Earth Observation and Big Data for Improved Financial Resilience

Webinar Series (Part I): November 23, 8:00 AM - 9:30 AM EST

How latest technology can support innovative risk financing solutions for climate shocks and other complex risks
Earth Observation & Big Data for improved Financial Resilience
The IDF has five pillars of focus. Each of these pillars is a barrier to closing the Protection Gap. The goal is to drive and enhance coordination and collaboration on inclusive insurance projects, and maximise the impact and efficiency of programmes that build financial resilience and inclusion in local communities vulnerable to climate change and other disasters.

There is an urgent need to improve global understanding and quantification of natural hazard disaster risk through the use, development and sharing of the re/insurance sector’s catastrophe risk modelling capabilities.

We need to support the development of insurance laws, regulations and public policy frameworks that enable and enhance sustainable development and economic/social resilience to natural catastrophes and other insurable loss events.

We must increase the sectors and countries in which insurance investments can operate by exploring how insurers, working with development banks and others, can support the requirements for investment in resilient and sustainable infrastructure in emerging and developing countries.

**What and who is the IDF?**

- Over 250 experts and practitioners from industry, governments, international institutions, NGOs and academia

- **5 Working Groups**
  - Risk Modelling
  - Law, Regulation & Resilience Policies
  - Sovereign & Humanitarian
  - Inclusive Insurance
  - Investment

The IDF is a public/private partnership led by the insurance industry and supported by international organisations.

The IDF aims to optimise and extend the use of insurance and its related risk management capabilities to build greater resilience and protection for people, communities, businesses, and public institutions that are vulnerable to disasters and their associated economic shocks.
The Protection Gap

The *insurance protection gap* is the difference between economic losses caused by disasters, and the amount of those losses covered by insurance coverage.

$162.5bn  
The size of the global insurance protection gap. Emerging economies account for $160bn (96%) of this.
Lloyd's World At Risk report, Oct 2018  
www.lloyds.com/worldatrisk

1%  
The percentage of natural disaster losses in developing countries 1980-2004 that were insured. This compares to c.30% in developed countries.
Dag Hammarskjöld Foundation and UNDP 2019  
Financing the UN Development System: Time for Hard Choices

$4tn  
The estimated figure lost to extreme natural disaster events globally over the past 40yrs, US $2.9 trillion of which was uninsured.
Swiss Re database of natural catastrophes
The image shows a map with various colored regions indicating levels of vulnerability to natural hazards. The map is color-coded as follows:

- **Very low**: 26.19 – 35.56
- **Low**: 35.57 – 45.11
- **Medium**: 45.12 – 51.70
- **High**: 51.71 – 62.62
- **Very high**: 62.63 – 74.36
- **No data available**

Max. vulnerability = 100%

Classification according to the quantile method.

The text on the map mentions:

1. **Coastal flooding exposure in Asia**
   - 2005: 1 Asian city in top 10
   - 2070: 8 Asian cities in top 10

2. **What is driving the exposure?**
   - Socio-economic growth
   - Urbanization
   - Population growth

3. **Africa very vulnerable**
   - 13 of the 15 countries with the highest vulnerability ratings are in Africa.

Footnotes:

2. World Risk Index (2017)

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**THOSE IN MOST NEED OF PROTECTION ARE UNINSURED**
Technology as part of the solution

Technology may hold the key to bridging the protection gap but not a panacea

- 3 closely interrelated categories of technological advancements that are contributing to a more detailed understanding of natural hazard and weather risks:
  
  - **increasing availability of data** (earth observation (EO), the internet of things (IoT), crowdsourcing etc.);
  
  - **increasing capacity to process that data** (artificial intelligence (AI – Machine Learning), cloud computing, etc.); and
  
  - **new tools for communicating risk data and mitigation advice** (including insurance distribution)
Earth Observation & Big Data: Application

- Building a historical record of events
- Early warning
- Post event assessment
- Understanding exposure
Benefits

- Advances in satellite technology and data analysis expand the potential reach of insurance policies to rural areas previously considered uninsurable
  - Avoid the pitfalls of high transaction costs
  - Enabling new distribution channels
  - Reducing cost of sales
  - Improving client on boarding
  - Understanding client needs
  - Underwriting
  - New product development
  - Gathering premium and paying claims
  - Building trust, knowledge and engagement
  - Streamlining claims handling and verification
The case of Accra, Ghana

To provide affordable, accessible, and reliable solution:

- Invest in risk reduction (e.g., waste management, drain expansion, etc.)
- Improve risk awareness and attitude towards risk in general
- Public sector support/local ownership needed to implement these measures

Challenging situation

- Lack of accessible historical loss data despite frequent floods.
- Patchy hazard and exposure data; flood risk not quantified.
- Out-dated public assets registry
- Challenges with waste management; blocked drains.

Towards insurability

- Updated public assets registry (geo-referenced).
- Hazard and exposure analysis with risk profile of all public assets.
- Cost-benefit analysis of identified risk reduction measures.
- Flood risk app to improve awareness and support for waste management awareness.

Understanding the risk

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Towards insurability

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Allianz

9
Enabling the creation of innovative services and products to help governments understand natural hazard risks and design systems to protect their citizens and infrastructure.
Some reflections

• Overwhelming quantity of data
  • How can low-income countries be expected to ingest, curate and analyse it?
    ▪ The private sector can potentially help
      ▪ Apart from global organisations, part of the answer may well be in the vast number of start-ups that are springing up with clever algorithms focused on specific risk problems.

• Potentially a bewildering number of approaches and data formats.
  • Justification for data standards, interoperability and use of open platforms that support these standards.
  • Necessary for any sensible modelling for financial resilience, because they enable:
    ▪ Less labour-intensive comparison and validation
    ▪ Shared views of risk across sectors
IDF Reports

IDF Practical Guide to Insuring Public Assets

How technology can help bridge the protection gap

Technology and Innovation: Tools to help close the Protection Gap in Microinsurance Markets

The Development Impact of Risk Analytics

IDF reports explore a number critical issues
Earth Observation Data to support Risk and Disaster Management

Driss EL HADANI
Director - Royal Centre for Remote Sensing - Morocco

World Bank / ESA Webinar
“EO & BIG DATA for improved financial resilience"
23 Nov 2020
Value Added Services provided by CRTS to Support User Community

✓ Ministry of Agriculture
✓ Irrigation Agencies
✓ Ministry of Finance / Treasury / Public Solidarity Fund
✓ Royal Police
✓ Regional Governorates
✓ Civil Protection Department
✓ Ministry of Interior
✓ Ministry of Agriculture
✓ Irrigation Agencies
✓ Ministry of Water Resources
✓ Basin Agencies
✓ Waters
✓ Ministry of land Management
✓ Urban Planning Agencies
✓ Local Authorities
✓ Private companies
✓ Ministry in charge of fisheries
✓ National Agency of Aquaculture
✓ National Agency of Harbors
✓ Fisheries National Office
✓ High Authority in charge of Forest resources
✓ Regional Direction
✓ Ministry of Interior
✓ Ministry of Agriculture
Emergency Response
• Disaster extent
• Monitoring
• Damage assessment

Recovery
• Damage assessment (ctd)
• Logistics and infrastructure analysis

Mitigation
• Hazard assessment
• Exposure mapping
• Vulnerability assessment
• Risk scenarios
• Emergency plans

Preparedness
• Early Warning System
• Forecasting/Nowcasting
• Event scenario

Data -> Products -> Services

First responders
Disaster managers
Local Authorities
National Decision makers
Scientists
Modeling of tsunami-induced floods

Flood maps based on the modeled tsunami scenario
Building Damage Modeling Approach to TSUNAMI Risk

Hazard Map

Vulnerability Map

Damage Map

Users: civil protection, regional planning department, local authorities
Estimation of building damage levels
Risks of Desert Locust invasion

Users: Ministry of Agriculture, CLNAA, CLCPRO (FAO)
Wildfires: mapping of burnt areas and damage evaluation
Région de Ouazzan, August, 2004

Image SPOT-XS acquise après le feu, Août 2004
Mapping & Monitoring of flooded areas
Région du Gharb, Jan-Mars 2010
Mapping flood extent by crop type (damage evaluation)
Région Gharb, Février 2009
Composite Drought Index (CDI)

December 2017

- Drought detection and warning
- Reduce the impact on the agricultural and socio-economic sectors
- Intervention assistance tools for the authorities

Users: Ministère de l’Agriculture, INRA, HCEFLCD, département de Eau, département de l’environnement, Assurances, ANDZOA, BANQUES du MAROC, DMN
Earth Observation and Big Data for improved financial resilience

Matt Foote, Climate and Resilience Hub
Willis Towers Watson
Climate Risk and Resilience – the critical role of EO

- 12th December 2020 - Paris Agreement 5th anniversary
- Climate and resilience is now a global mainstream issue
- Requiring new sources of data to inform and support far reaching decisions – net zero, NDCs
  - Physical impacts - acute and chronic
  - Transition – fundamental impacts on energy, industry and services at every scale
- Global, collaborative action to reduce GHG emissions – investment, risk financing, development
- Critical need for accurate, consistent and granular data
  - Climate futures
  - Infrastructure and societal assets
  - Monitoring and response
Where have we come in a decade?
How to unlock and exploit latent EO potential for DRF?

- **2012** – ESA workshop on use of EO for insurance
- ‘unprecedented’ global losses from catastrophes – many unmodelled, or poorly represented
- At the start of the Sentinel programme – most useable data behind paywalls or unavailable
- Fewer platforms in orbit
- Low level of uptake, or expertise within industry or public sector
- Most re/insurance products indemnity based
- **Potential** for innovation and DRF
In 2020...

- EO data now being directly applied to arrange of innovative DRF initiatives
- Parametric insurance triggers
- Regional scale data capture
- High overpass frequencies
- SAR / visible
- Sentinel / NASA open access data
- Improving catastrophe model calibration:
  - Hazard
  - Exposure
  - Vulnerability
To the future…

- Ongoing investment in open access multi-sensor platforms
- Sentinel 6 Michael Freilich – Sea level Rise and coastal risks
- CHIME Hyperspectral platform – agriculture / crop yield, senescence monitoring, natural assets, biodiversity – parametric insurance product triggers?
- Increased collaboration between EO agencies and role of commercial entities
- Democratisation of data and role of local expertise and application
GOST
Geospatial Operational Support Team

DEC Analytics and Tools (DECAT)
• Hundreds of millions of people around the world live in extreme poverty.
• Reducing poverty and boosting shared prosperity need measurement and monitoring.

• Minority groups, women and the poor are at greater risk to financial emergencies than the rest of the population.
• Moreover, many of these people live in countries that are constantly vulnerable to large natural disasters

• So when disaster strikes, we need to know where to target our intervention = where are the people/ assets at risk located?
GOST brings geospatial insight to World Bank operations while reducing costs and waste. GOST advises operational teams, brings analysis in house, gives geospatial data a home, shares it and coordinates investment with external partners.
Advice: Satellite imagery || Derivative Products

Landsat 8

Sentinel 2 A/B

Planet (PlanetScope)

Maxar (WorldView)

Sentinel 1A/B (Radar)
NightTime Lights: a proxy for economic development

- A nighttime view of the earth
- Polar orbiting satellites that can detect low levels of visible-near infrared radiance at night: clouds illuminated by moonlight, lights from cities and towns, industrial sites, gas flares, fires, lighting and aurora.
- Primary data source to measure human activities at a local, regional and global scale
- It can quantitatively characterize the intensity of the socio-economic activities and urbanization
NightTime Lights - applications

Current projects:

- **Open Nighttime Lights Archive** - will make the global nightly repository open and available in the public domain
- NTL is widely used in Energy Access projects
- Commonly used in studies of urban productivity
- Novel uses in poverty estimation

Past projects:

- Spatio-Temporal Dynamics of Urban Growth in Latin American Cities: An Analysis Using Nighttime Lights
- Imagery Analysis of nighttime lights over five South Asian Cities
- Tracking Electrification in Vietnam Using Nighttime Lights
- Twenty Years of India Lights web application
The WSF2015 is a 10m resolution binary mask outlining the 2015 global settlement extent derived by jointly exploiting multitemporal radar and optical satellite imagery.

OPEN SOURCE + the most accurate existing global layer of its kind

The WSF evolution is a dataset outlining the growth of settlement extent globally at 30m spatial resolution on a yearly basis from 1985 to 2015.
WSF - applications

**Urban landscape expansion index**: LEI measures change in urban extent; used to assess urban planning policies and design improved land allocation systems.
Digitize Africa

- Free to use by Gate’s Foundation partners (WB)
- Free to use any NGO, Uni, or GOV for HUMANITARIAN PURPOSES
- Ecopia will launch a public facing data portal for access request

Building Footprints: 416,419,314
Roads: 17,604,557

Powered by satellite imagery and artificial intelligence, Maxar & Ecopia.AI are mapping building footprints and roads across 51 African countries in just one year, with updates in year two.
Digitize Africa - applications

- **World Bank projects:**

  - **Census support:** work with client country census cartography unit to improve methodology.

  - **Input to estimations of economic activity and subnational poverty analysis:** South Sudan | Eritrea

  - **Exposure of population to floods:** Niger | Sierra Leone | Sudan

  - **Prioritization of rural roads:** Comoros | Uganda

  - **Least cost electrification plans:** Zimbabwe | South Sudan | Djibouti | Kenya
World Pop – population density estimates

- New constraints based on DigitizeAfrica building footprints
  - a more accurate population distribution
- 100 m resolution
- UN adjusted
- Age and Sex structures
World Pop - applications
WSF & World Pop - applications

Market Accessibility

- Markets
- Schools?
- Hospitals?
- Fire Stations?
COVID-19 response

Health Intervention Planning and Monitoring Data Support

- Visualizing distributions at various national or sub-national aggregations,
- Locating, quantifying populations at risk due to age and comorbidity factors,
- Identifying access to health facilities and critical care capacity,
- Quantifying availability of response supplies, facilities, and front-line workers,
- Mapping local case counts, testing, and fatalities,
- Assessing the secondary effects on the local economy, the safety of individuals and the environment.
The Global Infrastructure Map provides an unprecedented global scale compilation of ~60 layers of high quality, hyper-local geospatial data depicting infrastructure assets, networks and service flows, as well as related economic and geographic features.


Consistent, accessible canvas to spur discussions internally and with partners concerning the importance and location of key infrastructure.
Share: Open Tools “free and fit for purpose”

https://datacatalog.worldbank.org/
https://github.com/worldbank
https://github.com/worldbank/GOST_PublicGoods
https://maps.worldbank.org/
Thank you
Nowcasting disaster-related business *downtime* through social media data

Robert Eyre, Flavia De Luca, Filippo Simini
Our approach

Goal: determine the recovery status of small businesses in real time through the analysis of their posting activity on Facebook.

How: comparing the businesses’ posting activity after the event with the typical posting activity before the event.

Assumption: businesses tend to publish more posts when they are open and fewer when they are closed.
Aggregated posting activity

(a) Kathmandu, Nepal

(b) San Juan, Puerto Rico

(c) Juchitán de Zaragoza, Mexico

(d) Gorkha Earthquake, 2015

(e) Hurricane Maria, 2017

(f) Chiapas Earthquake, 2017

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of businesses</th>
<th>Number of posts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kathmandu, Nepal</td>
<td>11,818</td>
<td>1,182,878</td>
</tr>
<tr>
<td>San Juan, Puerto Rico</td>
<td>10,894</td>
<td>2,258,872</td>
</tr>
<tr>
<td>Juchitán de Zaragoza, Mexico</td>
<td>1,728</td>
<td>62,999</td>
</tr>
</tbody>
</table>
Event detection

- **Graph (a)**: Time series of $r(t)$ from 2013 to 2018.
- **Graph (b)**: Time series of $r_{PT}(t)$ from 2013 to 2018.
- **Graph (c)**: Time series of $\tilde{r}_N(t)$ from 2013 to 2018.
- **Graph (d)**: Time series of $r_T(t)$ from 2013 to 2018.

**Formulas:**

- $y = f(T)$
- $y = \theta T$
- $\max[f(\theta) - f(T)]$

**Data Flow:**

1. Data Collection
2. Data Processing
3. Downtime Detection
4. Event Detection

- $x_1(t), x_2(t), \ldots, x_B(t)$
- $q_1(t), q_2(t), \ldots, q_B(t)$
- $r_{PT}(t) = \sum_{i=1}^{B} q_i(t)$
- $r_N(t) = \frac{r_{PT}(t) - (n(t)/2)}{\sqrt{n(t)/12}}$
- $r_U(t) = P_N(\tilde{r}(t))$

**Threshold Detection:**

$T^*$, Threshold detection
Downtime estimates & Validation

<table>
<thead>
<tr>
<th>Region and Event</th>
<th>Source</th>
<th>Downtime Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kathmandu, Nepal</td>
<td>Estimated downtime</td>
<td>48 days</td>
</tr>
<tr>
<td>Gorkha Earthquake</td>
<td>Business surveys, from [12]</td>
<td>41 days</td>
</tr>
<tr>
<td></td>
<td>Kathmandu Post Disaster Needs Assessment [38]*</td>
<td>37 days</td>
</tr>
<tr>
<td></td>
<td>Mobile phone data, from [24]</td>
<td>56 days</td>
</tr>
<tr>
<td></td>
<td>Facebook posts text analysis (n = 299)</td>
<td>51 days</td>
</tr>
<tr>
<td>San Juan, Puerto Rico</td>
<td>Estimated downtime</td>
<td>118 days</td>
</tr>
<tr>
<td>Hurricane Maria</td>
<td>Satellite imagery, from [11, 39]</td>
<td>134 days</td>
</tr>
<tr>
<td></td>
<td>Puerto Rico Tourism Company¹</td>
<td>97 days</td>
</tr>
<tr>
<td></td>
<td>U.S. Energy Information Administration¹²</td>
<td>128 days</td>
</tr>
<tr>
<td></td>
<td>Facebook posts text analysis (n = 755)</td>
<td>71 days</td>
</tr>
<tr>
<td>Juchitán de Zaragoza, Mexico</td>
<td>Estimated downtime</td>
<td>52 days</td>
</tr>
<tr>
<td>Chiapas Earthquake</td>
<td>Facebook surveys (n = 16)</td>
<td>63 days</td>
</tr>
<tr>
<td></td>
<td>Facebook posts text analysis (n = 19)</td>
<td>55 days</td>
</tr>
</tbody>
</table>
Conclusions

- The posting activity of small businesses on social media can be used to accurately estimate the recovery status of regions hit by natural disasters in real time.

- The methodology works for different types of natural disasters (earthquakes and hurricanes) and in both developed and developing countries.

- The methodology is generally applicable to detect anomalies in non-stationary aggregated time series.

Paper describing the methodology has been published in Nature Communications: https://www.nature.com/articles/s41467-020-15405-7