Model Output as a Universal Currency For Disaster Risk Financing And Management

Dr. Akshay Gupta
SVP and Director, Catastrophe Risk Engineering
AIR Worldwide
Panel Discussion

- Model use by governments, IFOs, emergency management organizations, and others for DRF, DRM, and DRR activities
- Development of new tools, data sets, and applications that assist DRF, DRM, and DRR activities
- Challenges in development of models and communication of output and limitations of models
- Model output as a universal risk currency
Panelists

- Dr. Milan Simic
  Senior Vice President & Managing Director – International Operations
  AIR Worldwide

- Catastrophe Modeling Framework
- Model Output as Currency of Risk
- Challenges in Model Development
  • Data
  • Communication of Risk Metrics
- Opportunities for Growth
Panelists

- Dr. Olivier Mahul
  Program Manager
  Disaster Risk Financing and Insurance Program, GFDRR
  World Bank

- Applications of Analytics and Tools in decision making associated with Disaster Risk Financing and Insurance
- Examples from South Pacific, Indonesia, and Mexico
Panelists

- Ivo Menzinger
  Head, Global Partnerships, Asia Pacific
  Managing Director
  Swiss Reinsurance Company Limited

- Importance of transparency and universally accepted view of risk in DRF and DRM.
Panelists

- Dr. Simon Young
  Lead Advisor – African Risk Capacity

- Experience of CCRIF and ARC in using in-house models and transferring the risk to the markets
Panelists

- Dr. Eugene Gurenko  
  Lead Insurance Specialist  
  World Bank

- Role of catastrophe risk models in developing new insurance markets
Panelists

- Andrew Eddy
  CEO – Athena Global Europe
  Program Manager – RASOR FP7

- DRM and new tools with an emphasis on near real time applications and other emerging applications
How Do Catastrophe Models Work?

HAZARD

EVENT GENERATION
LOCAL INTENSITY CALCULATION

EXPOSURE DATA

POLICY CONDITIONS

ENGINEERING

DAMAGE ESTIMATION

FINANCIAL

INSURED LOSS CALCULATION

Base Damage Functions

Concrete
Masonry

Philippines Aggregate Combined Loss Curve

Mean Loss ($M per)

Mean Return Period (Years)

Combined Prod Loss
Earthquake Loss
Tropical Cyclone Loss
HIT Precipitation Loss

Note:
- Mean return period reflects annual aggregate coverage to losses and includes both government assets and private assets
- Based on 0.25% annual exceedance rate ratio
Loss Exceedance Probability Curve is the Key Output of Catastrophe Models
Example – Hungary Flood Risk (DTM using 90m SRTM)
Example – Hungary Flood Risk (built-up areas using 250m satellite land cover)
Example – Hungary Flood Risk (indicative 2m flood extent – Upper Tisza, Koros, Danube)
Example – Hungary Flood Risk (combined indicative floodplain and built-up areas)
Disaster Risk Financing and Insurance Analytics
Empowering governments for DRFI decision making

Understanding Risk
Technical Session – Models as the universal currency
July 2, 2014
As a Minister of Finance, how do you develop your financial protection strategy against natural disasters?

Figure 5: Peak horizontal acceleration of the ground acceleration of gravity that has about a 40% chance to the next 50 years (100-year mean return period).

Figure 7: Contribution cyclone and earthquake

Figure 10: Direct losses caused by either tropical storms or earthquakes that are expected to be equaled or exceeded, on average, once in the time period indicated. Losses represented in absolute terms and normalized by GDP.
Governments struggle to make informed decisions on financial protection against natural disasters

- MoF increasingly include disaster risks in their fiscal risk management strategies
- Shift from products to strategies: optimal combination of reserves, contingent credit, risk transfer, ex post lending
- Massive amount of disaster risk data/information is produced through various disaster risk assessment and modeling initiatives
- “Ready to use” financial products, sometimes complex, have been offered by the private sector
Proposed Solution

- **Decision making framework** to help governments focus on key policy decisions about disaster risk financing and insurance solutions
- **Flexible, interactive financial tools** to guide the governments in their decision making process
  - Help the government identify and answer key policy questions
  - Development of national DRFI strategy
  - Support discussions with the private (re)insurance sector
  - Support monitoring and evaluation
- **Capacity building** on disaster risk transfer solutions
  - Consultations with the private sector
  - International experience
DRFI Analytics – Helping governments make informed decisions on financial protection against disasters

Building on reliable and appropriate data, DRFI Analytics empowers governments to take informed decisions on the financial management of natural disasters.

**DRFI Analytics Tools:**

- Are an effective interface between the policy maker and underlying technical models.
- Empower decision makers through technical capacity building.

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**Cat Risk Models**
- Hazard
- Exposure
- Vulnerability

**Historical loss data**

**Macro economic data**

**DRFI Analytics**
- Cost Benefit Analysis
- Risk Financing and Insurance Solutions

**Informed Financial Decision Making**

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[Logos: World Bank Group, GFDRR]
DRFI Analytics naturally fit within a control cycle approach to DRFI decision making

Specify the key DRFI policy decisions

Country specific DRFI Analytics tools

Implement and monitor experience

Analysis and Evaluation of Proposed Risk Financing Products/Strategies
Quantitative cost benefit analysis for different strategies can help strategy selection and instrument prioritization.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Ex-post credit</th>
<th>Insurance</th>
<th>Emergency budget reallocation</th>
<th>Contingent credit</th>
<th>Reserve fund / ex-ante annual budget allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$67.1m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$66.8m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$61.6m</td>
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</table>
Pacific Catastrophe Risk Insurance Pilot

Helping Ministries of Finance select catastrophe risk insurance coverage options

### Country-specific risk profile

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Tornado Loss</th>
<th>Tsunami Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeled Peril</td>
<td>20,000,000</td>
<td>2,630,000</td>
</tr>
<tr>
<td>Normal Display</td>
<td>1,70%</td>
<td>17,970,000</td>
</tr>
</tbody>
</table>

### Details of three different strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Earthquake and Tsunami Cover</th>
<th>Tropical Cyclone Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>1,110,000</td>
<td>2,630,000</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>1,590,000</td>
<td>4,160,000</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>2,340,000</td>
<td>5,950,000</td>
</tr>
</tbody>
</table>

### Calculations

- A loss from a tropical cyclone at least this large is expected to occur with annual probability...
  - 1.70% in 59 years

- The insurance claim payment under each strategy would:
  - Strategy A: 1-in-10 year per-peril attachment point: 2,630,000
  - Strategy B: 1-in-15 year per-peril attachment point: 2,740,000
  - Strategy C: 1-in-20 year per-peril attachment point: 2,800,000

- The retained loss under each strategy would:
  - Strategy A: 17,970,000
  - Strategy B: 17,260,000
  - Strategy C: 17,200,000

Note: Figures are highly indicative. Coverage limit may change depending on market conditions. Under all strategies the Ceding Percentage is set so that the total expected claim payment (over both policies) is US$200,000.
Sovereign cat risk transfer in Indonesia

Helping Ministry of Finance identify catastrophe risk transfer options

1. Which regions of Indonesia should be covered by a financial protection scheme?
2. How should financial cover be apportioned across each region?
3. How much annual premium can be spent on a risk transfer product?
4. What frequency or severity of events should trigger a payout?
5. How should the payout structure be designed?
Cost-benefit analysis of financial options in Mexico

Helping Ministry of Finance improve their DRFI strategy through an optimal combination of financial instruments
Olivier Mahul,
Program Manager
Disaster Risk Financing and Insurance Program, FCMNB and GFDRR, World Bank
omahul@worldbank.org
Models as Universal Currency for Disaster Risk Financing & Mgmt

Ivo Menzinger, Managing Director
Swiss Reinsurance Company
Disaster Risk Financing: growing alternative capital requires a universal, transparent currency

- "Alternative capital" broadly refers to reinsurance/retro capacity provided by capital markets investors rather than via traditional reinsurance.
- Alternative capital increased sharply since 2011 to USD 45 bn.
- Collateralized reinsurance grows fastest, reaching the volume of cat bond market.
- Alternative capital market share accounts for 11% globally and about 17% in the US, exceeding the 2007 level (post-Katrina).
Disaster Risk Financing: Regional risk sharing requires a universal currency

- **Haiti/Central America:** Micro catastrophe insurance
- **Caribbean:** Earthquake & Hurricane risk for governments
- **Mexico:** Earthquake/hurricane and livestock risk
- **Ethiopia/Senegal:** R4: Crop insurance for small scale farmers
- **Uruguay:** Hydropower shortfall due to drought
- **Kenya:** Drought insurance for seed growers
- **Vietnam:** Agriculture yield cover
- **India:** Weather insurance for farmers
- **Serbia/Macedonia/Albania:** Homeowner's earthquake & flood insurance (Europa Re)
- **Bangladesh:** Community flood insurance
- **Pacific Islands:** Earthquake & tropical cyclone risk
- **Mexico:** Earthquake/hurricane and livestock risk
- **Vietnam:** Agriculture yield cover
Disaster Risk Management: Cost-benefit assessments require a transparent, universal currency

Example Barbados: 75% of adaptation measures have net economic benefit
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Modelling and DRR for Sovereign Risk Management

Dr Simon Young
GeoSY Ltd
Context

• DRR activities in many developing world countries are undertaken with little reference to Ministries of Finance or to the economic benefits of DRM (or the costs of cat risk)

• Cat models provide a bridge, enabling the true cost/benefit relationships for DRR to be identified;
  – This is increasingly important as climate change adaptation and DRR/DRM become more and more integrated
Caribbean – shock and awe

- The first cat risk profiles generated for multiple countries to underpin the CCRIF launch in 2007 were greeted with dropped jaws by MoF officials
  - They had never seen annualised costs of cat risk before, even though they were generally aware of what the big events could do to the economies of their small islands
- CCRIF subsequently commissioned development of an in-house modelling platform by Kinetic Analysis Corp (KAC) to build on this entry point to:
  - Provide a solid, regionally-appropriate basis for CCRIF’s parametric policies
  - Provide high resolution, nationally appropriate risk information for multiple hazards
  - Potentially provide a regional public good for use by governments for other DRM/DRR needs
Africa – another paradigm shift

• The African Risk Capacity Agency has taken the Caribbean example further in two particular ways:
  – *Africa RiskView* has been designed to act both as the underpinning model for the drought risk pool (other perils to follow) AND as an early-warning tool for governments
  – Membership of ARC Ltd, the mutual insurance company affiliate of the Agency, and issuance of a policy, is only possible after Contingency Plans have been certified by a technical review panel – which outline how payouts will be used to mitigate food insecurity
Discussion Points

• While progress is definitely being made on quantifying sovereign disaster risk and implementing tools to improve management, we still see significant challenges in building capacity within countries to act on the information
  – The Country Risk Officer concept has been considered by OECD and others, but implementing at the country level is challenging
  – Utilising cat risk models to undertake DRR (and climate change adaptation) cost-benefit analysis remains more of a dream than a reality in most development contexts
• There remains a significant moral hazard element to *ex ante* DRM decision-making
• DRR (and risk transfer) costs are still largely seen for their (negative) short-term budget implications rather than as long term strategic investments to offset ongoing liabilities
The Role of Risk Models in Developing New Catastrophe Insurance Markets

Examples from Southeastern Europe Catastrophe Insurance Facility Program

Eugene N. Gurenko, Ph.D., CPCU, ARe

July 2, 2014
Catastrophe Risk Models

- “All models are wrong but some are useful…”
  
  *George E. P. Box, Statistician*

- In August 2013, AIR released Comprehensive Earthquake and Flood Risk Models for Albania, FYR of Macedonia, and Serbia.
SEEC CRIF Risk Model Applications in Insurance

- Pricing
- Loss assessment
- Reinsurance
- Regulation
- Consumer education
Models and rate making

Premium Rate = f (AEL, SDV, Loadings)
Models and Portfolio Loss Assessment: Serbia Floods, 2014

AIR Model outputs such as:
- Industry Exposure Data Base
- Vulnerability Functions for different types of buildings
- Digital Elevation Model
- On-the-ground water depth observations
- Aerial and Satellite Imagery

Footprint of Flood Superimposed on IED

Damage to Buildings and Contents

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>Apartments/Condominiums</th>
<th>General Commercial</th>
<th>General Industrial</th>
<th>General Residential</th>
<th>Grand Total</th>
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<tbody>
<tr>
<td>Light Metal</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Masonry</td>
<td></td>
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<tr>
<td>Reinforced Concrete</td>
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<tr>
<td>Steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Frame (Modern)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
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### Risk Models and Reinsurance

**Return Period** 250

<table>
<thead>
<tr>
<th>Month</th>
<th>Exposure</th>
<th>PML 250</th>
<th>RETENTION</th>
<th>Retro need</th>
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<tr>
<td>Jan-14</td>
<td>0</td>
<td>0</td>
<td>4,000,000</td>
<td>0</td>
</tr>
<tr>
<td>Feb-14</td>
<td>0</td>
<td>0</td>
<td>4,000,000</td>
<td>0</td>
</tr>
</tbody>
</table>

**XYZ Reinsurance Needs**

- Risk models are used to determine the amount of reinsurance capacity needed by a risk taking entity based on projected risk aggregates in areas exposed to catastrophe risk.
Application of models to Risk Based Supervision

- Insurer should have enough capacity (funds) to be able to face the probable maximum loss (PML) expected to arise from a large catastrophe event - with a given probability of exceedance - 0.5% (200 year-RP) – Solvency II.

- Insurer’s Net Earthquake Insurance Capacity should exceed Net Aggregate Risk Retention of arising from EQ property risks (EISR >1).
Models and Consumer Education: CatMonitor
Thank you for your attention!

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Short Bio:
Dr. Eugene N. Gurenko is a Lead Insurance Specialist at the World Bank Insurance Practice. During his career at the World Bank Group, which he joined in 1998, he designed and managed the World Bank programs of lending and technical assistance to the Turkish Catastrophe Insurance Pool, Romanian Catastrophe Insurance Pool, Europa Reinsurance Facility and, recently, the Kazakhstan Catastrophe Insurance Pool. From 2005-2006, Mr. Gurenko was with Munich Re, where he headed the company’s working group on Terrorism Risk Management. Dr. Gurenko holds a Ph.D. from Columbia University, a title of Chartered Property Casualty Underwriter (CPCU) and an associate degree in reinsurance (ARe). He is an author of numerous professional publications on catastrophe insurance and reinsurance.
DRM – new tools for a changing paradigm (RASOR Overview)

Presentation to UR London
Andrew Eddy, President, Athena Global
2 July, 2014
What do DRM Users Need?

• Up-to-date spatialised view of hazard extent (across several hazards)
• Up-to-date information on exposure of people and assets (and ability to project change)
• Comprehensive information on past disasters (to assist in risk identification)
• Ability to modify key parameters and project impact
• Ability to project cumulative effect of risk and correlations
• Ability to integrate analysis in a single tool
• Ability to produce information (layers) for ingestion in other tools
Logic Architecture

Ingested data, Inputs, Outputs

Catalogue

Data Search

Data Preparation

Elaboration

Analysis

EO Non-EO

Ingested data, Inputs, Outputs

Catalogue

Elaboration

Analysis

EO Non-EO
RASOR – what does it do?

• **Rapid:**
  – Mitigation: compile new analysis with or without in-situ data in hours or days instead of weeks and months
  – Warning: update existing risk analysis with NRT data from satellites as risk materializes; projections of future impact
  – Response: mark up data layers and inject new information to refine analysis
  – Recovery: track assets and support logistics of major recovery in NRT

• **Analysis:**
  – Past case studies of events, current situations, future scenarios
  – Multiple variables, sectoral perspectives, inter-related hazards
  – Evolving exposure and hazards
  – Flexible outputs

• **Spatialisation:**
  – VHR DEMs (TanDEM-X and Pleiades)
  – Satellite-based visualization

• **Risk:**
  – Hazard: from known data bases and new EO-based sources
  – Exposure: from global data bases and newly extracted EO-based
  – Vulnerability: from in-situ information when available
Equation Loss to School Buildings

- Without Mitigation
- Benefit of Mitigation
- With Mitigation

Event Generation
Local Intensity Calculation
Exposure Data
Policy Conditions
Engineering
Financial

Base Damage Functions
Residential Buildings - 66%
Accumulated Precipitation
Maximum Winds
Total Modeled Ground-Up Mean Loss per Division
Residential Buildings

EQ Loss to School Buildings

As-Is
Improved

- Mean Return Period (Years)
- Full Country Loss (Billion PHP)
- Total loss
- Benefit of Mitigation
- With Mitigation

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