Technologies Driving Earthquake Loss Reduction

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- Earthquake warning systems
- Precision imaging
- Post-quake UAV imaging
- Real-time deformation monitoring (even seafloor)
- Displacement and shaking alerting for lifelines
- Social media for earthquake information and alerting
- Near-real-time financial products & decision-making
- and much much more!
Earthquake Early Warning

Goal: Real-time alerting of an earthquake’s initiation, growth, expected and measured ground-shaking, fault orientation and slip — this information used by emergency managers, utilities, private companies and the public to reduce deaths, injuries, fear, business disruption, and economic losses.

Technology challenges:
• Low-latency in the system
• Mass distribution of alerts
• Targeted distribution of alerts

Societal challenges:
• False alarms and missed earthquakes
• I didn’t experience what I expected
ShakeAlert Data Products

**Source parameter stream**
- Latitude/longitude, depth
- Magnitude
- Origin time
- Fault parameters – *coming soon!*
- Update more than once per second
- User-calculated intensity & time
- XML format

**Intensity polygon stream**
*In development:*
- Ground motion estimates (MMI)
  - “Strong shaking” (>II)
  - “Weak shaking” (>V)
- Simple alerting polygons
- CAP alerting format
Cell Broadcast: Two-Step Alerts Likely

First Message

- **Fast** (<3 seconds?) over a control channel
- **Little information** (2 levels)
  - “Weak shaking expected”
  - “Strong shaking expected”
- Pre-set phone response

Second Message

- **Slower** (~10 seconds?)
- **More information**
- **Short term**: (1-2 years)
  - Text content only via WEA
  - 90 → 360 characters?
- **Long term**: >2 years
  - New message type
  - Info to calculate user-specific time and intensity in the phone
  - Receiver geolocation limitations

Japan ETWS based on 3GPP TR 23.828
ShakeAlert Roll-out Plan

Planned Steps

• **Pilots** - selected fault tolerant uses

• Automated Actions - wider industrial use, transportation

• Limited people alerts - groups who can be trained

• Expanded people alerts in public venues (no advance training)

• Geographically limited public alerts (where network is dense)

• Full public alerts via all available pathways

• **Encourage** responsible use of alerts

• **Pace** applications with system capabilities
<table>
<thead>
<tr>
<th>Sector</th>
<th>Current Betas</th>
<th>Current &amp; Likely Pilots</th>
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<tbody>
<tr>
<td>Automated controls (commercial, home)</td>
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<td>Fire Dispatch for Menlo Park FD, JPL</td>
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<td>Co's: LA, Orange, Riverside, San Diego, Santa Barbara, San Bernardino, Marin, San Mateo. The Salvation Army, CHP, JPL</td>
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Low-Cost Sensor Networks – Seismic and GPS
“An Earthquake & Tsunami Rapid Situational Awareness System for Chile” – USAID/OFDA

Objectives
• Demonstrate the crowd-sourced EEW approach with a low-cost sensor network (seismic and GPS - cell phone technology)
• Test and develop new algorithms, using ground-truth observations from the Chile Seismic Network (CSN)
• Expand CSN/USGS collaboration

Technical Accomplishments
• Android Software
• GPS printed circuit board
• AC/DC enclosures
• Server socket manager
• Prototypes installed
• Network expanded

Next Steps
• Tune algorithms
Real-time Geodesy, High-Resolution Imagery and UAVs
Mobile Laser Scanning

3D laser scanning technology from tripod mounts and mobile platforms (*vehicles*, *backpacks*, *balloons*, etc.) enable measurement of landscapes at centimeter-level precision over large areas.
2014 Napa earthquake: Precision geodesy to track fault afterslip

Postseismic slip (cm):
August 26 - October 22, 2014
Seafloor geodetic techniques allow for measurements of deformation over the 70% of Earth's surface that is inaccessible to the standard tools of tectonic geodesy. Acoustic **ranging**; **pressure** sensors; underwater **strain-**, **tilt-** and **gravity** meters; and repeat multi-beam **sonar** and **seismic** measurements are able to capture small-scale or regional deformation with approximately centimeter-level precision.
Drones Enabling Damage Modeling
FINANCIAL DECISION-MAKING BASED ON NEAR–REAL-TIME EARTHQUAKE INFORMATION

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(2) Global Head of Cat Risk Research, Guy Carpenter, Guillermo.E.Franco@guycarp.com

Abstract

Post-earthquake financial decision-making has evolved considerably over the past decade. Companies, governments, and aid organizations have shown increasing creativity in utilizing real-time earthquake information for their own loss estimation, financial adjudication, and situational analyses. Such information can be of significant benefit to stakeholders, facilitating risk transfer operations, risk management, and assisting disaster responders. The main motivation for this paper is to review and develop post-earthquake financial decision-making strategies using real-time earthquake information. A better understanding of the tools of the trade and specific needs can enhance NRT earthquake information systems, which in turn may enhance the further development of additional risk management alternatives for real-time post-earthquake financial instruments. In particular, this paper demonstrates that the right earthquake parameters and more quantitative geospatial hazard information, such as theshakeMap system, are likely to prove most useful. Herein, we describe several developments that streamline post-earthquake decision-making, including spatial variability characterization and, in particular, the use of quantitative risk management alternatives for real-time decision-making.
many earthquake information products...
... and many interested users of those products
Swiss Re plans parametric quake cover using USGS ShakeMap data

by ARTEMIS on FEBRUARY 9, 2017

Global reinsurance giant Swiss Re is planning to launch a new parametric earthquake reinsurance product soon. The new product, dubbed Swiss Re QUAKE, will utilise USGS ShakeMap data to structure triggers that payout rapidly.

Parametric insurance and reinsurance protection is becoming increasingly available, with efforts to sell the product seemingly ramping up and new products being launched all the time.

The use of parametric triggers as a way to offer coverage that pays out rapidly, on the occurrence of specific catastrophe or weather event parameters, is nothing new. But the way the parametric product is thought about, marketed and sold is advancing, which bodes well for uptake.
**Inter-American Development Bank (IDB) Disaster Contingency Loans**

(Six Latin America countries; up to $300M coverage per country)

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**Example of PAGER - USGS Report**

Estimates the people exposed to a given shaking intensity in every point.

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**Earthquake Coverage: A hypothetical example**

- **The Coverage Index (CI) calculation:**

  \[ CI = \frac{(\text{Total Affected Population} - \text{MiAP}) \times 100}{(\text{MAP} - \text{MiAP})} \]

  - **Total Affected Population:** 322,000
  - **MiAP (5% of Country Population):** 5% \[\times (10,000,000) = 500,000\]
  - **MAP (2% of Country Population):** 2% \[\times (10,000,000) = 200,000\]

  \[ CI = \frac{(322,000 - 500,000) \times 100}{(500,000 - 200,000)} = 41\% \]

  The Contingent Loan provides coverage for up to US$100M. Therefore, an event with a CI of 68% would be eligible for a pay out of up to 41 US$M.

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**Earthquake Coverage: Eligible Event**

- **Event Intensity and Exposure definitions:**

  The Event has to register a VII (or higher) shaking intensity in the Modified Mercalli Intensity Scale (MMI), and expose a certain country population inside the General Coverage Area.

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Courtesy of J. Martinez, IDB
IDB supports Ecuador with credit line of $300 million after the earthquake

Northern coast on April 10.

"In this difficult time, our thoughts are with Ecuador," said Luis Alberto Moreno, IDB president. "Especially, I would like to extend my deepest condolences to the families affected by this tragic event, and give them all of our encouragement and support."

"At the IDB we are closely following the situation and we stand ready to help the Ecuadorian government face the disaster," added Moreno. "We have approved an emergency donation of US$ 200,000 to supplement government measures already underway to provide food, water, medicine and shelter to the victims of the worst affected provinces."

The contingency loan of up to $ 300 million will be financed with resources from the Contingent Credit Facility for Natural Disaster Emergencies, one of the main tools of the IDB for the financial management of natural disaster risks.

"In coordination with the Ecuadorian government, we are refocusing our portfolio to provide additional reconstruction resources at this hour of need. We are also in contact with other donors to exchange information and coordinate response actions," added Moreno.

To date, more than 500 people have died after the earthquake of 7.8 degrees recorded on Saturday in northwest Ecuador. A new 6.2-degree earthquake has rocked the coastal area early this morning.
Cat Bonds: Investment bonds are sold by an entity seeking insurance---like a local government or transit agency. An risk-modeling firm calculates the odds of a particular disaster occurring. Investors are paid relatively high interest rates but lose their principal if disaster hits. The determination if event occurred -- and thus if payment is “triggered”--- by independent authority. “In all, there are $72 billion of cat bonds and similar investments outstanding, and is expected to double in the next few years” (Source: WSJ)
Cat Bonds go Online
The Indonesian government has historically thought the concept of launching a national disaster insurance scheme too costly and as a significant proportion of the population would be unable to afford private insurance coverage, it seems any effort in this area will have to focus initially on sovereign risk transfer to provide risk capital for government reconstruction and immediate post-disaster recovery costs. But with risk transfer becoming increasingly efficient, particularly parametric protection which is benefiting from technology and big data innovations, and reinsurance capital increasingly efficient thanks to capital markets, Indonesia may find protection is more affordable than ever right now.

**Parametric triggers let CCRIF pay $29.2m in 14 days post-Matthew**

**Indonesia urged to use cat bonds to back disaster insurance scheme**

**NZ quake loss tail grows again, settled insurance claims hit $19bn**

**Haiti in line for $20m after CCRIF parametric trigger hit by Matthew**