MANAGING EXTREMES Willis Re

CATASTROPHE MODELLING IN THE NEW REGULATORY ENVIRONMENT - NEW GAME, NEW RULES

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Singapore, 18th January 2011

Introduction

- Insurance regulation; new game, new rules
- Impact upon insurance companies
- Why the insurance industry should care about climate change
- Lessons and conclusions

INSURANCE REGULATION - NEW GAME, NEW RULES

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Solvency II (or very similar Risk Based Regulation) is coming

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- Solvency II is Europe's new insurance regulatory regime
  - Inspired by Basel II banking regulation
  - Process launched in 2005, due to be introduced in 2013
- Solvency II is part of an international move towards Risk Based Regulation
  - Led by the International Association of Insurance Supervisors (IAIS)
  - The IAIS published Insurance Core Principle (ICP) papers in October 2010 which define emerging international regulatory standards
  - Definitive standards are to be agreed in October 2011
  - Many regulators are moving towards a Solvency II like system in advance ,often encouraged by desire to be deemed "equivalent" to Solvency II
  - Rating Agencies, especially S&P are moving rapidly in a similar direction
- Solvency II raises the threshold of Regulatory Capital Requirements
  - There is a standard risk adjusted capital formula, latest iteration QIS5 was completed in October 2010
  - 11% of European insurers who took QIS4 in 2008 failed to meet the Solvency Capital Requirement
  - QIS5 is much tougher, so far more (up to 30%?) will fail
  - Solvency II allows insurers to replace all or some of the standard formula with approved internal models - catastrophe risk is an obvious candidate for replacement

But Risk Based Regulation is not just about capital

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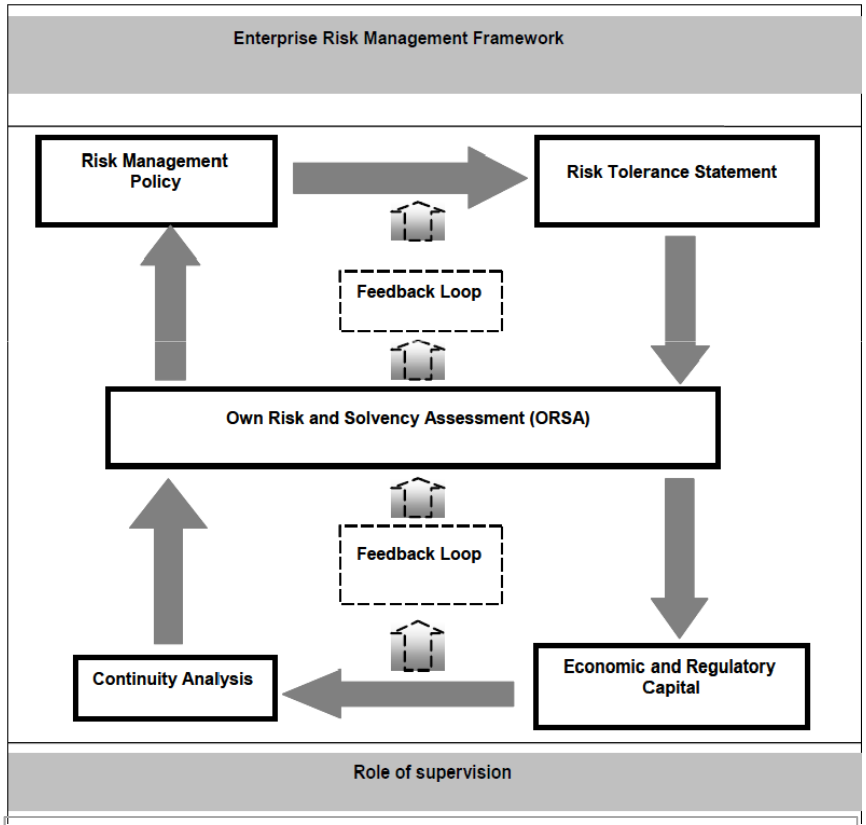
- It is as much about good governance
  - Capital assessment is within an ERM regime
- Companies must do an ORSA (Own Risk Solvency Assessment) to show
  - Have identified the risks they face
  - Understand these risks
  - Are able to quantify these risks
  - Know the limits of that quantification
  - Can demonstrate that they take appropriate action to manage and mitigate those risks consistent with their stated business objectives
- This places a very high standards of care on directors and management
  - They are expected to understand the broad features, limitations and sensitivities of the models used within the company
  - Outsourcing modelling, eg to cat modelling companies, does not remove this requirement



The IAIS standard ERM framework from IPC 16 showing the centrality of the ORSA to the whole risk capital regime

Regulators and rating agencies will struggle as well

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- Regulators and rating agencies cannot realistically audit internal capital models
  - They are resource restrained as well
  - In reality it takes as long to properly check a full internal capital model as it takes to build it
  - They will therefore look at:
    - adherence to procedures
    - competence of staff
    - reliability of software
    - Some key assumptions compared to others in the market
    - how the model result compares to the standard capital formula results
    - how model compare to the results of peer companies' models
    - adherence to procedures (again)
- But also they will want to see that the model is used throughout the business
  - They will see through a model built just for regulatory reasons
  - They will want to see the model used for decision making throughout the business
  - They will want to see the capital model; and the business plan in close agreement using the same assumption set

"Show me you really believe the model" – the USE TEST

Internal Capital Models

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- Under Solvency II insurers can apply to replace some or all of the standard capital formula with a full or partial internal model
  - Under QIS4 companies that used internal models obtained a capital requirement on average 20% lower than the standard capital formula
  - Given that standard formula QIS 5 results may be 20% to 30% higher than QIS4 the motivation to move to internal models will be enormous
  - For example in the UK 200 insurance entities (including Lloyd's syndicates) have applied for internal model pre-approval
- But internal models come at a cost
  - Even small syndicates at Lloyds have 5 to 10 people working on their internal model
  - One large international company recently talked of having 300 people working Solvency II worldwide, most on their internal capital model
  - Actuaries aren't cheap and they aren't going to get any cheaper – lack of qualified staff will be a major constraint going forward
  - Consultants can help (Solvency II has been a goldmine for actuarial and management consultants), but management cannot outsource ownership of the model and its assumptions
  - This is NOT an IT or software issue, it is a business issue that will involve every senior member of staff if the **Use Test** is to be satisfied

Natural Catastrophe Risks under Solvency II

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- QIS 5 introduced a “scenario” based method to calculate catastrophe capital
  - Loss factors applied to aggregate sums insured per cresta zone by country and peril
  - Diversification factors are applied
    - within country and peril
    - then by peril across Europe
    - then between perils
  - But a typical business mix is assumed
    - Fails if writing a different mix (eg commercial or agricultural rather than mostly domestic)
    - Fails if writing high deductible inwards business
- Fallback is a simple factor based method
  - Factors applied to gross premium
  - Reinsurance impact then netted off
  - But very conservative
- We expect most insurers to move quickly to a partial or full internal model
  - Limited by how quickly their regulator allows internal model approval
  - This will encourage development of reliable models where currently there are none (eg Vietnam) or where current models are of questionable quality (many Asian territories)
  - But this will imply very different demands on the company and changes to business practice

IMPACT UPON INSURANCE COMPANIES

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Model selection

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- Insurers must explain how and why they have chosen their catastrophe model and/or their approach to quantifying catastrophe risk
  - Insurers' advisors, eg reinsurance brokers, must help them make this decision
  - Implies catastrophe modelling companies must be far more open about the assumptions used in their models and how those assumptions were derived
  - Also implies that senior management within the insurer understand all of the above and the limitations of the modelling
  - Where there is little/no perceived catastrophe risk, insurers will be required to justify ignoring the peril
- Insurers must show they use the model for all significant decision making
  - Regulators and rating agencies are aware of the risk of "model shopping", for example using one model to calculate (low) regulatory capital but another to rate original business
  - The same model must be seen to be used for every business decision
- Regulators will probably not endorse one or more particular models
  - Companies may chose to amend a standard model if they feel the standard model is incorrect (eg Singapore or Philippines Earthquake) and they can give good reasons to make the change (eg the low return period numbers of the distribution significantly disagreeing with observed actual results)
  - But there is the real systemic risk that models will tend to converge, regulators will always compare results and will look at suspicion at a company or model very different from expectation – the "consensus" view may not be reality

Business consequences

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- Model companies will find it even more difficult to change their models significantly
  - Client companies' regulatory capital may be very sensitive to the modelled 1 in 200 number
  - Regulators confidence in a model could weaken if model results seem to be volatile
  - Potentially use credibility theory to weight model results and reduce reliance on one particular model
  - This factor is another drive towards model convergence and systemic risk
- Reinsurance brokers will need to come of the fence
  - Less multi-model, more chosen model
  - More sophisticated companies will expect their broker to help them choose which model to use
  - Smaller companies will initially expect a recommendation which model to use (though they will need to be able to defend that decision on the quality of the models not the quality of their advisor)
- The assumptions of the models will need to be tested
  - Requires model vendors to open their black boxes
  - Requires greater understanding of the science behind the models
  - The selected model should not be accepted as is, rather tested and possibly changed if underlying assumptions appear inappropriate or if, say, underlying climate trends or cycles are not included
- Models inherent uncertainty must better understood
  - Model variability is generally massively underestimate, robust stress testing is required

Example 1: Indonesian Earthquake

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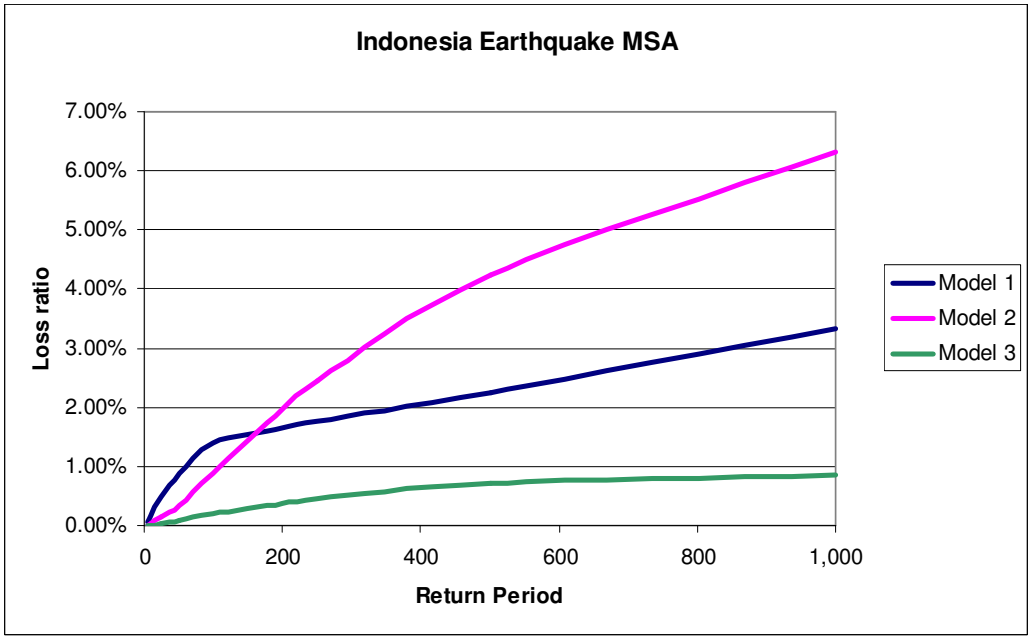
- Indonesia earthquake
- Three commercial models
- MSA shows very different loss curves
- Model 3 is considered too low in the market
- Choice between models 1 and 2
  - 100 year return period model 2 is approx 60% of model 1
  - 250 year return period model 2 is approx 130% of model 1



Return Period	Model 1	Model 2	Model 3
1,000	3.32%	6.33%	0.84%
500	2.25%	4.24%	0.72%
250	1.77%	2.44%	0.47%
200	1.65%	1.97%	0.36%
100	1.40%	0.88%	0.20%
50	0.87%	0.33%	0.08%
25	0.50%	0.14%	0.03%
10	0.16%	0.02%	0.01%
5	0.05%	0.00%	0.00%

Example 2: Turkey Earthquake

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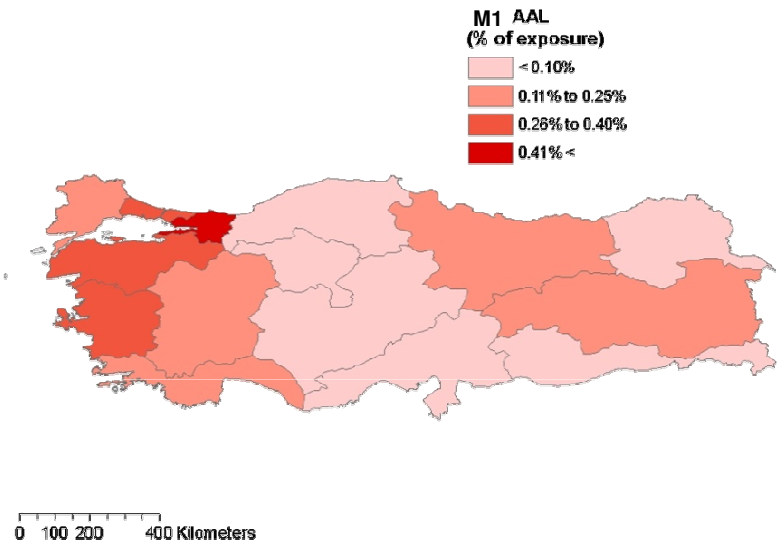
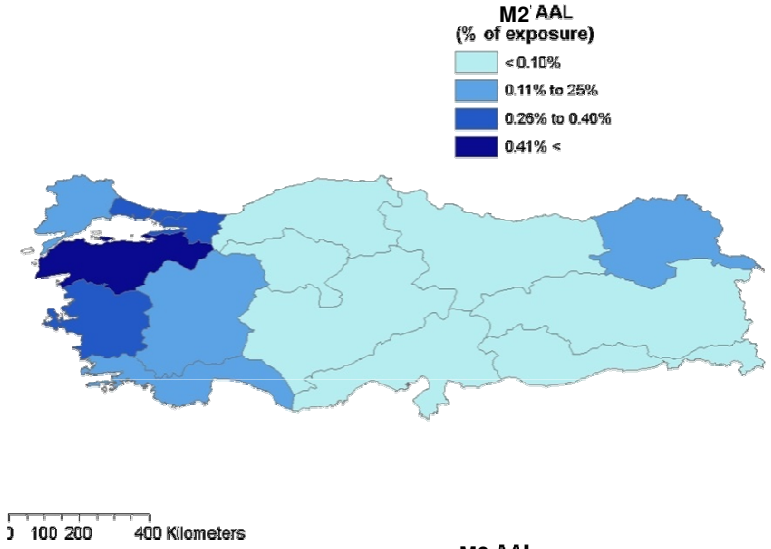
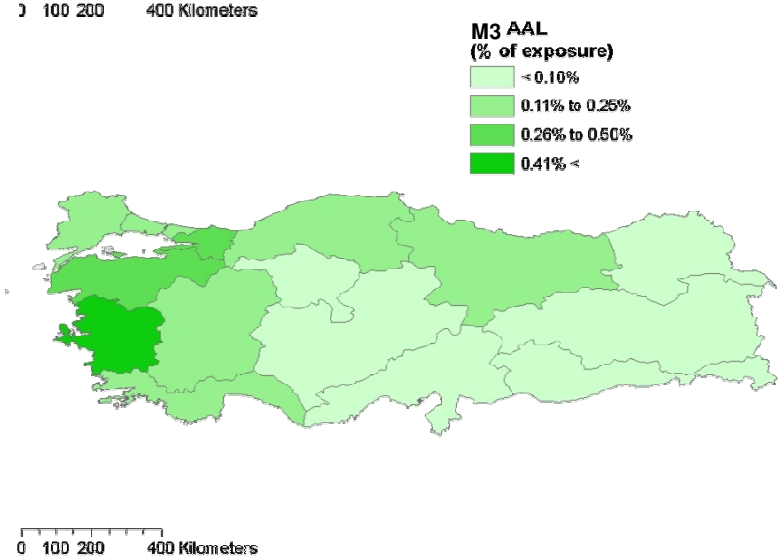




Average annual loss comparison of three vendor models based on a test flat portfolio (equal exposure per cresta)



Example 2: Turkey Earthquake detail

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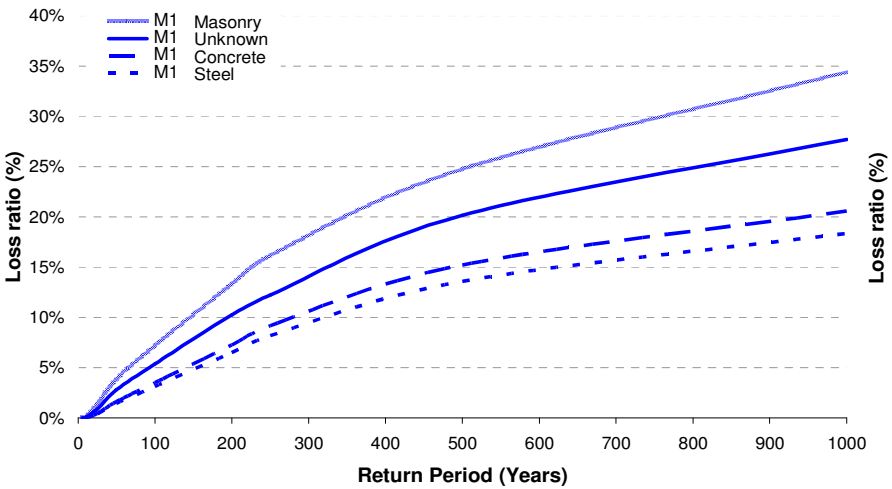

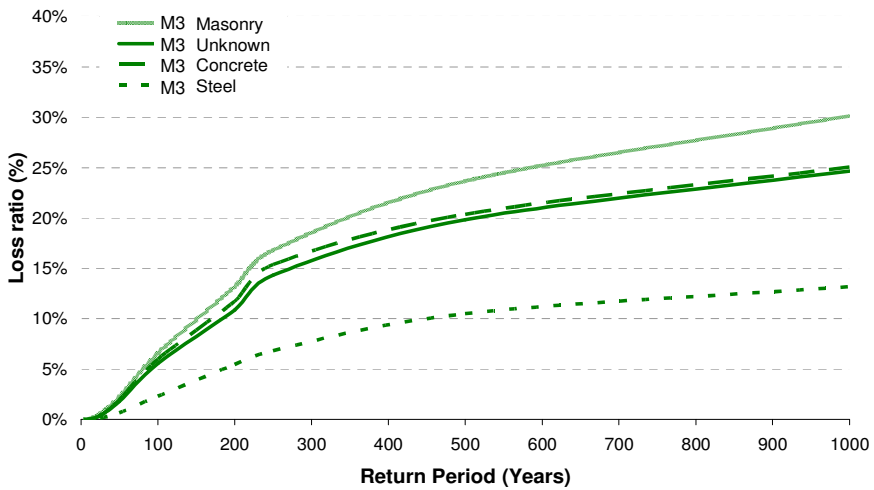

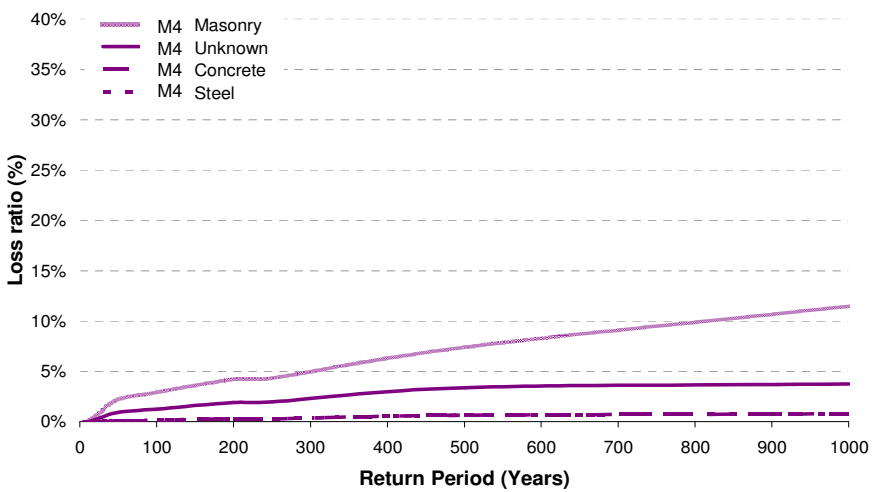

WHY SHOULD THE INSURANCE INDUSTRY CARE ABOUT CLIMATE CHANGE

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Climate Change – adding risk uncertainty

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- Anthropogenic climate change creates increased event uncertainty
  - Frequency and severity
- Current understanding is limited by model resolution
  - Particularly the water cycle
- Catastrophe modelling does not explicitly include considerations of climate change
  - But Asia is expected to show high sensitivity to climate variability
- High risk areas include coastal cities (Manila, Jakarta, Bangkok, Shanghai)
  - Storm surge, rainfall flooding, subsidence
- Agriculture is a particular concern
  - Impact of weather events on crop yields
- Infrastructure and transport
  - Cargo / container transport risks

Companies will need to show that they understand climate change/uncertainty and

Why the insurance industry must interact with science

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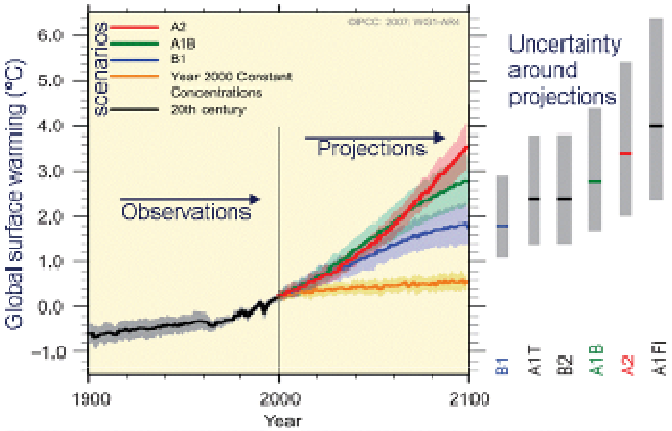
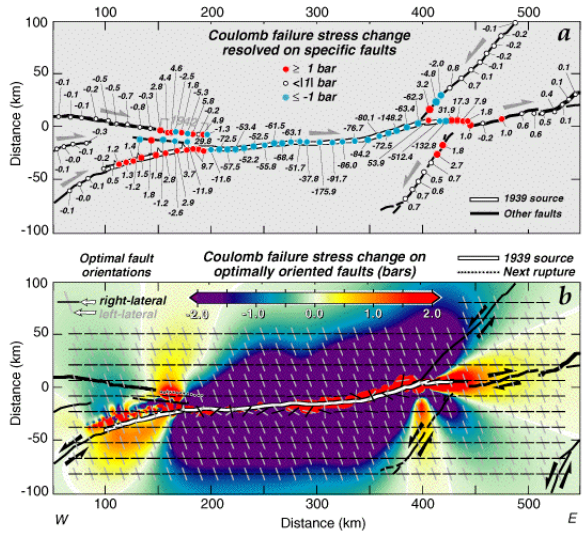
- Insurance decisions are sensitive to model changes – these must be understood and strategies developed to minimise them
- Allow rational decisions to be made when more than one possible model or modelling approach is available by weighing up the evidence (e.g. seismic risk multi-modelling)
- Historical data is limited – there uncertainty about the likelihood of future events (e.g. tropical cyclones across Asia-Pacific)
- Climate cycles (eg El Nino/La Nina) and trends (eg climate change) are poorly modelled if at all
- Climate change is not just a matter of the far future - understanding it is fundamental to understanding the past and so understanding risks faced NOW
- Regulatory pressures drive need for greater understanding and communication of risk and uncertainty





Source: USGS

Willis Research Network: World's largest insurance research group

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ambiental
Birkbeck UNIVERSITY OF LONDON
Bogaziçi University
British Geological Survey
UNIVERSITY OF CAMBRIDGE
BEIJING NORMAL UNIVERSITY
UNIVERSITÀ DI BOLOGNA
University of BRISTOL
CAMBRIDGE ARCHITECTURAL RESEARCH LIMITED
CITY UNIVERSITY LONDON
Colorado University of Colorado at Boulder
Durham University
EUCENTRE
ETH
UNIVERSITY OF EXETER
FLUVIUS Floodplain Ecology and River Basin Management
THE FLORIDA STATE UNIVERSITY
THE GENEVA ASSOCIATION Risk & Insurance Economics
GFDL Geophysical Fluid Dynamics Laboratory
GNS SCIENCE
Georgia State University
GFZ Helmholtz Centre POTSDAM
Imperial College London
Institute for Business & Home Safety
KIT Karlsruhe Institute of Technology
Georgia Tech
Met Office
Universidad de los Andes
National Centre for Earth Observation NATURAL ENVIRONMENT RESEARCH COUNCIL
NANYANG TECHNOLOGICAL UNIVERSITY
NUS National University of Singapore
KYOTO UNIVERSITY FOUNDED 1897
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University of Reading
SCRIPPS INSTITUTION OF OCEANOGRAPHY GLOBAL DISCOVERIES FOR TOMORROW'S WORLD
UWI
Walker INSTITUTE
Swansea University
TOHOKU UNIVERSITY

WRN Asia/Pac partners

- Credit Risk Initiative
  - National University of Singapore; Risk Management Institute; Prof Jin Duan
- Flood, precipitation, climate
  - National University of Singapore; Tropical Marine Science Institute; Dr Yui Liong
  - Downscaling climate models for precipitation – Jakarta flood
- Marine Cargo Initiative
  - Nanyang Technological Institute
    - Marine cargo exposure – Prof Jasmine Lam
    - Marine cargo vulnerability – Prof Sing Ping Chiew
- China natural hazards
  - Beijing Normal University
- Infrastructure systems vulnerability
  - Kyoto University
- Tsunami hazard and risk
  - Tohoko University

Moving from interesting theory to useful practice

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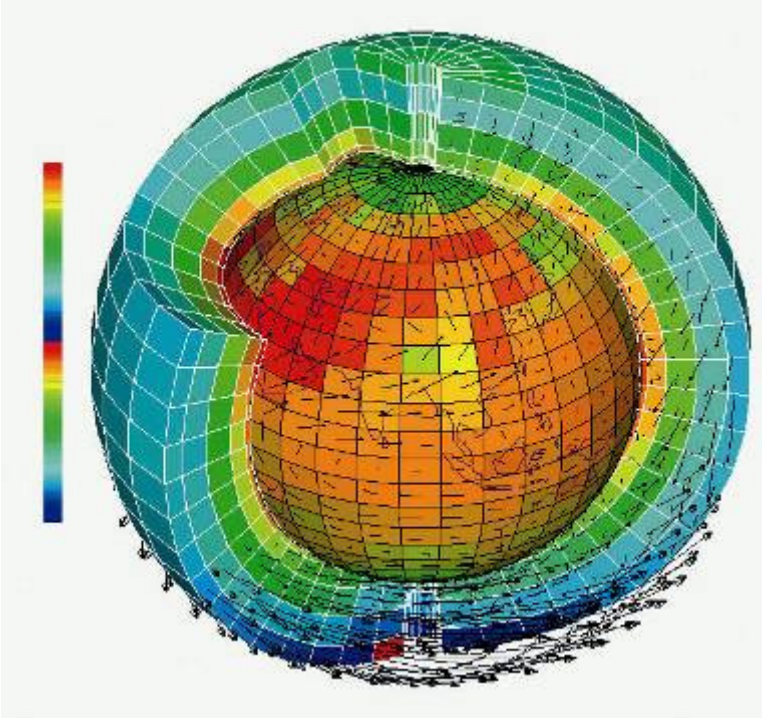
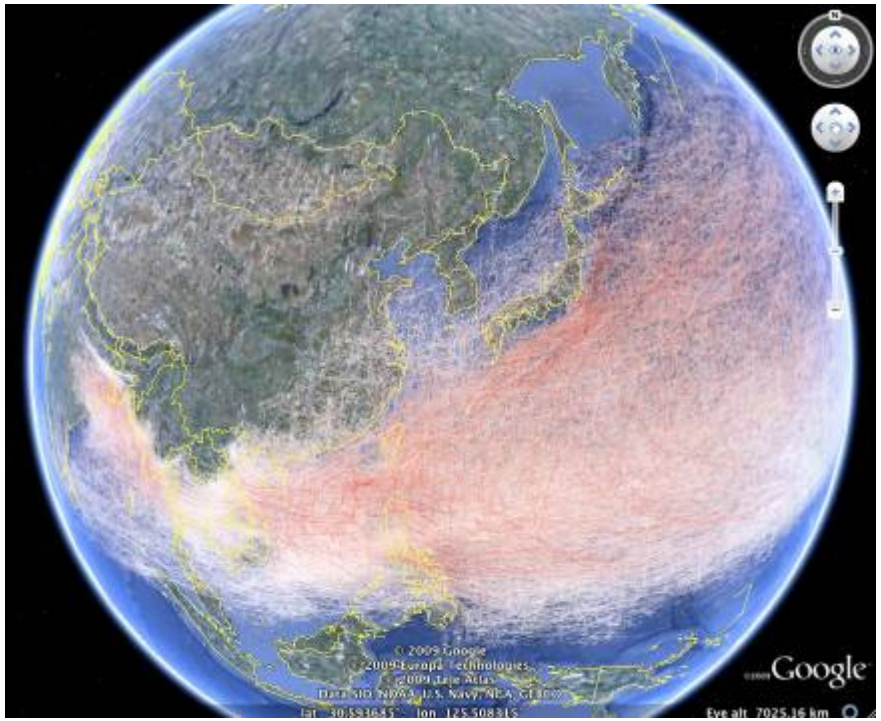
From this…



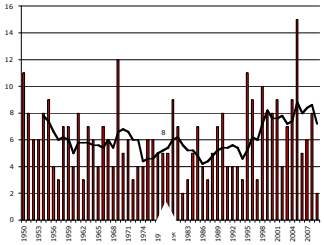
High resolution global climate models – UK HiGEM

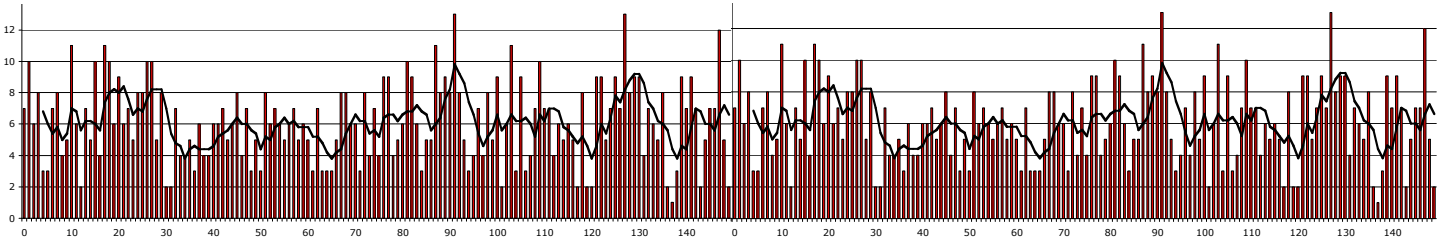
To this…



Extreme weather features as a direct output of climate model

Extending the limited historical data set

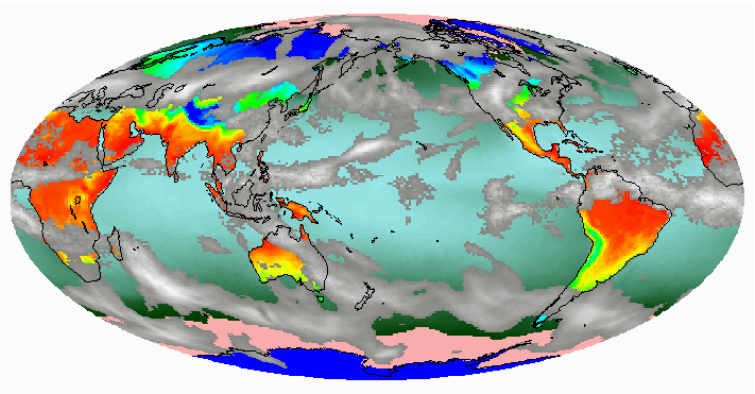




60 years observed

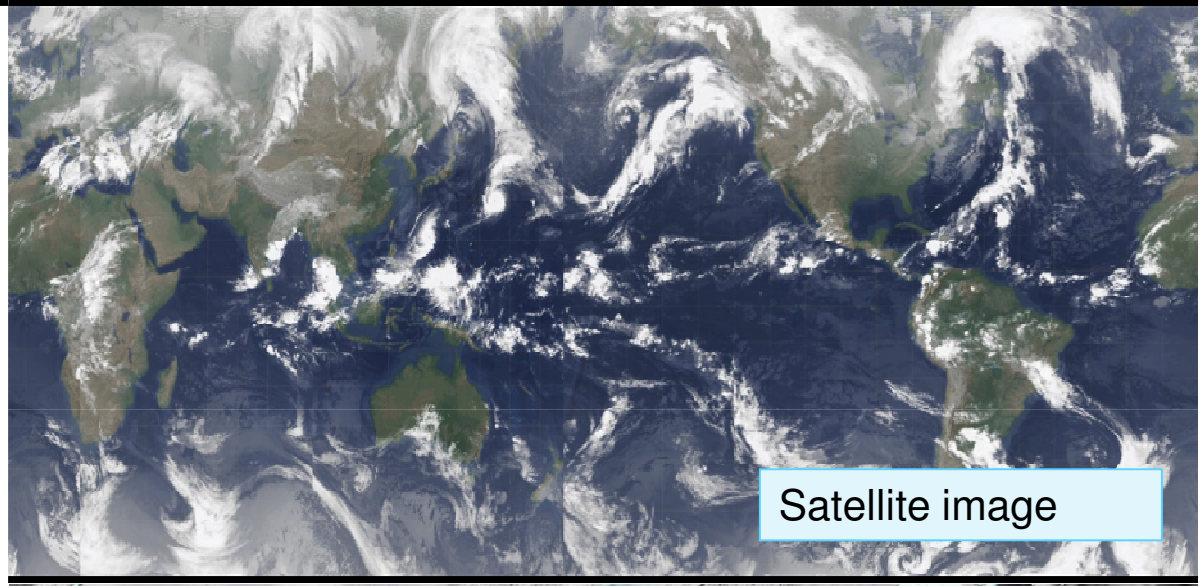
Example Simulated 300 years (here modelled assuming current climate)

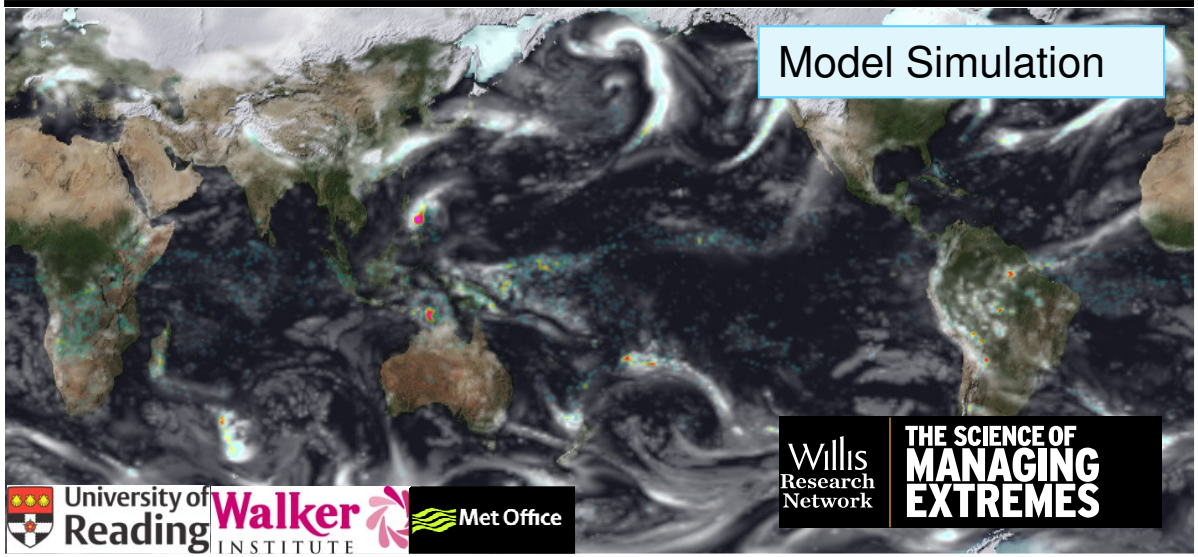
- Methodology
  - 300 years of HiGEM climate model output simulated with different base assumptions
  - Alternative (plausible) current climate scenarios including strong/weak El Nino or La Nina, Atlantic Multi-decadal Oscillation, climate change trends and other drivers of hurricane/tropical cyclone activity
- Application
  - Test sensitivity of current models to assumption change, including climate change scenarios
  - Test changes in stochastic internal capital models, adjusting catastrophe model frequency and/or severity assumptions



Practical applications of WRN research

- Theories tested, for example:
  - Landfall/path probabilities for basis cyclones
  - Event clustering
- Model sensitivity to assumptions to be tested and quantified
  - Event set selection
  - El Nino/La Nina effects
  - Climate change impacts
  - Uncertainty quantification
- New products developed
  - Decadal climate prediction
  - Hurricane Indices
- Helped by Willis Re, insurer staff then implement in practical real world models, demonstrating understanding and expertise





Tropical Cyclone Frequency, Severity and correlation

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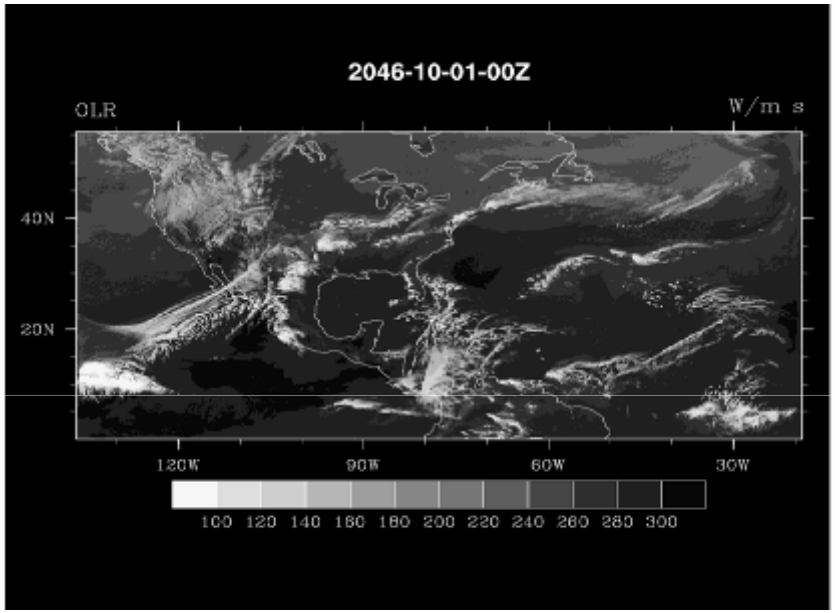
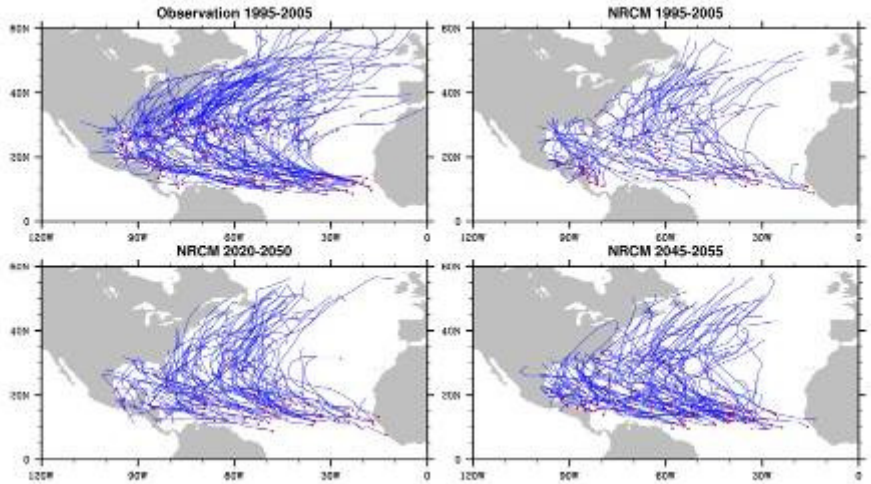
- Methodology
  - The world's leading hurricane experts
    - National Center for Atmospheric Research (including the leading global hurricane expert Dr Greg Holland)
    - Plus staff for Princeton and other leading international organisations
  - Key research areas include:
    - Correlated land falling modelling of US/Caribbean hurricane from nested global/regional climate models
    - Hurricane formation and track position under climate variability
    - Hurricane damage indices
- Application
  - Results used to check standard model assumptions and, if required, amend or stress them
  - Similar methods will be applied to Asian Typhoon





Wind storm frequency/ clustering

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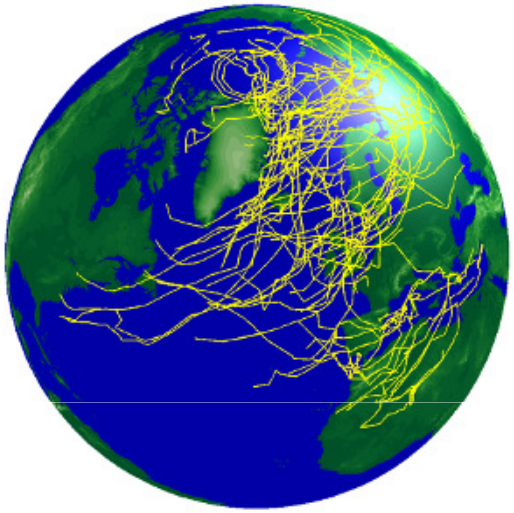
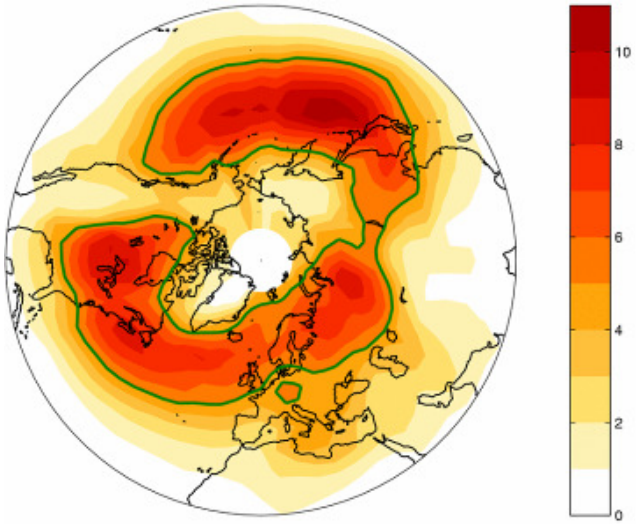
- Methodology
  - Eastward cyclone tracks identified using Kevin Hodges' TRACK software
  - Extended winters: 1 October – 31 March
  - 6 hourly NCAR/NCEP reanalyses from 1948-2003
- Application
  - Clustering results may be applied in a partial internal model, resampling native peril model results
  - The sensitivity of the internal model, and so capital assumptions, to changes in clustering assumption can be tested

Vorticity tracks crossing Greenwich 1 Oct 1989-31 Mar 1990



Mean number of storms crossing 20 deg barriers per month



Asian example: Jakarta Flood 2007

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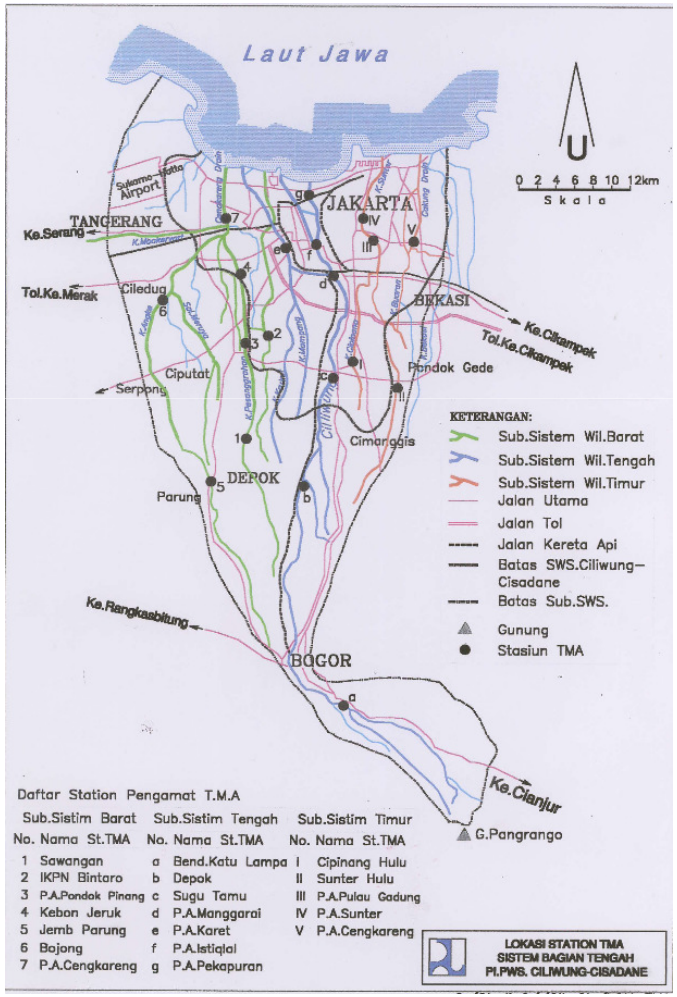
02 to 12th February 2007

- Affected Jakarta and east Java, west Java and Banten
- Caused by unusually intense rain during rainy season
- Affected 80 separate regions in and around Jakarta, over 70,000 homes flooded, 200,000 displaced
- US$880 million economic loss
- The Indonesian General Insurance Association estimated insured loss of approximately US$400 million
- Insured losses to residential, commercial, industrial and automotive – flood is usually an add-on to policies

Jakarta Project

- Singapore-led project, collaborating with international partners
- Integrating climate / meteorological data to assess flood risk to the city
  - Rainfall
  - Flow (water level; discharge)
  - River cross-sections
  - Tidal data
  - Surface models and urban structures
- Utilise various hydrological models to assess applicability and sensitivity
  - 1. Sobek (Package for RR and 1D, 2D flow, Deltares)
  - 2. Lisflood-FP (Bristol)
- Develop loss estimations from exposure



Sobek Model for Jakarta

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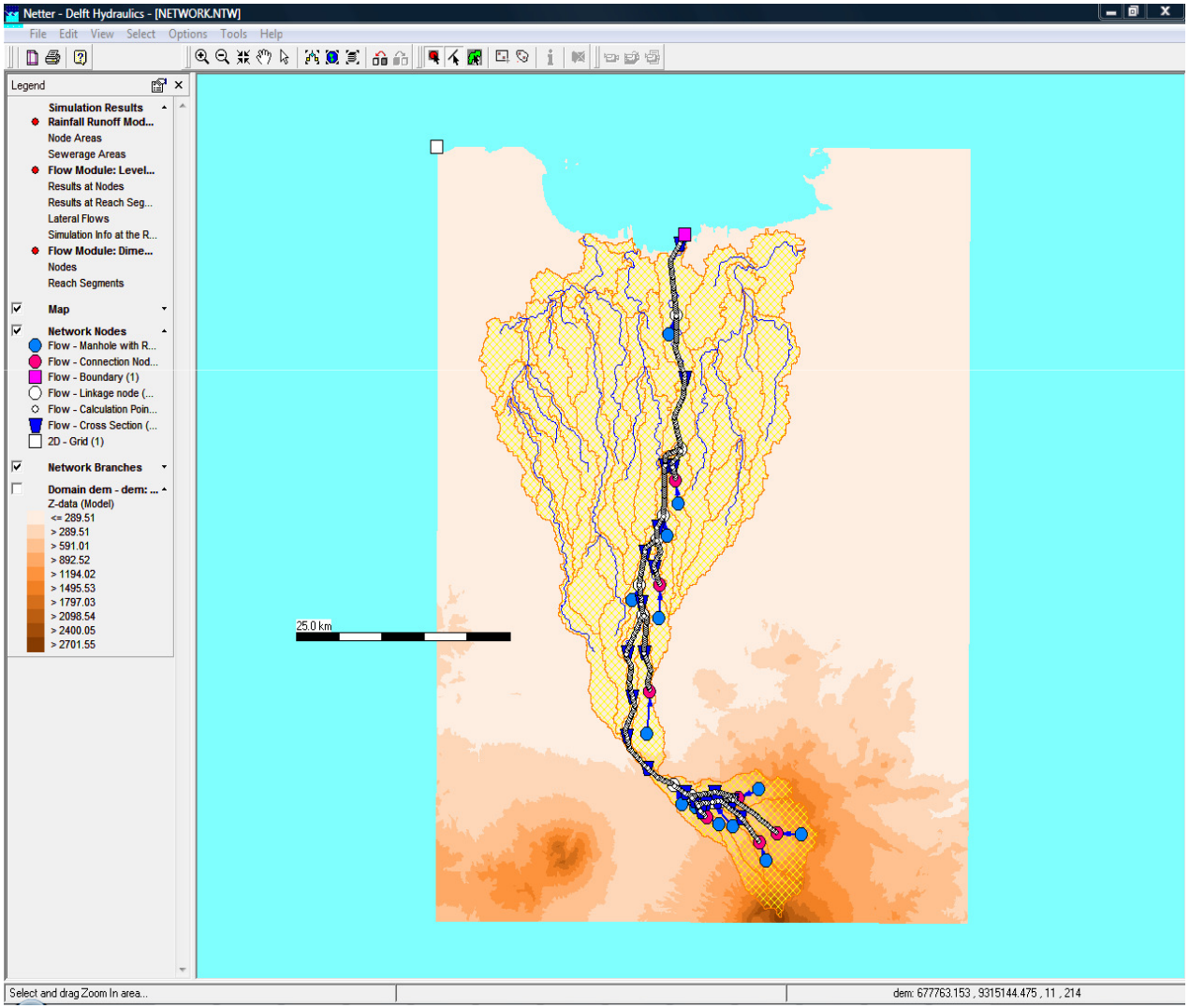

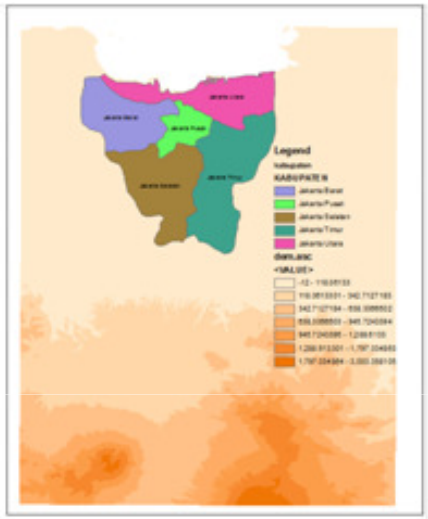

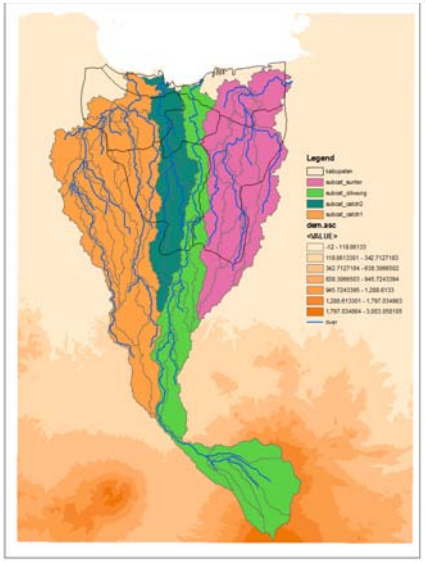

LESSONS AND CONCLUSIONS

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The pain

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As Solvency II like regulatory regimes spread throughout Asia, the threshold of technical competence required in the insurance industry will be raised

- Insurers will need to demonstrate that they fully understand the risks that they face
- Climate risks are significant in Asia, but are often poorly modelled
- Climate change adds another layer of uncertainty to current and future risk levels
- Insurers, including senior managers and directors, will need to demonstrate that they understand the underlying assumptions and limitations of the climate risk models/assumptions used in their business
- If insurers want to gain the benefit of internal capital models over punitive standard formula they will have to prove usage of the model throughout the organisation
- Company culture will change – all companies will have a Chief Risk Officer (some in the UK now have Chief Capital Modelling Officer as well)
- Actuaries and modellers, already a scarce and expensive resource, will become scarcer and rarer
- Additional costs will be incurred and management time spent on “compliance”

The gain

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As Solvency II like regulatory regimes spread throughout Asia, the threshold of technical competence required in the insurance industry will be raised

- Companies will understand the risks they face better
- They will better understand the inherent variability of these risks
- They will better understand the potential impact of these risks on their business
- They will therefore be better placed to make better, informed business decisions
- These decisions can be more transparently justified to stakeholders
- Governance should improve
- Profitability should improve (despite increased “compliance” costs)

But these benefits only accrue if the new world is enthusiastically embraced, if it is treated as just compliance all that will remain will be the extra costs

The truth

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- You are not alone, your reinsurance broker is ready to help
- Remember that this is not a technological problem, it is a business one, select the partner that adds the most value and you feel comfortable working with
- Software costs will be but a very, very small part of the total cost to your company, the bigger part with be staff, including senior management, time
- There is a large science base that probably has the answers you need about climate change – use it
- Help is at hand to translate scientific results relating to climate change, into useful, tangible, measurable output
- Even if your prime aim is compliance at minimal cost, being seen to embrace science and best modelling practice improves perception and so improves the chances of impressing regulators
- Move early, it won't get any cheaper or qualified staff more plentiful
- Become a "master of the modelled world" - gain an edge over your competitors

Start now, the new regulatory world could be here sooner than you think

CONTACTS

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