A Preview of the AIR Typhoon Models for Southeast Asia

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A Preview of the AIR Typhoon Models for Southeast Asia

Apoorv Dabral, Ph.D. Kevin Hill, Ph.D., Ruilong Li, Ph.D.



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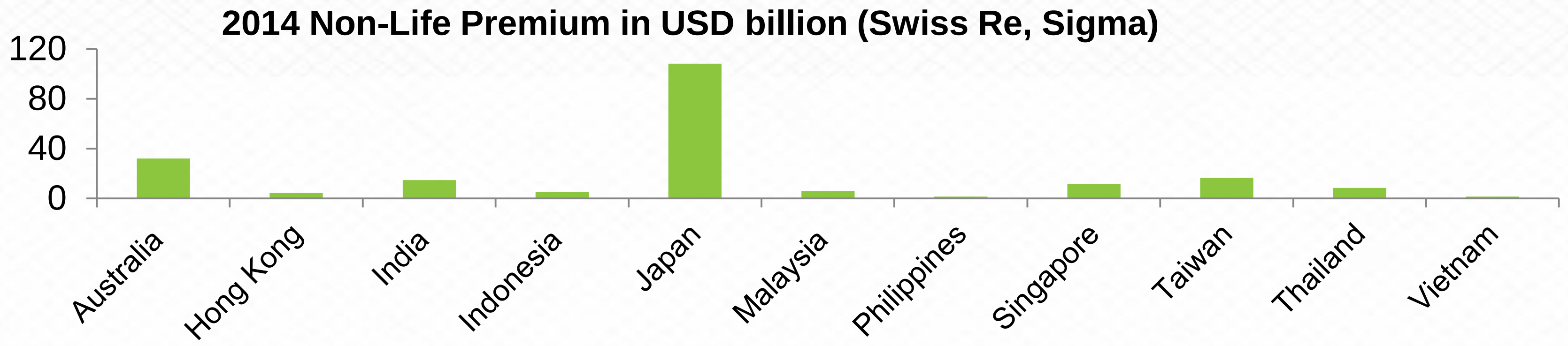
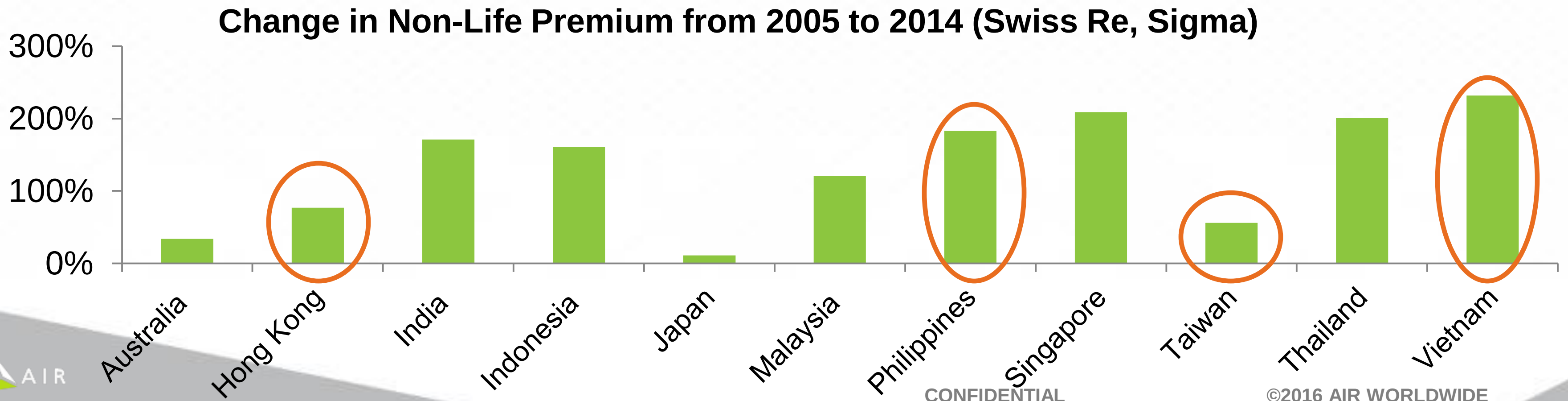
Growth in Non-Life Insurance Market in Asia-Pacific

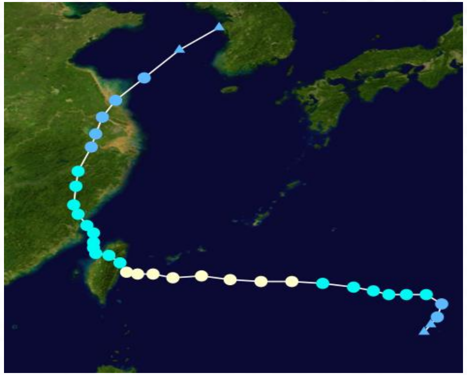




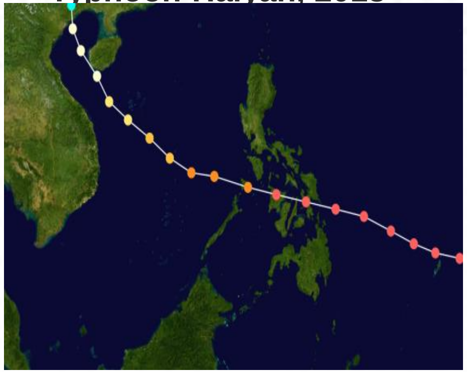
Some Major Typhoons that Have Affected Southeast Asia

- Haiyan
  - One of the strongest typhoons to make landfall
  - Significant storm surge
- Morakot
  - Record-breaking precipitation
- Ketsana
  - Significant flooding
  - Major losses in Philippines and Vietnam

Typhoon Morakot, 2009

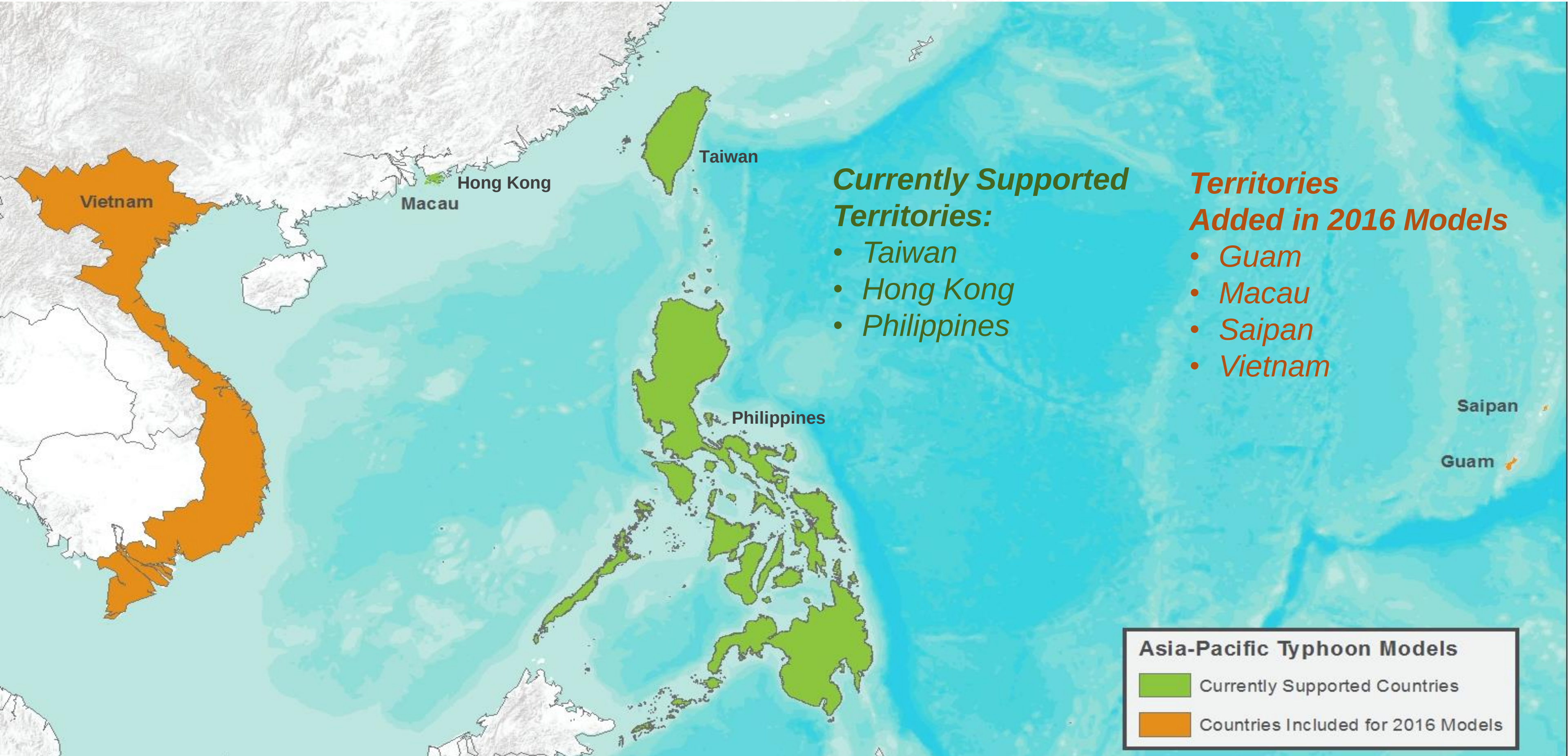


Typhoon Haiyan, 2013



Typhoon Ketsana, 2009

Southeast Asia Typhoon Models – Update and Expansion



Currently Supported Territories:

- *Taiwan*
- *Hong Kong*
- *Philippines*

Territories Added in 2016 Models

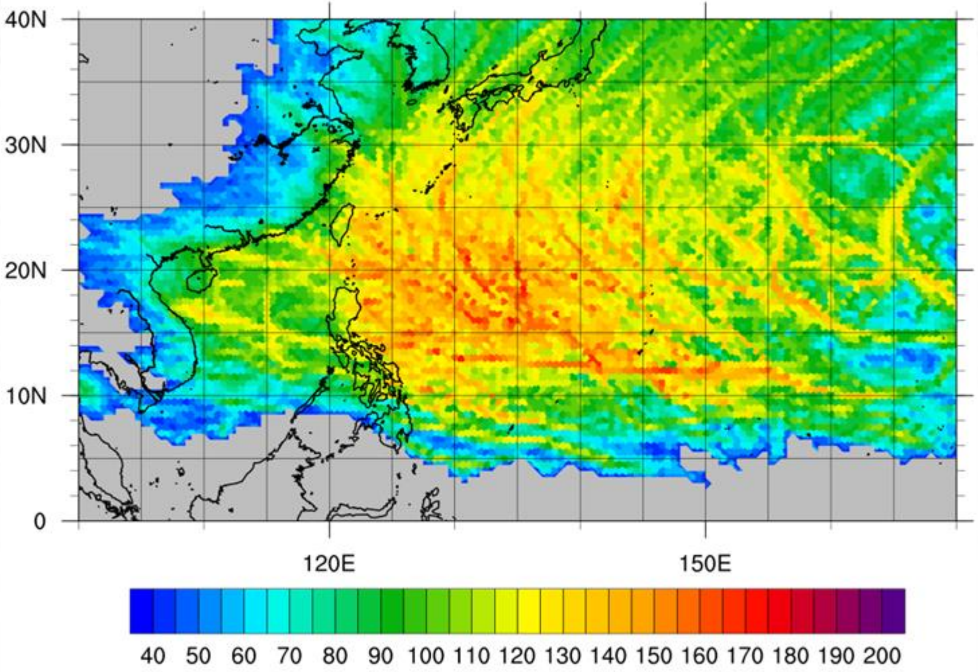
- *Guam*
- *Macau*
- *Saipan*
- *Vietnam*

High Resolution IEDs Explicitly Capture Large Industrial Facilities and Tall Buildings

- Explicitly capturing large industrial facilities and parks
- Tall buildings classification
- High geographic resolution
- Better risk differentiation

The Southeast Asia Typhoon Models Include Significant Hazard Updates

- Part of basinwide catalogue that covers the region
- 1 km resolution
- Updated wind field and flood modules
  - Wind: region-specific wind–central pressure relationship, Willoughby decay
  - Flood: CASC2D, time-dependent
- Storm surge module for the Philippines, Hong Kong, and Taiwan



The Updated Southeast Asia Typhoon Models Provide Capability to Assess a Wide Variety of Risk Types

- Conventional buildings, contents, and business interruption
- Infrastructure
- Marine cargo and hull
- Large industrial facilities
- CAR/EAR
- General auto
- 2-wheeled vehicles
- Warehouses

Upcoming AIR Events with More Comprehensive Model Details

envision '16

April – Philadelphia

ASIA SEMINAR SERIES 2016

June and August

- Singapore
- Philippines
- Indonesia
- Vietnam
- Beijing
- Taiwan

Hazard Updates

Kevin Hill, Ph.D.

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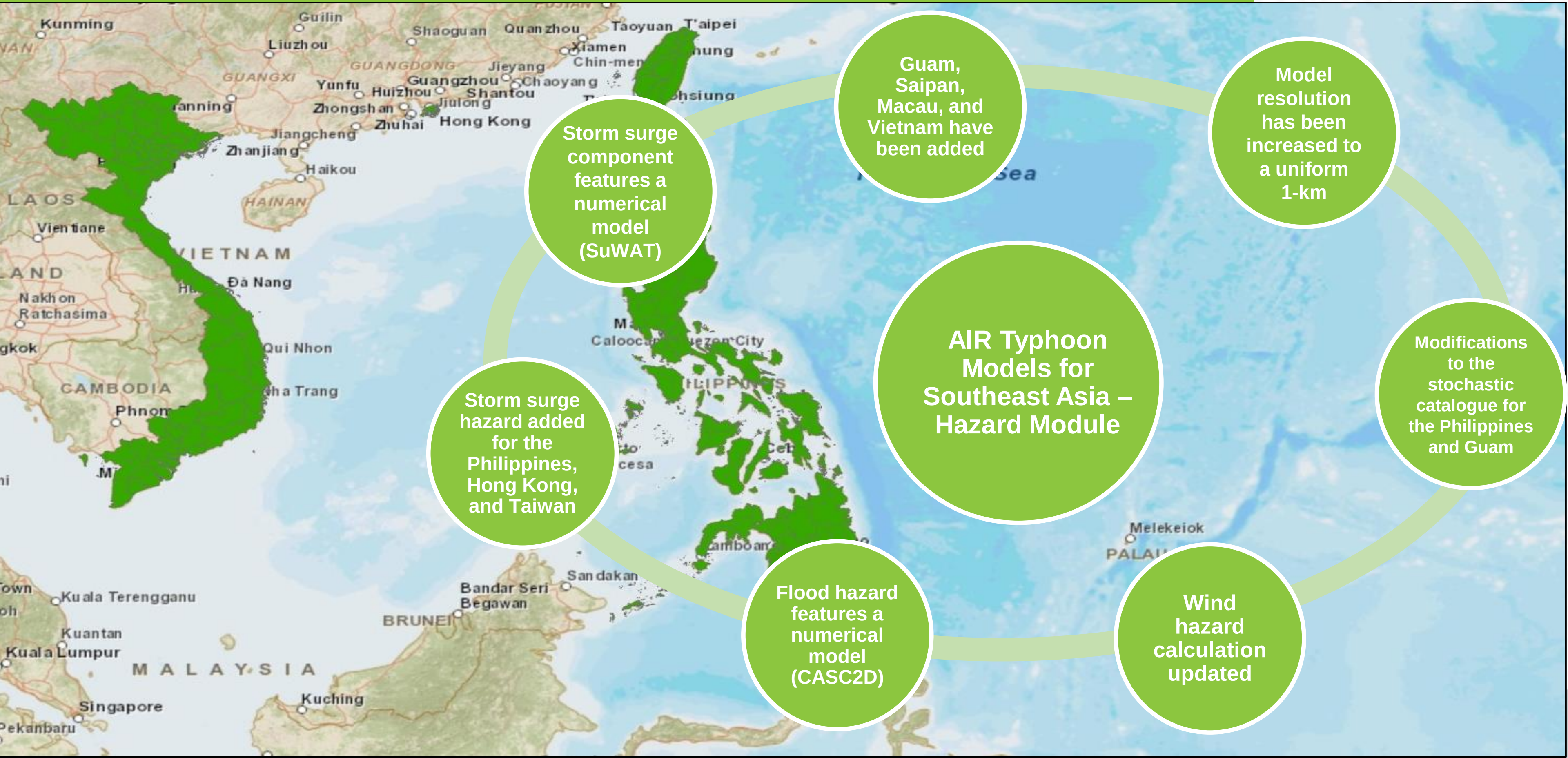
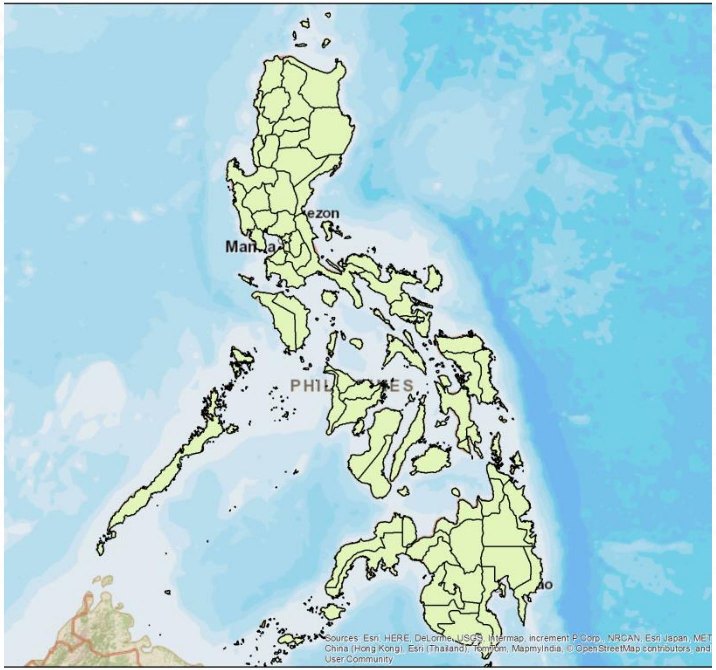
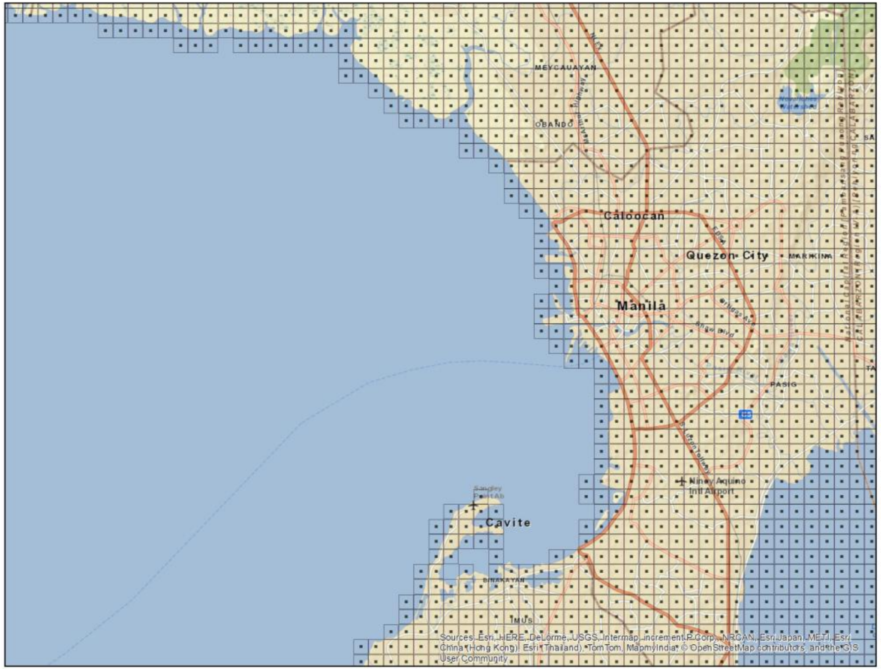
Hazard Module Has Undergone a Comprehensive Update



High-Resolution Model Allows for More Granular View of Risk



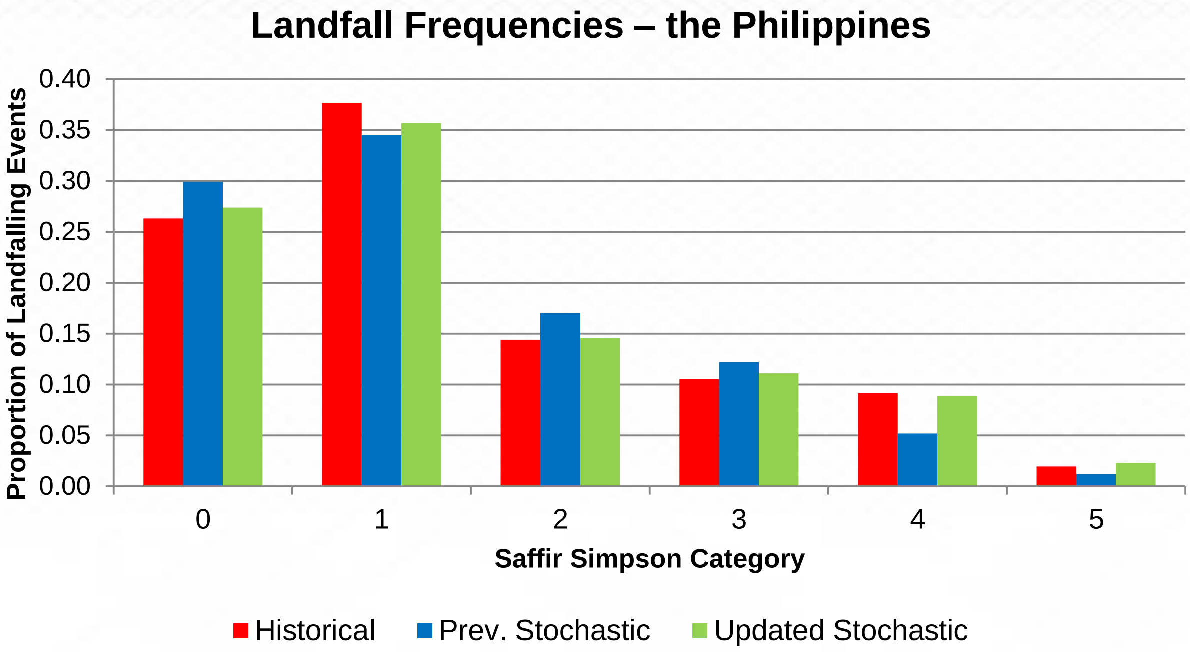
Previous Release: 81 unique points



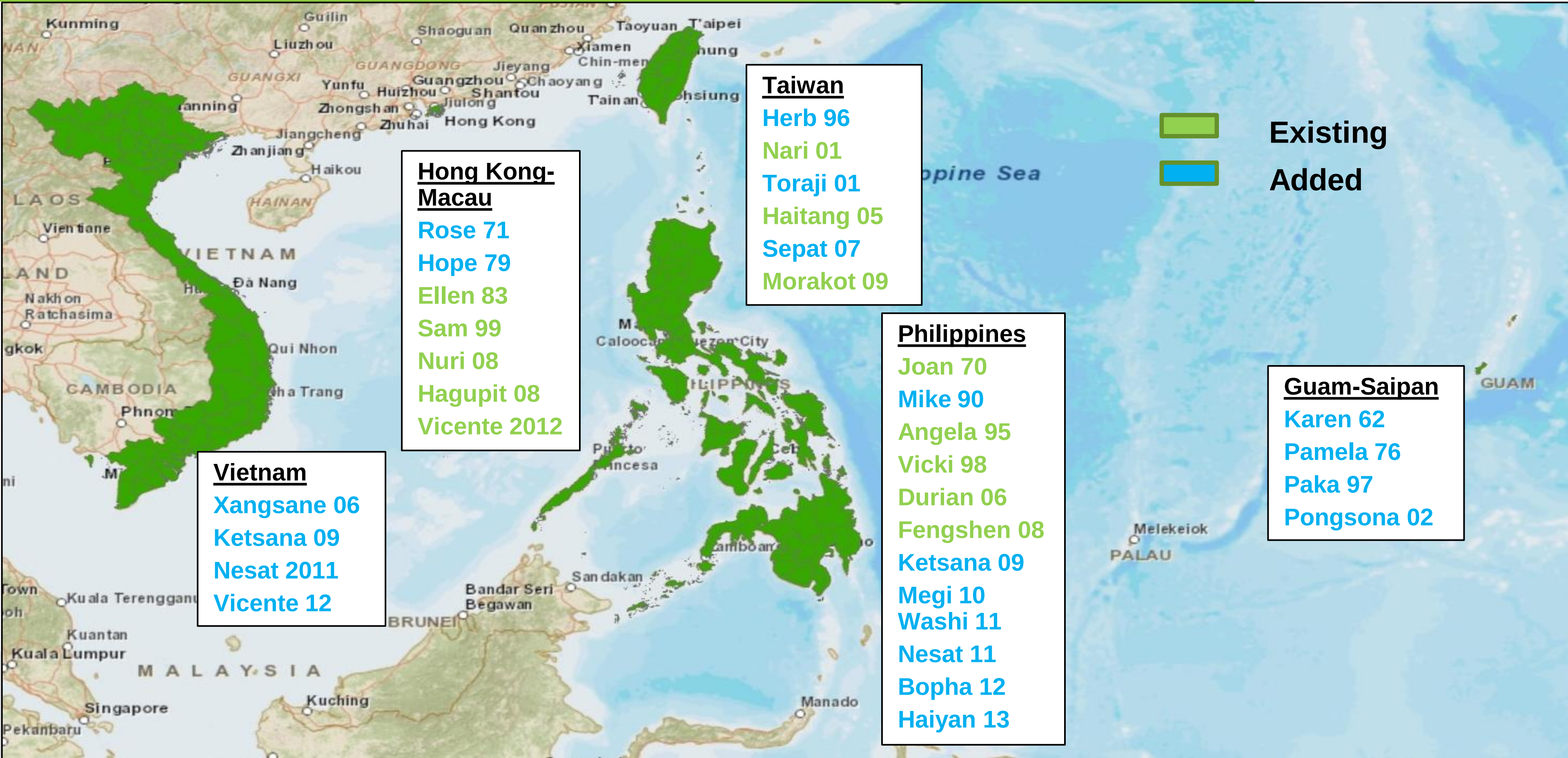
Updated model: ~400,000 points (Manila area shown)

Stochastic Catalogue Validates Well for Modelled Territories

- Modified landfall intensities are included in the models for Guam and Philippines



Many New Marquee Events Have Been Added



Existing

Added

Taiwan
- Herb 96
- Nari 01
- Toraji 01
- Haitang 05
- Sepat 07
- Morakot 09

Hong Kong-Macau
- Rose 71
- Hope 79
- Ellen 83
- Sam 99
- Nuri 08
- Hagupit 08
- Vicente 2012

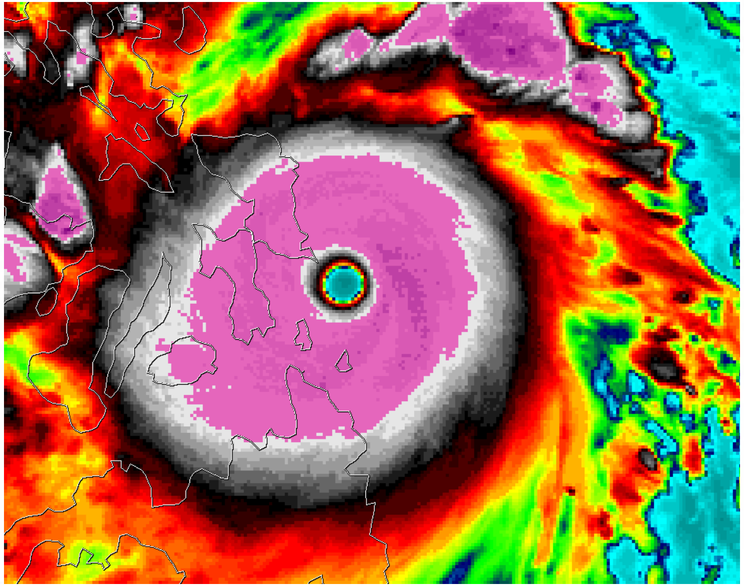
Vietnam
- Xangsane 06
- Ketsana 09
- Nesat 2011
- Vicente 12

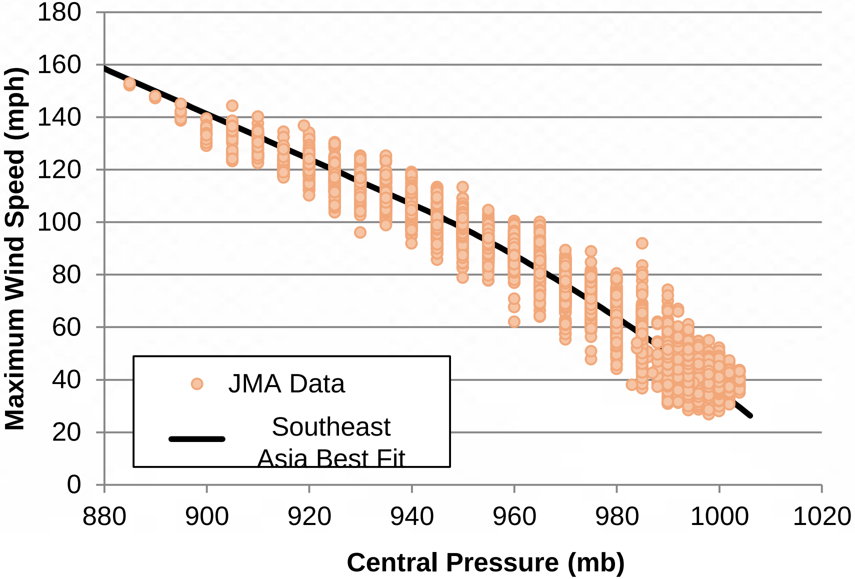
Philippines
- Joan 70
- Mike 90
- Angela 95
- Vicki 98
- Durian 06
- Fengshen 08
- Ketsana 09
- Megi 10
- Washi 11
- Nesat 11
- Bopha 12
- Haiyan 13

Guam-Saipan
- Karen 62
- Pamela 76
- Paka 97
- Pongsona 02

Wind Hazard Is Modelled in a Robust Fashion

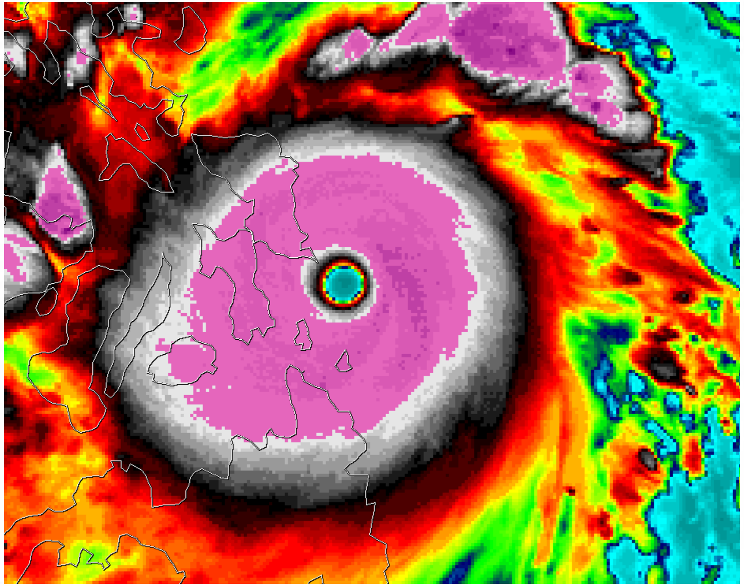
- Maximum wind speed is modelled using a wind–central pressure relationship customised for typhoons affecting Southeast Asia
  - Based on Japan Meteorological Agency (JMA) data





Wind Hazard Modelled in a Robust Fashion

- Radial decay of wind speed is based upon Willoughby et al. (2006)
  - Dual exponential wind profile is the most accurate match to observed wind speeds



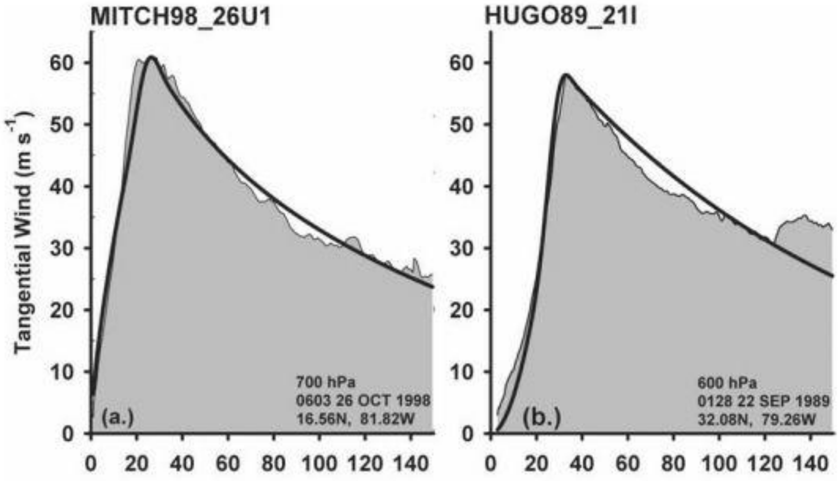
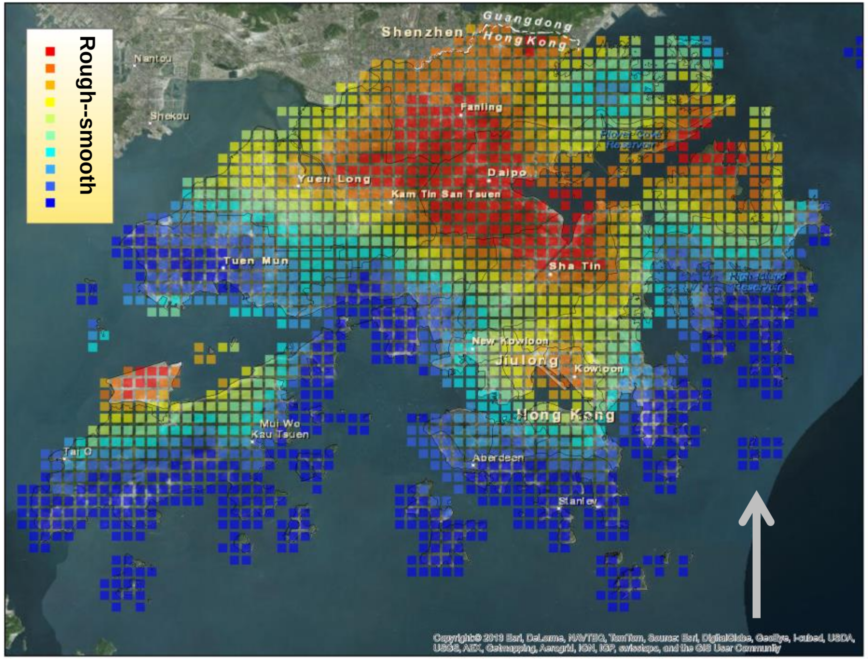


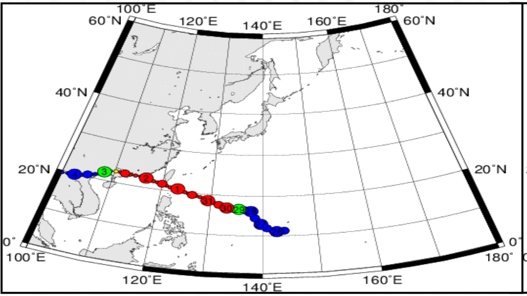
FIG. 10. Dual-exponential wind profiles fitted to Hurricanes (a) Mitch of 1998, (b) Hugo of 1989, (c) Edouard of 1996, and (d) Erika of 1997. Observed and fitted profiles are as indicated in Fig. 2.

Wind Hazard Modelled in a Robust Fashion

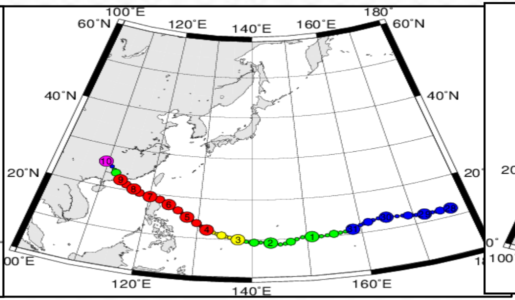
- Friction and gust factors recalculated using same methodology and data as for other Asia regions
  - These are dependent on wind direction
  - Provides detailed wind speed footprint for coastal and inland area



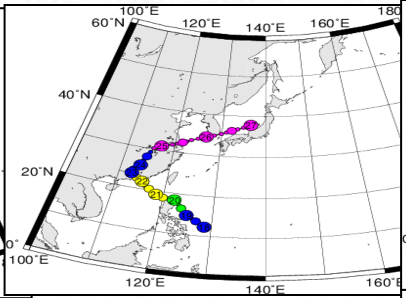
Maximum Winds for Hong Kong Events Modelled Accurately



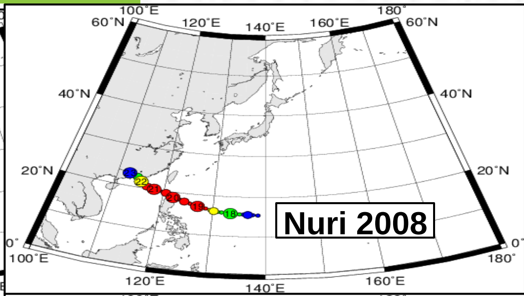
Hope 1979

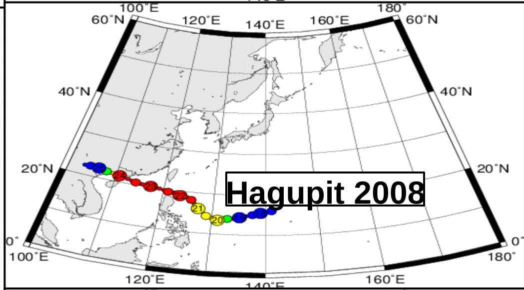


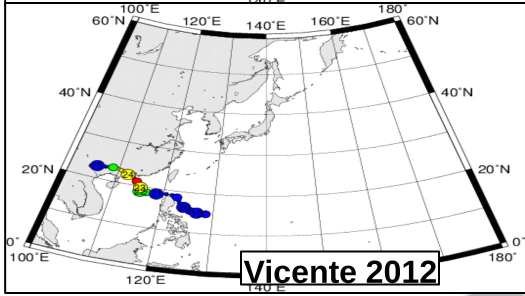
Ellen 1983

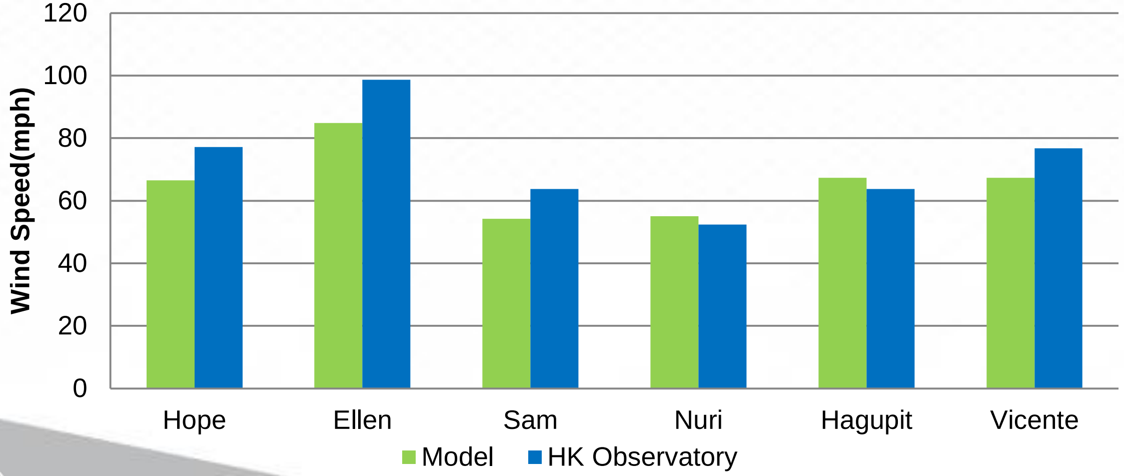


Sam 1999

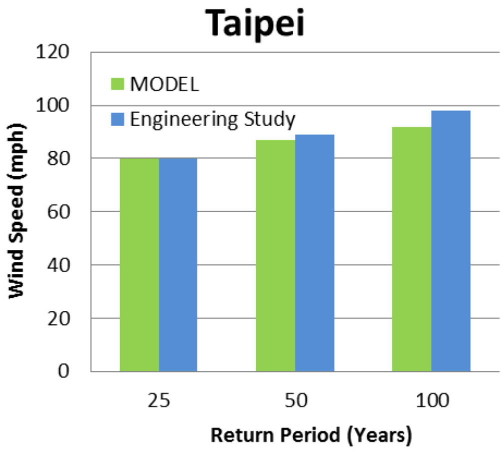


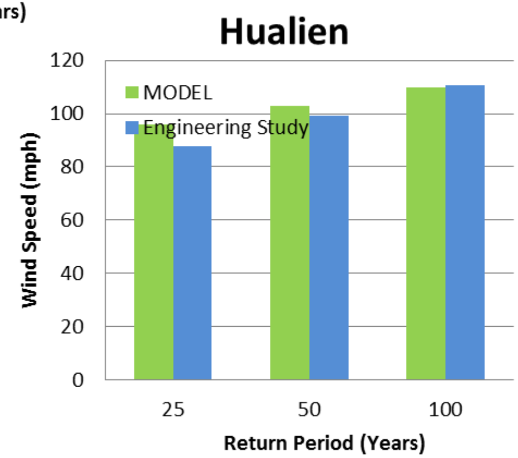




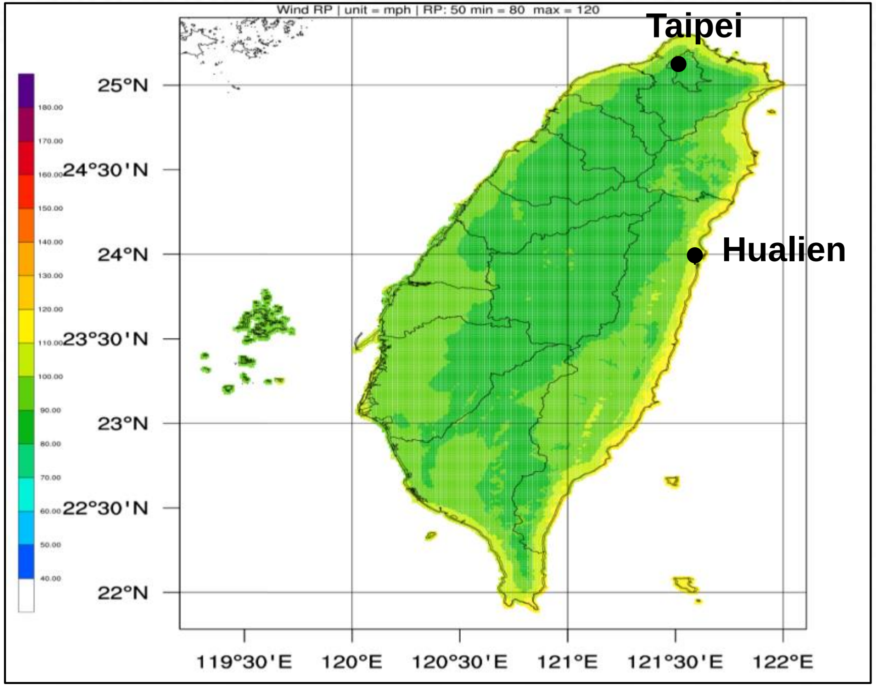


Taiwan Return Period Winds Compare Favorably to Engineering Studies





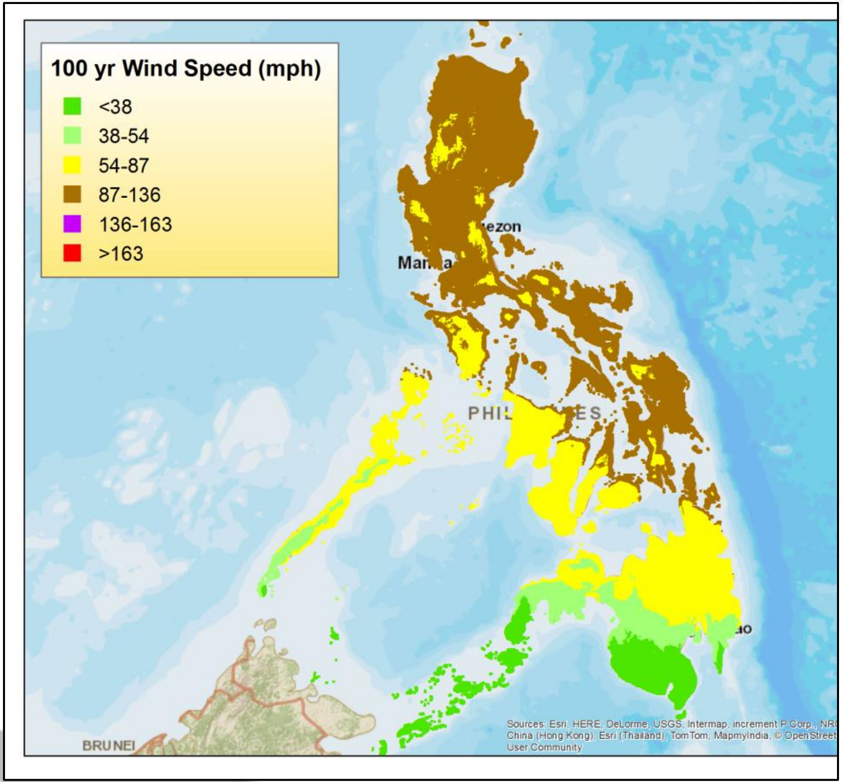
Model 100-year return period wind map

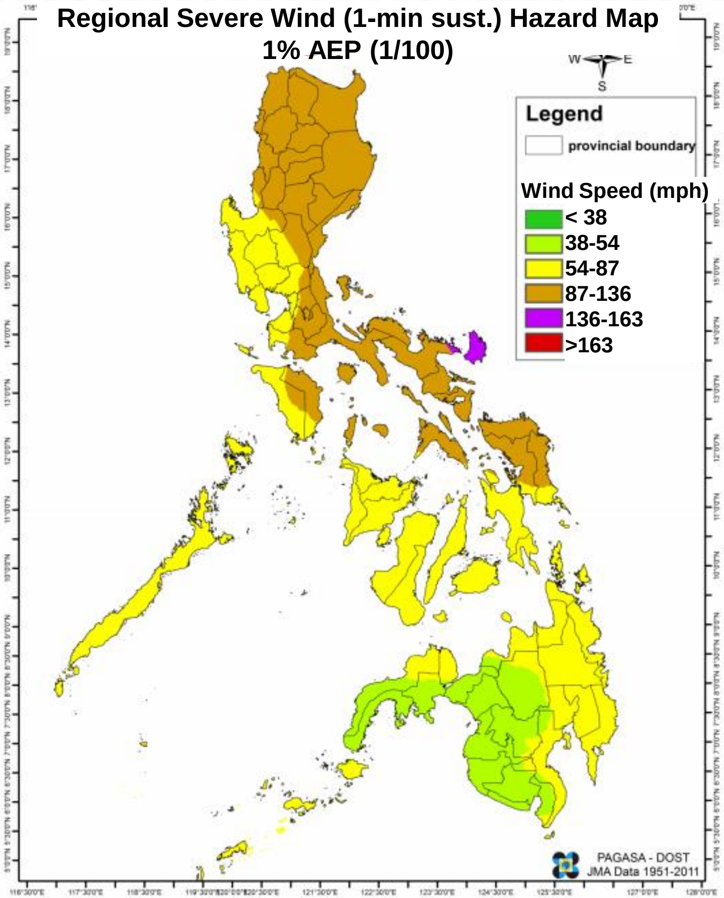


Engineering Study is Jang and Lee,1997: Analysis of Design Wind Speed Distribution of Taiwan Area, *J. Marine Science and Techn.*

The Philippines 100-Year Return Period Winds Compare Favorably to Local Study

Model 100 year return period wind speeds





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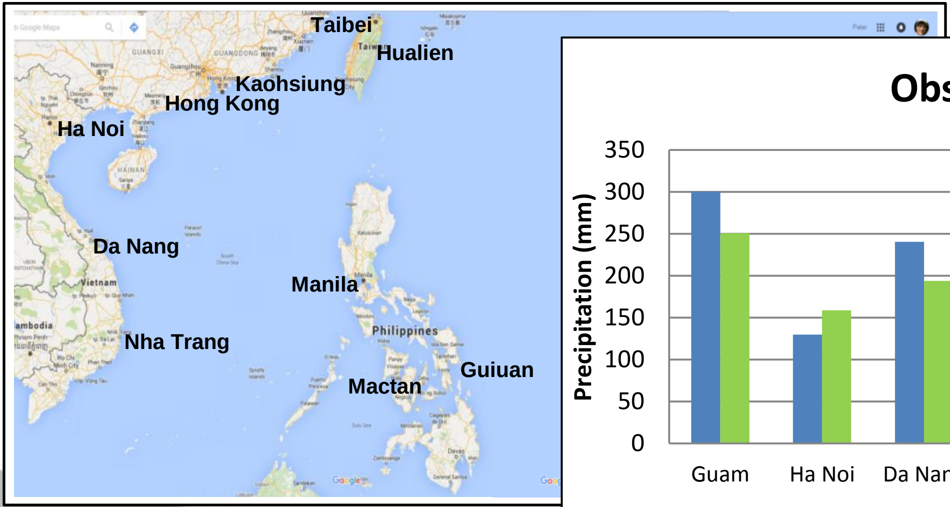
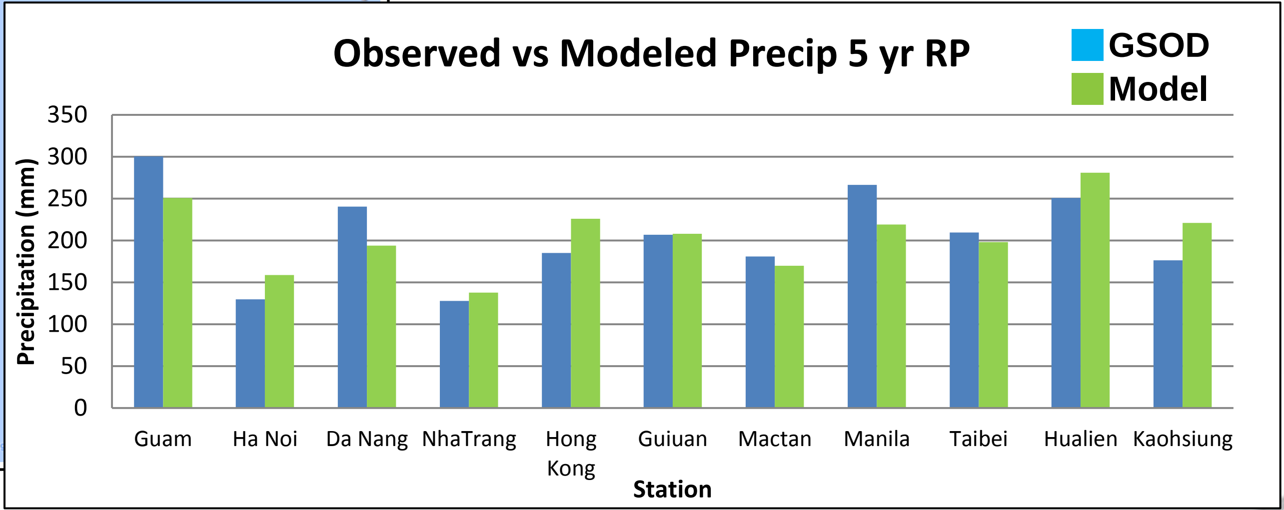
Precipitation Model Captures Storm and Local Effects

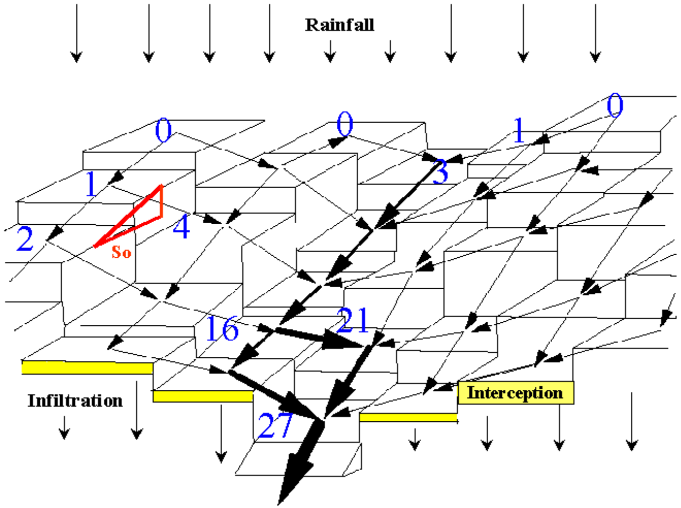
- Modelled precipitation depends on typhoon characteristics and accounts for geographic and local effects
- Higher resolution than previous model is more likely to resolve areas of maximum precipitation



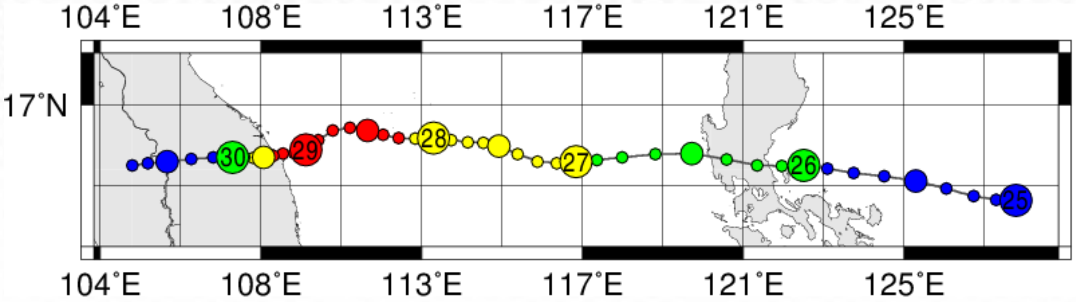


Flood Component Features Physically Based Hydrologic Model

- CASC2D is time dependent, so flood depth is influenced by rainfall rate and total precipitation
- Amount of water that infiltrates depends on soil type and slope
- Routing depends on slope and surface friction (vegetation, Manning Coefficient)

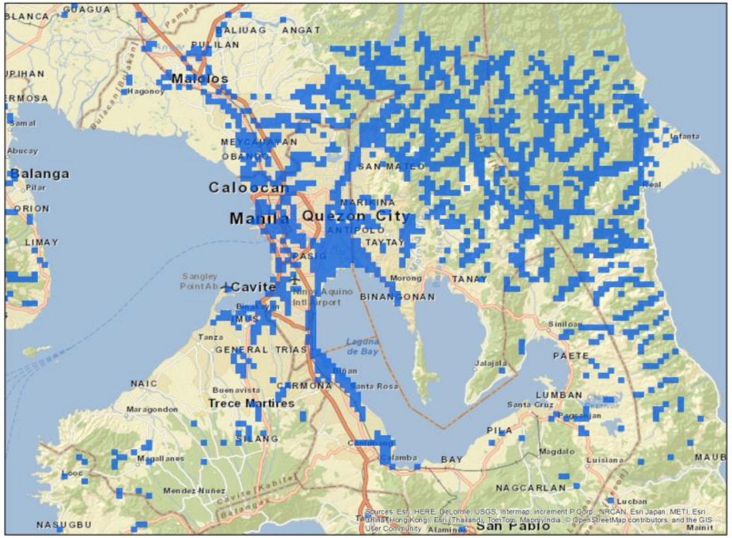


Flood for Ketsana (2009) Modelled Very Well



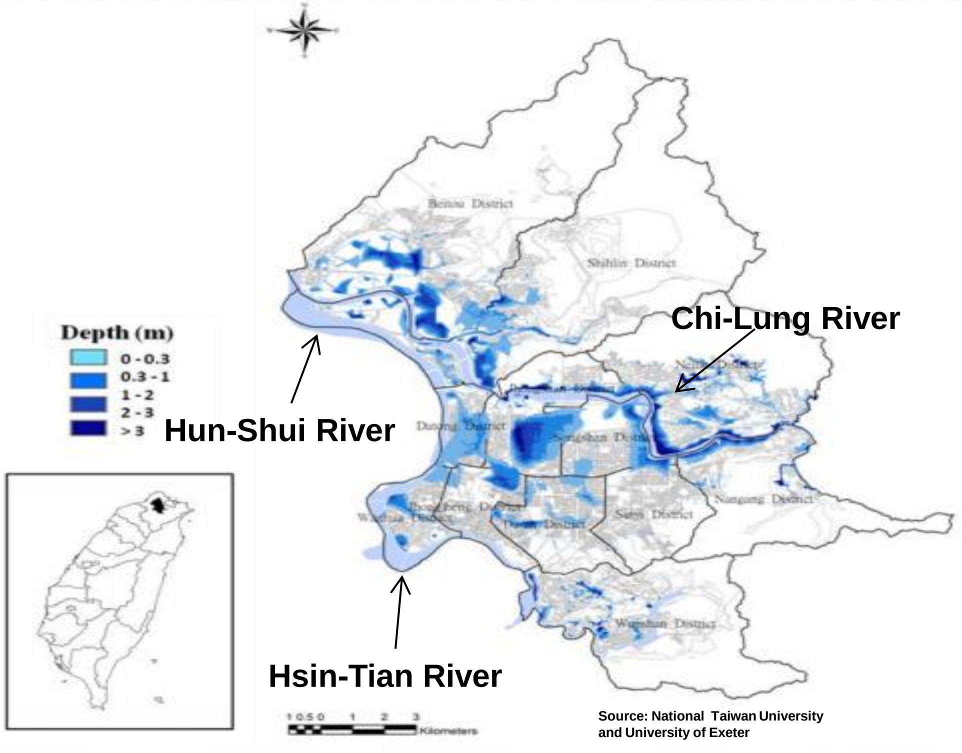
Track across The Philippines by Ketsana (Ondoy) as a weak Tropical Storm in Sept 2009.

Ketsana flooded more than 80% of the city of Manila

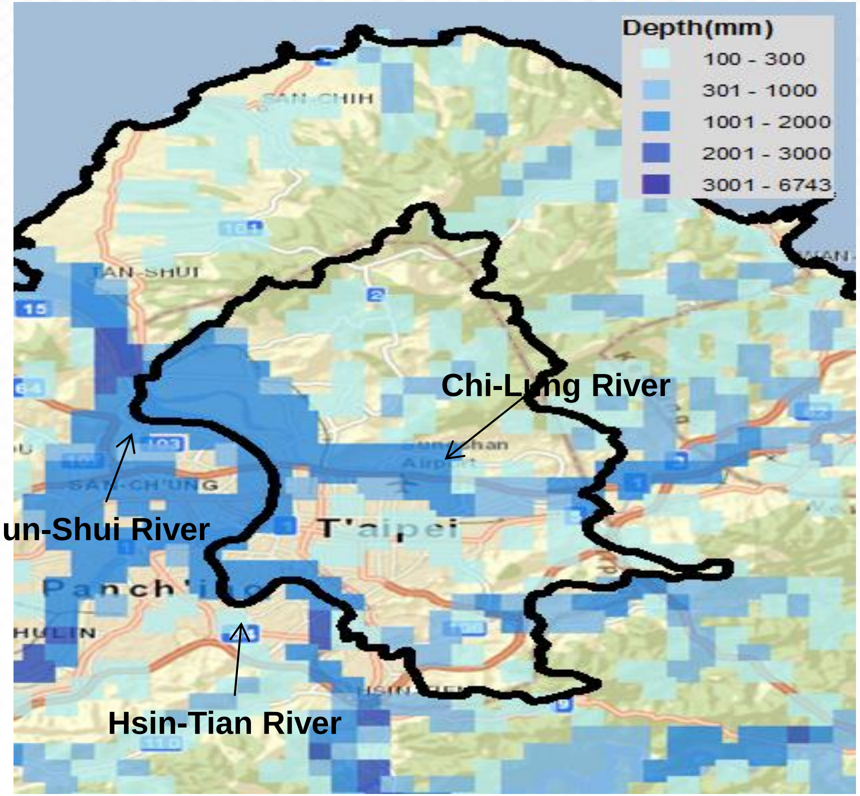


Modelled flood footprint

Flood Model Captures Areas Vulnerable to Flood Around Taipei



Flood Map of Taipei – 200 Year

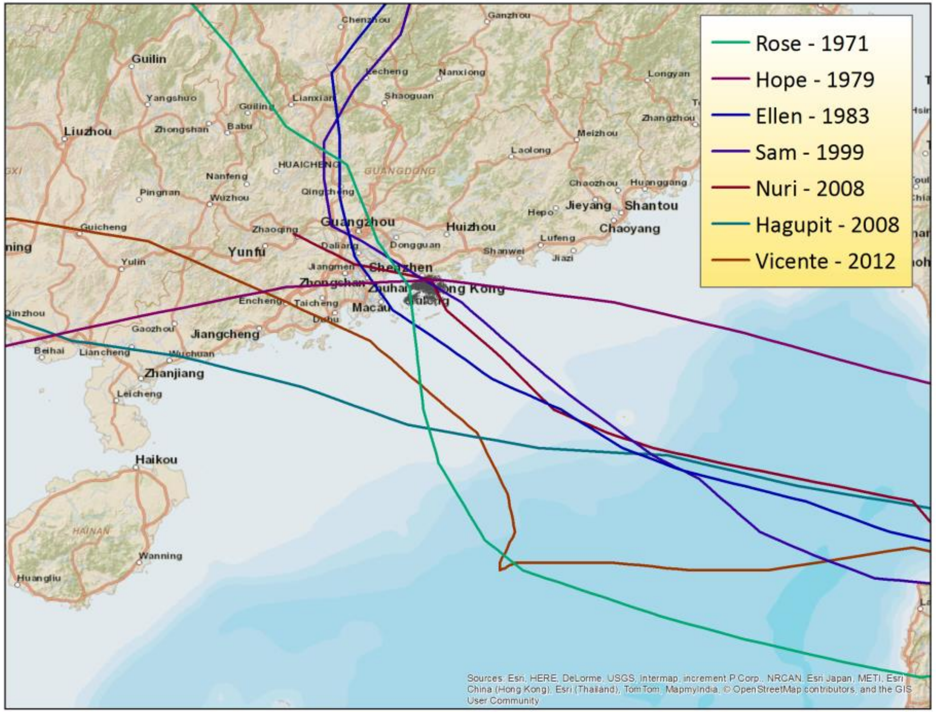


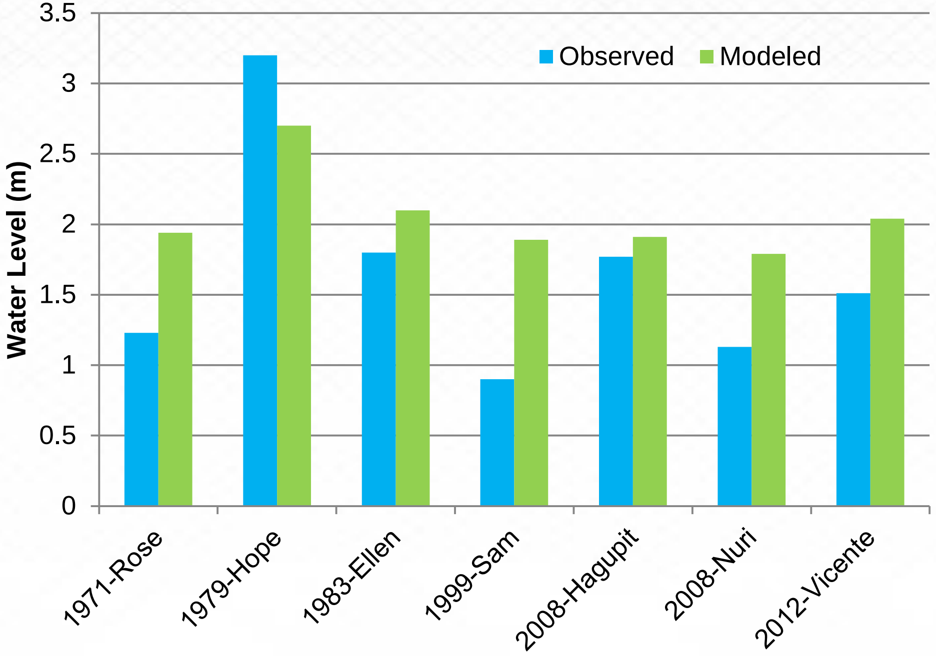
Taipei Region from AIR Model – 250 Year

Surge Component Also Features a Physically Based Model

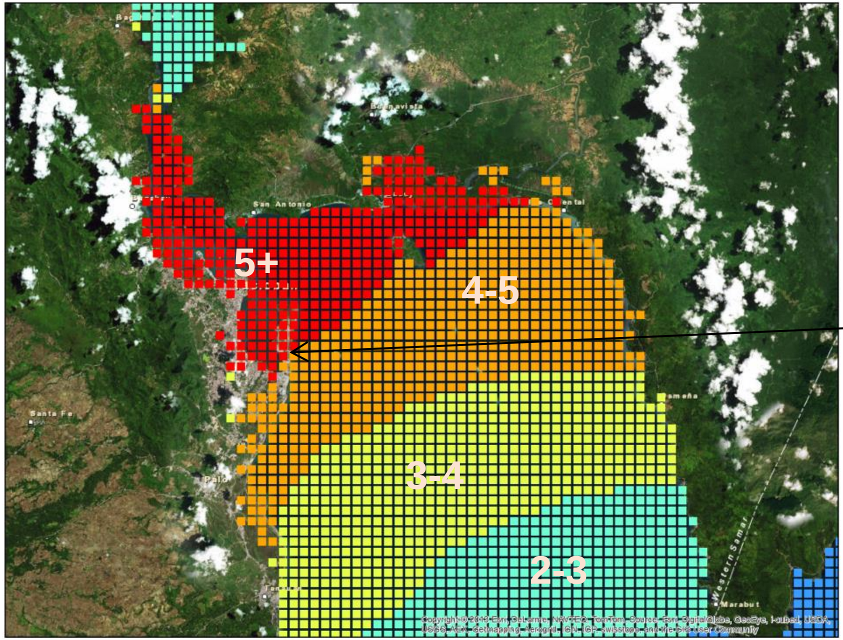
- Storm surge peril modelled using SuWAT - coupled numerical model of **S**urge, **WA**ve and **T**ide (same as Japan typhoon model)
  - Model developed in Japan and has been used in numerous peer-reviewed publications
  - Fully dynamical model which takes into account the impact of waves on storm surge
  - Model utilises high-resolution terrain information for accurate model storm surge inundation

Storm Surge Model Accurately Represents Historical Events for Hong Kong





Haiyan Simulation Validates Well with Survey and Other Model Studies



"In Tacloban, the terminal building of Tacloban Airport was destroyed by a 5.2 m (17 ft) storm surge up to the height of the second story. "

- Model produces a maximum storm surge of 5-6 meters
- JSCE-PICE joint survey team estimates the storm surge level was 5-6 meters inside of the Leyte Gulf

Vulnerability Updates

Ruilong Li, Ph.D.

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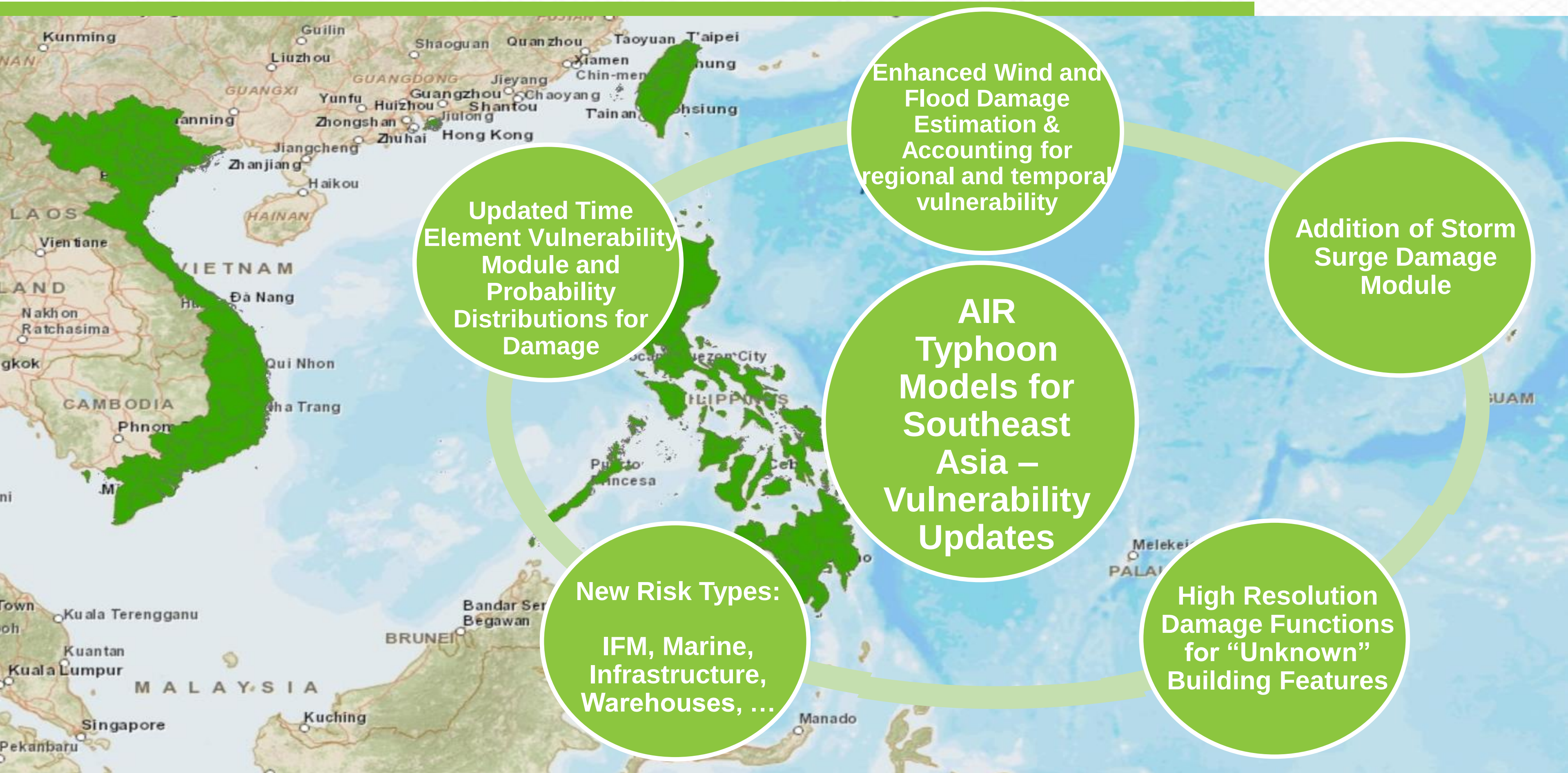
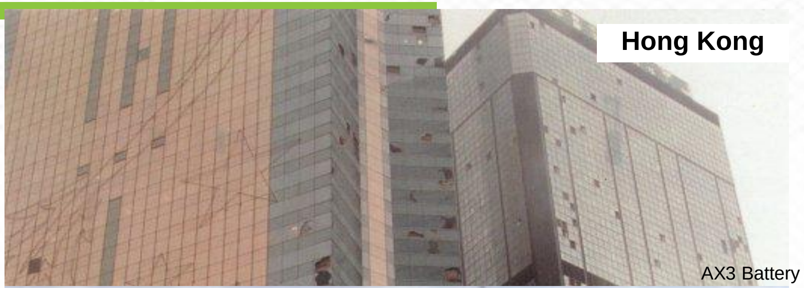
Vulnerability Module Has Undergone Comprehensive Update



Vulnerability Varies by Territory

- Hong Kong and Macau
  - Engineered structures
  - Quality and control referred to British Standards, with additional practice notes for engineers
- Philippines
  - Good building code
  - Building standards may not have been followed
- Taiwan
  - Robust wind design code
  - Engineered structures
  - Better enforcement



AX3 Battery

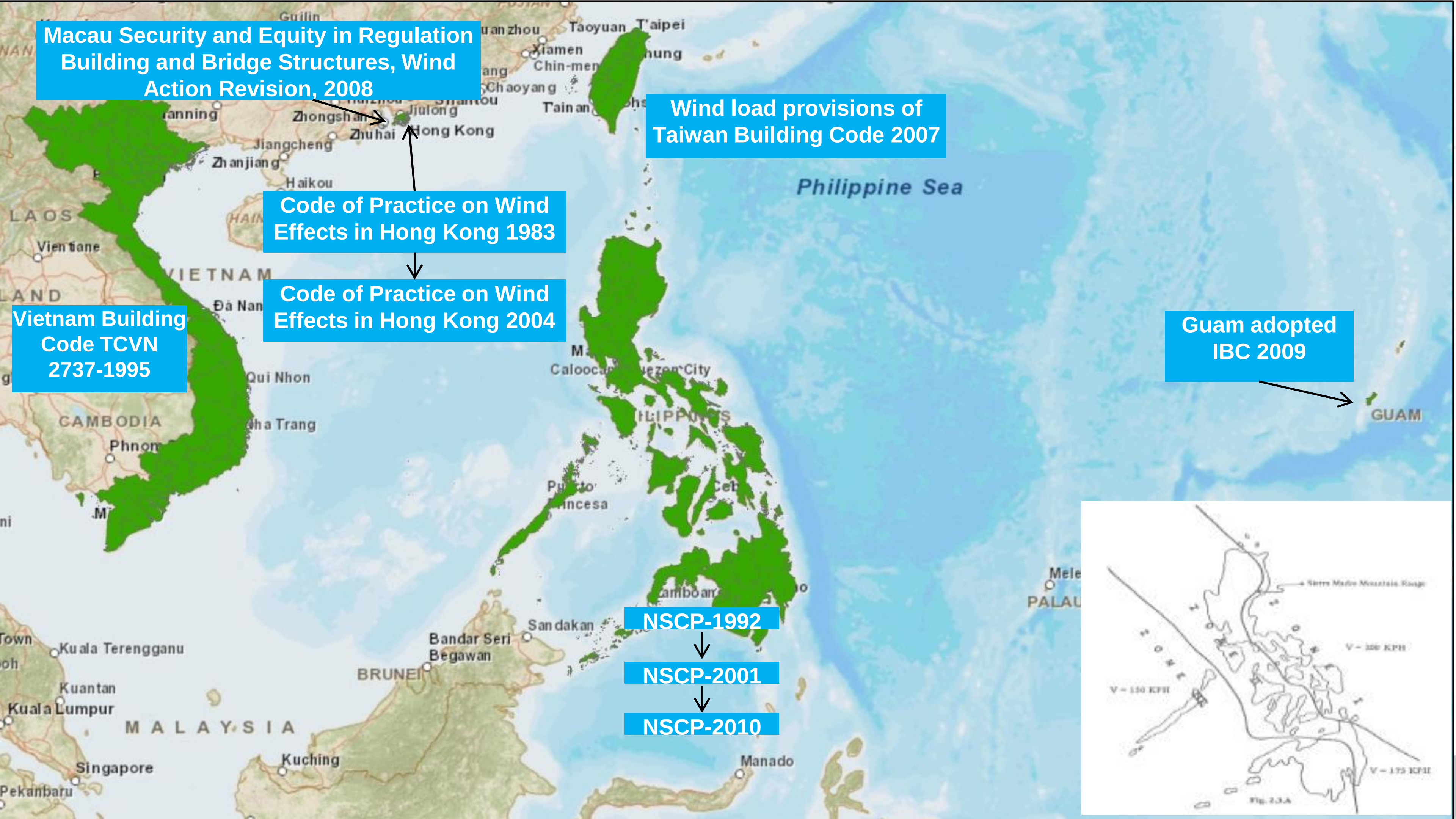
CTV

San Diego Tribune

Vulnerability Varies by Territory

- Vietnam
  - Little quality control
  - Wind is generally not extreme, but flooding is more significant

- Guam and Saipan
  - Good building code adoption and enforcement


Macau Security and Equity in Regulation Building and Bridge Structures, Wind Action Revision, 2008
Wind load provisions of Taiwan Building Code 2007
Philippine Sea
Code of Practice on Wind Effects in Hong Kong 1983
Code of Practice on Wind Effects in Hong Kong 2004
Vietnam Building Code TCVN 2737-1995
Guam adopted IBC 2009
NSCP-1992
NSCP-2001
NSCP-2010

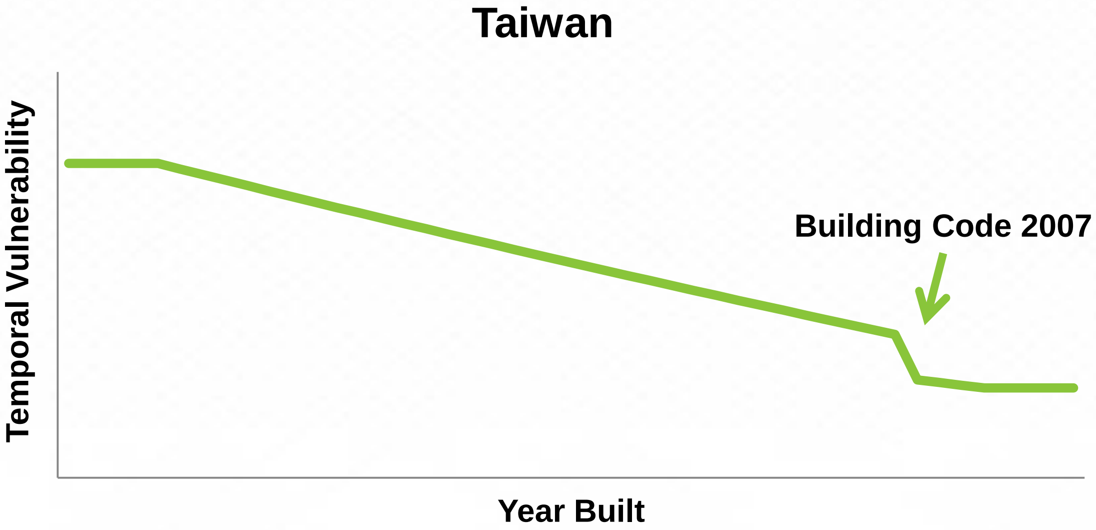
Wind Vulnerability Varies by Territory

- Wind vulnerability
  - Wind hazard level
    - High → Low vulnerability
    - Low → High vulnerability
  - Wind design and enforcement level
    - High → Low vulnerability
    - Low → High vulnerability

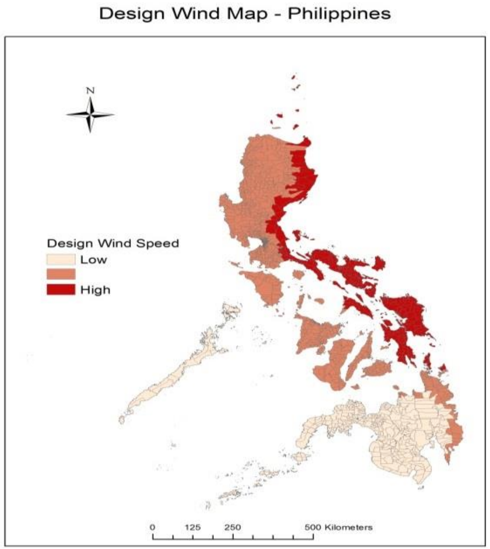
Territory	Wind Hazard Level	Building Design and Enforcement Level	Wind Vulnerability Level
Guam	Mid-High	High	Mid
Hong Kong	Mid-Low	High	Low-Mid
Macau	Mid-Low	High	Low-Mid
Philippines	High	Low	Mid-High
Saipan	Mid-High	High	Mid
Taiwan	High	High	Low
Vietnam	Low	Low-Mid	High

The AIR Southeast Asia Typhoon Models Support Temporal Vulnerability for Wind

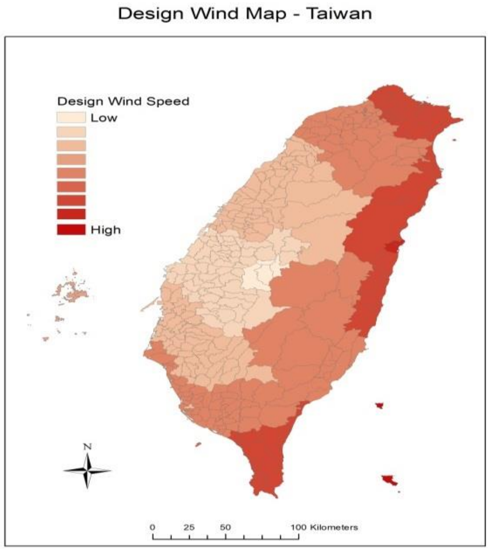
- Temporal vulnerability:
  - Building code evolution
  - Aging and deterioration



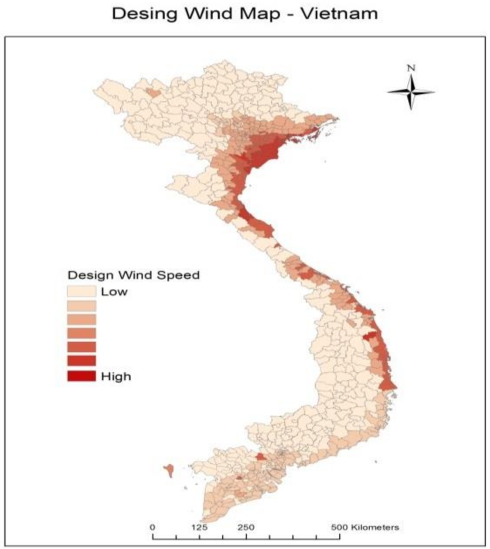
The AIR Southeast Asia Typhoon Models Support Regional Vulnerability for Wind



NSCP 1992



Taiwan Building Code 2007

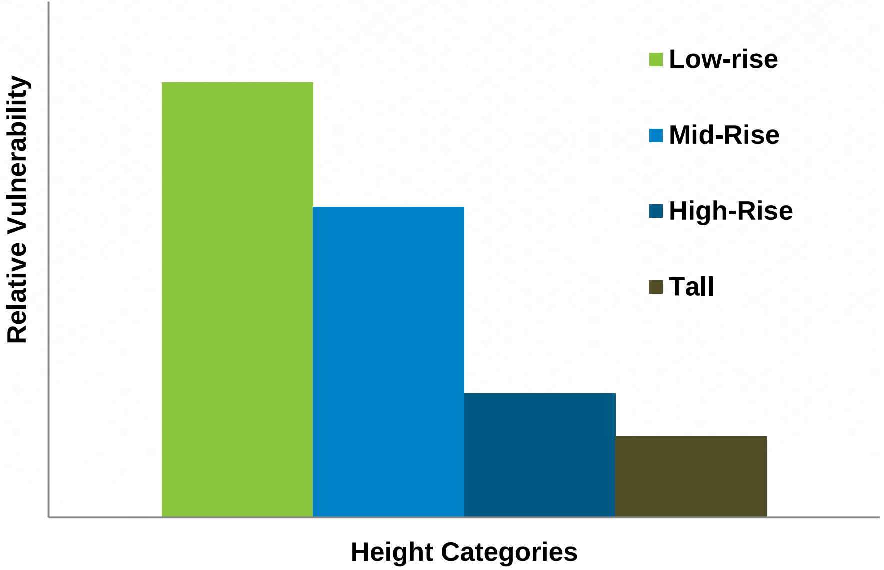


TCVN-2737-1995

Support regional vulnerability for Philippines, Taiwan, Vietnam

The AIR Southeast Asia Typhoon Models Differentiate Wind Vulnerability by Height

Number of Stories	Damage Function Classes
1-3	Low rise
4-7	Mid rise
8-29	High rise
30+	Tall



Taking into Account the Flood Defense System in Flood Risk Assessment Is Important

- Hong Kong:
    - Building codes and city planning requires flood mitigation measures
    - Better flood storage, levee system
- Taiwan: Good sewer system and levee system
- Philippines and Vietnam: fairly poor sewer and drainage system

Factors Such as Relative Flood Risk, Mitigation, and Resistance Vary Among Territories

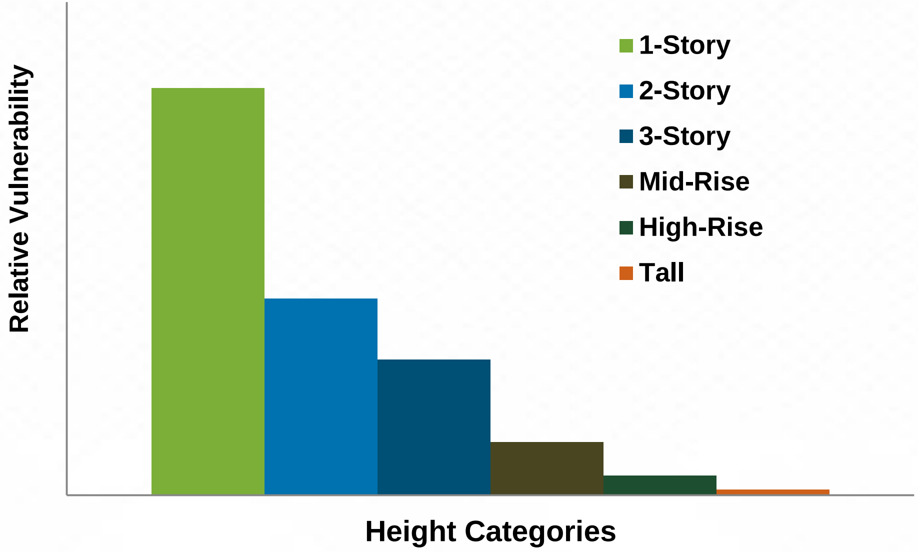
- Flood vulnerability
  - Flood hazard level
    - High → Low vulnerability
    - Low → High vulnerability
  - Flood Mitigation level
    - High → Low vulnerability
    - Low → High vulnerability

Territory	Flood Hazard level	Flood Mitigation Level	Flood Vulnerability Level
Guam	Low	Low	Low
Hong Kong	Mid	High	Mid
Macau	Mid	High	Mid
Philippines	Mid-High	Low	Mid-High
Saipan	Low	Low	Low
Taiwan	Mid-High	Mid-High	Low-Mid
Vietnam	High	Low	High

OCHA/Andrew Pendleton

The AIR Southeast Asia Typhoon Models Differentiate Flood Vulnerability by Height

Number of Stories	Damage Function Classes
1	1
2	2
3	3
4-7	Mid rise
8-29	High rise
30+	Tall



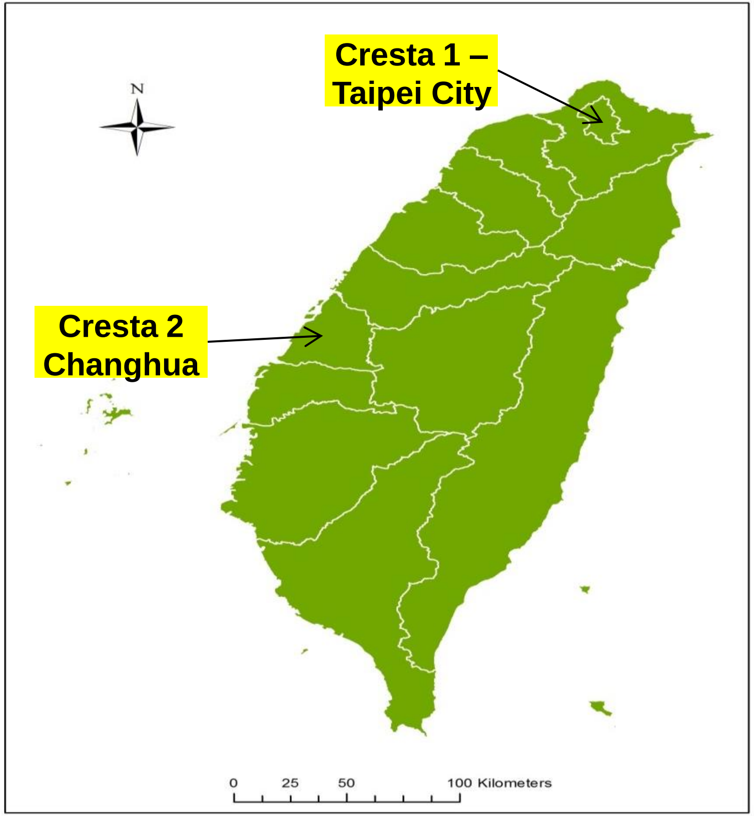
Surge Damage Functions Are Supported in the Models

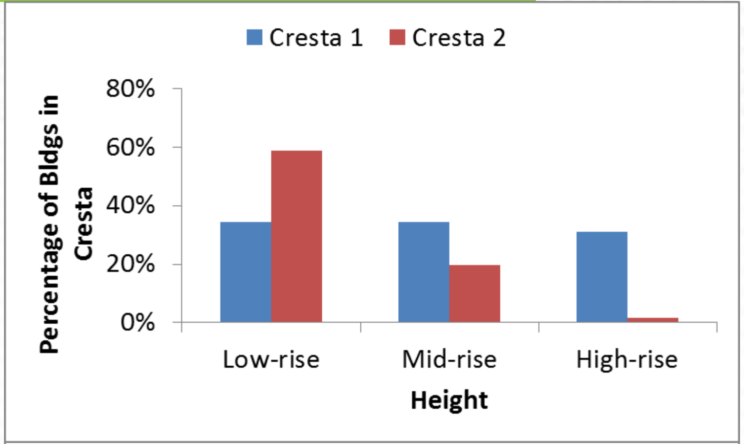
- As opposed to flood, surge is saltwater and has velocity component
- Accounting for the hydrodynamic effect of water using an equivalent static depth
- Supporting all lines of business, occupancy, and construction

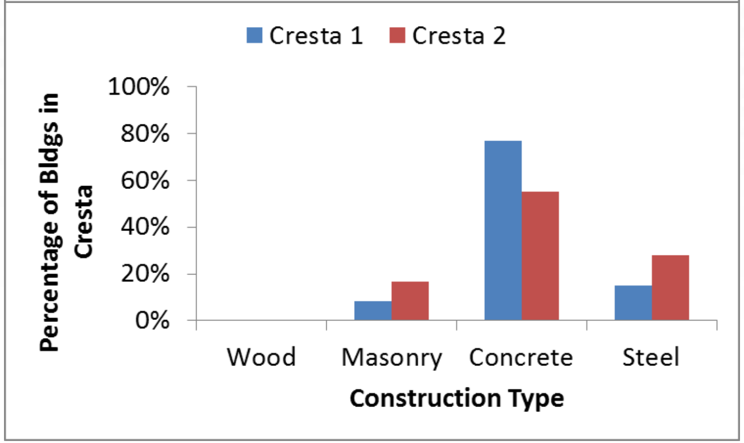
Haiyan, 2013, Surge damage in PHP

Nari, 2001, Flood in Taipei City, TW

Supporting CRESTA-Level Unknown Damage Functions Are Important in Assessing Risk in Southeast Asia







Several New Lines of Businesses and Sub-Perils Have Been Added

Risk Types	Wind	Flood	Surge*
Conventional Buildings	Existing	Existing	New
Infrastructure	New	New	New
Marine Cargo, Hull	New	New	New
Large Industrial Facilities	New	New	New
Builder’s Risk	Existing	Existing	New
Auto	Existing	Existing	New
2-wheeled vehicle	New	New	New
Warehouse	New	New	New

* Surge for the Philippines, Hong Kong, and Taiwan

Loss Benchmarks from Various Sources Are Used to Validate Losses

Industry losses

香港天文台
HONG KONG OBSERVATORY

NDRRMC
NATIONAL DISASTER RISK REDUCTION AND MANAGEMENT COUNCIL

中華民國產物保險商業同業公會
The Non-Life Insurance Association of the R.O.C.

DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

AON BENFIELD

Munich RE

JOINT TYPHOON WARNING CENTER
PEARL HARBOR HAWAII

Axco

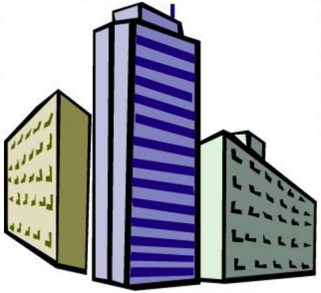
Swiss Re

GUY CARPENTER

Company losses

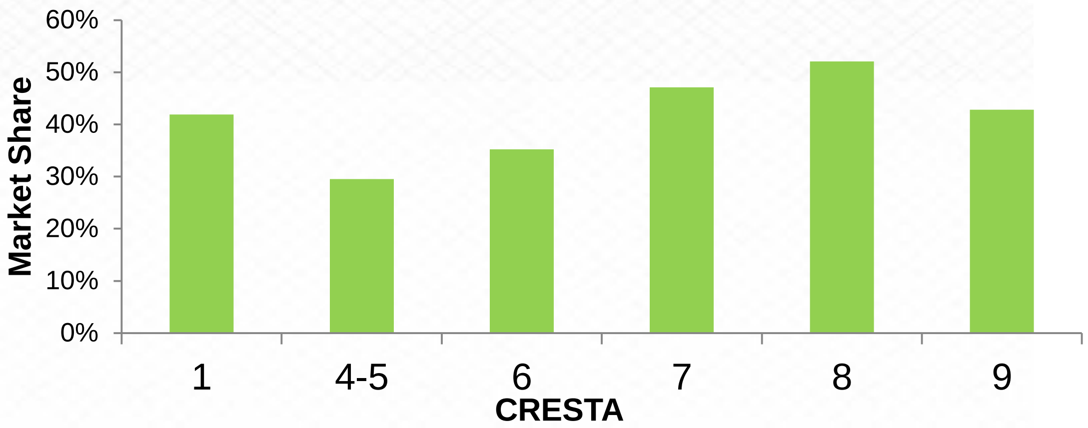
Company A

Company B

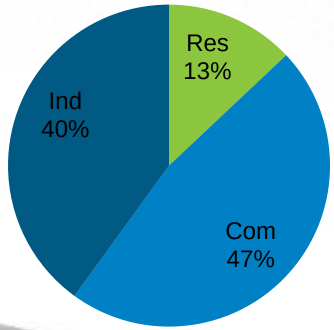


Company C

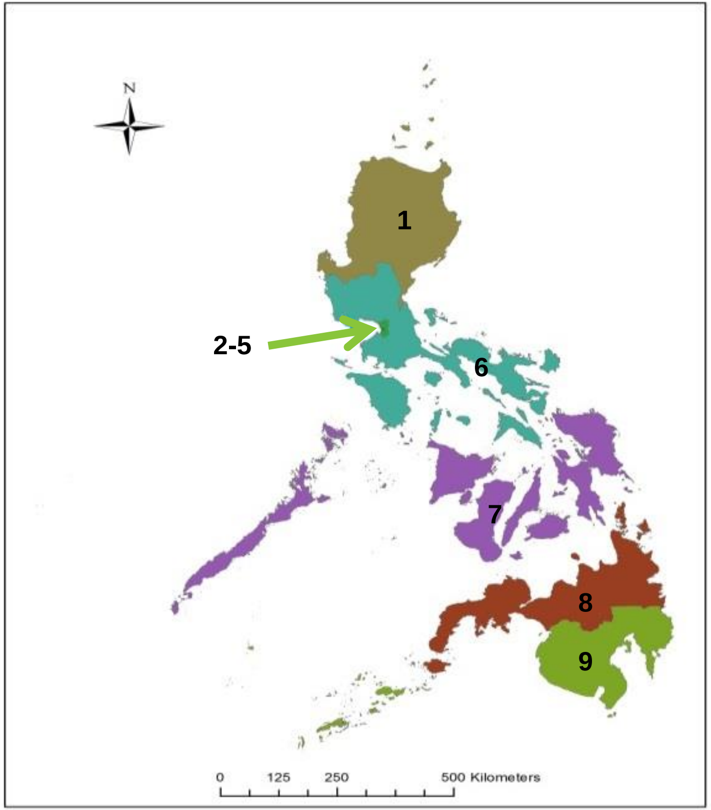
Representative Company Data Is Used for Model Development



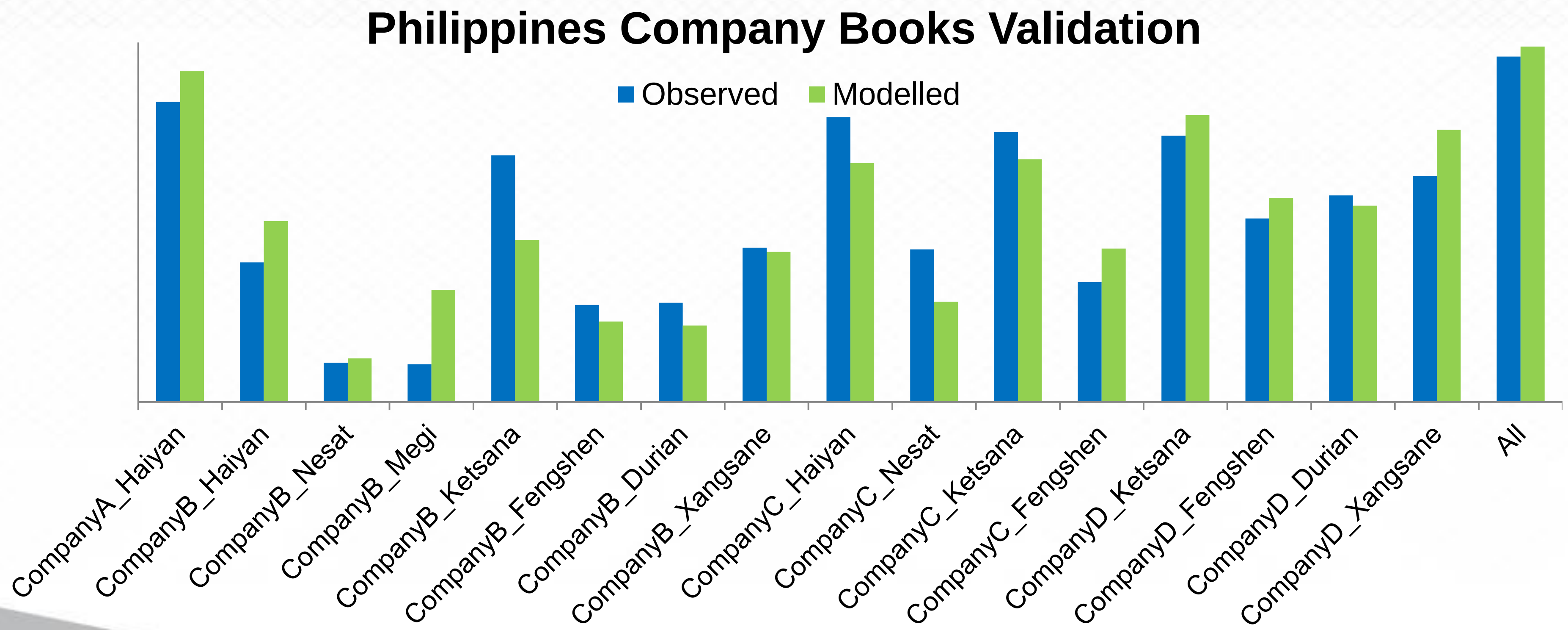
Replacement Value Distribution in Lines of Business



Cresta Map - Philippines

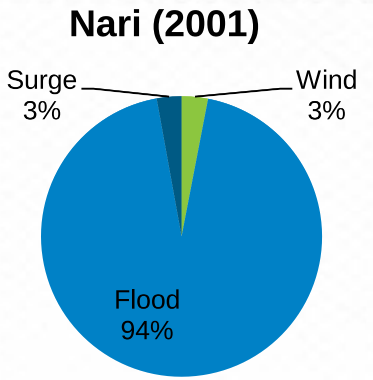


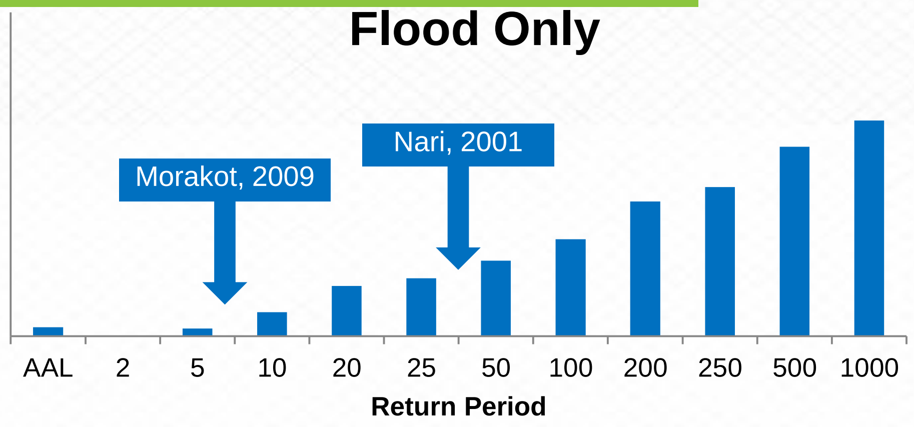
Company Books Validate Well Against the Models

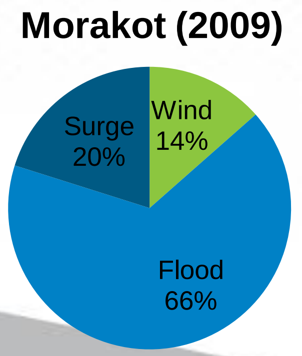


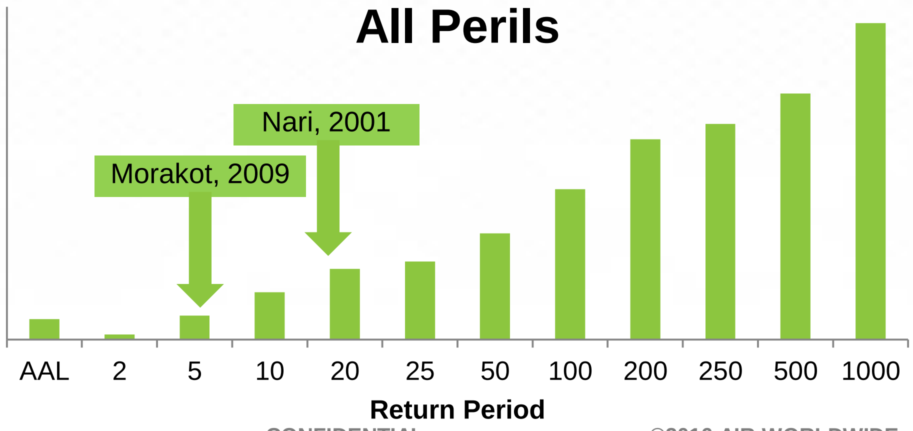
Major Historical Events Are Benchmarked on Loss Exceedance Probability Curves

An Example from Taiwan









Learn More About the AIR Typhoon Models for Southeast Asia on Our Website and at Upcoming Events


Learning From Typhoon Haiyan

Editor's Note: One year ago, the most powerful typhoon in the Philippines' histo
with far-reaching economic impacts. Read about what is being done to improv
catastrophes, including AIR's role in disaster risk assessment, risk reduction
and the Asian Development Bank.

The Philippines lies in the direct path of many of the typhoons tha
of more than 7,000 islands scattered over 1,830 km² is a large
annually, 5–10 of which typically make landfall on one of the
Philippines also occupies a particularly active portion of the
economy, costing on average about 0.5% of the gross do
rapid pace, the economic cost of natural disasters is risi
become unsustainable unless resources are diverted

At the time Super Typhoon Haiyan struck in late 20
proactively on disaster risk reduction and climate
of destruction and reconstruction. The Disaster
minister to lead each of the four aspects of the
and mitigation; and rehabilitation and recove
authority's revenue to go into its Local Disa
Disaster Risk Reduction and Manageme
but the plans it had in place were no m

Super Typhoon Haiyan

The Philippines is no stranger to super typhoons—even late in
2012 with winds of 280 km/h, and Typhoon Megi made landfall in late Oc

In Focus

The AIR blog about risk, modeling, and industry buzz.

Storm Surge in the Philippines

November 09, 2015

If we ask ourselves where in the world the greatest threat from storm surge is, the Philippines may not immediately come to mind. But it should. The archipelago spans 15 degrees of latitude in the tropics and is situated on the western edge of the most active typhoon-spawning ocean basin on the planet. As such, it is threatened by some 20 typhoons each year.

They don't all make landfall, of course, but of the eight or so that do there is a near guarantee that one will be a Category 3 or higher. With so many intense typhoons, an intricate coastline characterized by bays and inlets, and shallow bathymetry in many places, the Philippines is no stranger to storm surge.

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A Preview of the AIR Typhoon Models for Southeast Asia

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