff, or flooding. The model accounts for the fraction of runoff absorbed at a given location, which depends on vegetation type, the porosity of the soil, and the slope of the ground.

AIR's model also accounts for extratropical transitioning, which can lead to an expansion of a storm's precipitation shield and to intermittent periods of heavy rainfall. Using satellite imagery and Tropical Rainfall Measuring Mission data, the model transforms a storm's shape from a typhoon's roughly symmetric form to the "comma" shape of extratropical cyclones.

Damage Functions Provide a Robust View of Wind and Flood Risk

The South Korea typhoon model employs an extensive suite of damage functions that relate wind speed and flooding to the vulnerability of structures. These functions, which produce estimates of the possible damage that could result, are based on engineering studies, post-disaster surveys following recent storms, and analyses of large sets of claims data for several South Korea typhoons. AIR engineers have developed peril-specific (wind and flood) damage functions for 23 different construction classes and 52 occupancy classes in South Korea that reflect variations in local building practice, materials, and craftsmanship. Other highlights of the model's vulnerability component include:

- Functions that capture the effects of the duration of winds at a site
- Separate flood damage functions that exclude runoff diverted by mitigation measures

- Damage functions that capture the time-dependent vulnerability and replacement cost of buildings under construction (the construction-all-risks erection-all-risks [CAR/EAR] line of business)
- Modeling of business interruption losses that take into account business resiliency, condition of public lifelines, ability to relocate, etc.
- Accounts for the impact of flood defense systems in mitigating flood risk
- Region-specific damage functions for structures whose risk characteristics are "unknown"

Variability in Local Building Practices Captured with Regional Modifiers

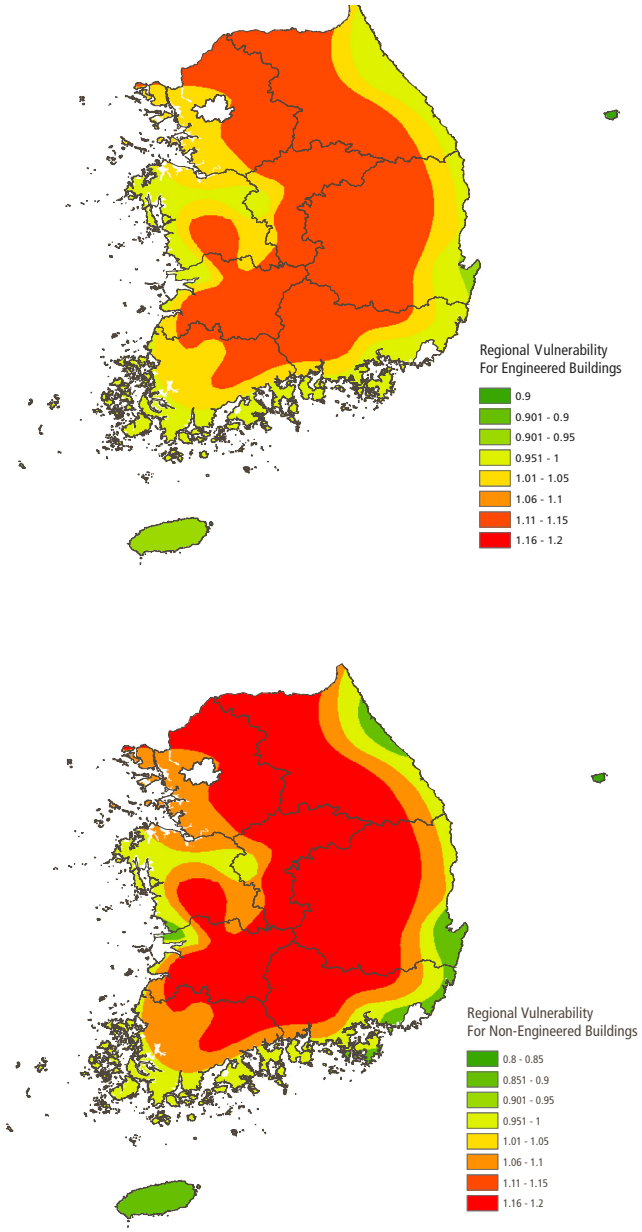
Wind hazard in South Korea is higher along the country's southeast coast. Construction practices in this region take into account the higher wind loads, and buildings there are more resistant to typhoon winds. Because each region of the country has had its own historical experience with locally prevalent perils, different regional design requirements and construction practices have evolved.

AIR researchers developed modifiers that reflect the hazard environments of different regions for both non-engineered structures (which do not follow the country's national building code) and engineered buildings (which do). For engineered buildings, design standards set by the Architectural Institute of Korea were used.

Insured Losses Validated Using Extensive Claims Data

To produce the most realistic and robust results, AIR builds its models from the ground up and validates each model component independently. Modeled wind speeds and precipitation totals, for example, are validated against observation data from actual storms.

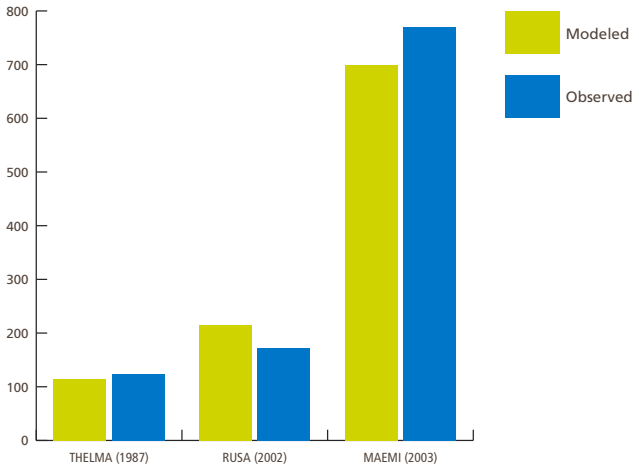
AIR also validates top down, comparing modeled losses to company data and industry loss estimates. Modeled losses have been validated against actual claims data from companies that together make up about 25% of the South Korean market. This comprehensive approach to validation confirms that overall losses are reasonable and that the final model output is both consistent with basic physical expectations of the underlying hazard and unbiased when tested against historical and real-time information.



Regional modifiers for engineered and non-engineered buildings in South Korea were developed based on the design standards of the Architectural Institute of Korea.

An extension to standard South Korean fire insurance policies for most assets covers windstorm and rainwater damage—but not flood. An alternate policy clause is now available that does cover wind, flood, and storm surge damage—but while insurers rarely decline taking on commercial/industrial risk, they usually decline residential risks in exposed areas.

AIR's Touchstone platform allows users to input different policy conditions for wind and flood for more accurate overall loss estimates. Touchstone also includes innovative disaggregation techniques that can produce even more accurate results by distributing province-level aggregate exposure data down to a 1-km x 1-km grid based on AIR's industry exposure database for South Korea.



Separating Wind and Flood Losses for More Realistic Model Results

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Model at a Glance

Modeled Perils	Tropical cyclone winds and precipitation-induced flooding
Model Domain	Northwest Pacific Ocean Basin and South Korea
Supported Geographic Resolution	Province, county, and postcode resolution, plus user-provided latitude and longitude
Stochastic Catalog	10,000-year catalog includes more than 293,000 simulated events of which more than 17,600 cause loss in South Korea
Supported Construction Classes and Occupancies	Supported Construction Classes: Separate wind and flood damage functions for 23 construction types Supported Occupancy Classes: 52 Unknown Damage Function: When detailed exposure data (e.g., construction type or height) is unavailable, the model applies an "unknown" damage function that is based on country-specific construction characteristics.
Supported Policy Conditions	The AIR Typhoon Model for South Korea supports an extensive portfolio of policy terms and conditions, including location and policy limits and deductibles and both treaty and facultative (assumed and ceded) reinsurances. It explicitly includes the "maximum of site" type of deductible, a common commercial policy condition in the Korean market.

Model Highlights

- Shares a basinwide catalog with other modeled countries in the Northwest Pacific, allowing clients to more realistically model losses to portfolios that cross borders
- Incorporates a central pressure/wind speed relationship specific to the Northwest Pacific
- Explicitly models precipitation-induced flooding
- Estimates wind and flood damage to buildings, content, and business interruption
- Accounts for the impact of flood defense systems in mitigating flood risk
- Includes regional variations in building vulnerability because of different historical experiences
- AIR's detailed software enables users to easily run wind/flood scenariosand can distribute province-level exposure data down to a 1-km x 1-km grid-levelbased on distributions in AIR's detailed industry exposure database

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber attacks, globally. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

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