Harnessing the Collective Power of Earthquake Eyewitnesses for Improved Situation Awareness:

The Nepal EQ Sequence Case Study

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www.emsc-csem.org  www.citizenseismology.eu
Improving Situation Awareness Within a Few Hours

Fulfilling their **immediate information needs** best way to engage with EQ eyewitnesses and crowdsourced information!

- Smartphones & smartphone app at the heart of the strategy
- Visual communication essential
- From rapid information towards risk reduction

300 LastQuake app within 3 hr of EQ
LastQuake Innovative EQ Information Tools

- Focus on felt and damaging earthquakes: the only ones that matter for the public
- Fast: 10’s of sec to 90 min
- Easily identifiable: Facebook, Twitter, websites...

QuakeBot, app., add-ons: automatically merges direct & indirect eyewitnesses contribution, seismic data, damage scenario & tsunami alert
Discriminating Felt EQ Through Public Reaction

Eyewitnesses rushes on the Internet to find & share information within sec of earthquake occurrence

- Traffic increases on EMSC website (*flashsourcing*)
- Twitter Earthquake Detection (P. Earle, USGS)
- Crowdsourced testimonies (online questionnaires, thumbnails)
Fast and Complementary Approaches

45 eq. over 429 detected by both

- EMSC Website Traffic Detection
- USGS Twitter Detection
- Both

![Map with detected events](image)
Mainshock & Main aftershock 17 days Later
Engaging with Eyewitnesses
T0 + 5 min: Automatic Detection in India

#Earthquake possibly felt 2 min ago in Haryana-Uttar Pradesh Reg, #India. Felt it? See emsc-csem.org
8:16 AM - 25 Apr 2015

This detection is automatic & not seismically verified. It often precedes seismic detection citizenseismology.eu pic.twitter.com/CD8mnNF74m
8:16 AM - 25 Apr 2015

How our Internet Earthquake Detections work?
T0 + 9 min: Preliminary Loc

Seen 35 000 times
T0 + 9 min : Damaging Earthquake

Powerful #quake shakes #Nepal 9 min ago. Damage cannot be excluded. Report info: emsc-csem.org/Earthquake/ear...
8:20 AM - 25 Apr 2015
-reply 5  ★  4

Your observations are crucial to understand earthquake's effects. Fill our questionnaire & share your pics at emsc-csem.org/Earthquake/Con...
8:20 AM - 25 Apr 2015
-reply 2  ★  1
T0 + 18 min : First Map of Testimonies

M 7.4 NEPAL
2015/04/25 06:11:34.5 UTC

Intensity I
Effects Felt

Updated on 2015/04/25 06:20:15 UTC

EMSC
@LastQuake

Major #earthquake shakes Nepal 18 min ago.
Effects derived from witnesses' reports:
8:29 AM - 25 Apr 2015

188
T0 + 19 min: Preliminary Mag

Felt #earthquake M7.5 strikes 89 km NW of #Kathmandu (#Nepal) 19 min ago. Please report to: emsc-csem.org/Earthquake/ear...

8:30 AM - 25 Apr 2015 • Nepal, Nepal

Seen 30 000 times
T0 + 20 min : Damage confirmed

EMSC
@LastQuake

M7.5 earthquake strikes 89 km Kathmandu, Nepal. Potential damage. Witnessed it? Report to emsc-csem.org/Earthquake/ear...

8:31 AM - 25 Apr 2015 - Nepal, Nepal
T0 + 26 min : Updated Map of Effects

M7.8 April 25
- 38 auto tweets in 90 min
- Mainshock + 5 felt aftershocks
- 406 RT

M7.3 May 12
- 41 auto tweets, 16 manual in 90 min
- Mainshock + 6 aftershocks
- 997 RT
Smartphone Revolution & *Push Information*

- Questionnaires replaced by thumbnails
- Best way to collect geolocated pics & videos
- Comments shared on Facebook, Twitter
- Notifications (push info rather than website visit)
M7.8: 1,000 testimonies, 100 pics, 400 comments

- Testimonies: 500 thumbnails & 506 online questionnaires
- 108 validated pics and videos
- M7.3: 860 thumbnails, 297 questionnaires, 484 comments
Example of Comments

Witness location: Bharatpur (Nepal) (69 km SW from epicenter)

I was on the road near a movie hall. Suddenly, the road under me started shaking. I saw the houses, beds shaking but never the ground itself so heavily. Ran towards the open space. It felt like it lasted for like 5 minutes. The houses and the electric poles were shaking heavily and all the people were out of their houses. We felt the aftershakes two or three more times. Homes used be a safer place, but everyone was afraid to go inside. People started making tents on the open grounds to spend their nights. The whole day and whole night was scarier.

Witness location: Kathmandu (Nepal) (84 km SE from epicenter)

I was in kathmandu at the time when it occurred. It was an 7.8 richter scale earthquake. Almost all the buildings and monuments that were at least 50 years old are now no more standing.
Example of Validated Geolocated Pics
Number of LastQuake App in Operation
LastQuake Users T0 + 72 hr: 1 479
Kathmandu after 72 hr
Which Communication Channels?

April 25th 06:11 UTC

![Graph showing visitor count per minute across different communication channels.](image)
Which Communication Channels?

April 26\textsuperscript{th} 16:26 UTC
Which Communication Channels?

April 27\textsuperscript{th} 12:35UTC

![Graph showing new visitors per minute by different communication channels]

- fixed users
- mobile users
- app users
- twitter
- facebook

Time (UTC)
Which Communication Channels?

May 3rd 11:35 UTC

![Graph showing the number of new visitors per minute from different communication channels over time. The x-axis represents time in UTC from 11:30:00 to 11:55:00, and the y-axis represents the number of new visitors per minute. Different channels are represented by different colors: fixed users (blue), mobile users (green), app users (red), twitter (cyan), and Facebook (magenta).]
Which Communication Channels?

May 16th 11:34 UTC

- fixed users
- mobile users
- app users
- twitter
- facebook

New visitors per minute

Time (UTC)
Number of Active App Users after a Notification
How People Nepal Access EQ Info?

85% through mobile devices!
Relative Daily Contribution in Testimony Collection

App: 1/3 of accesses, 70% of testimonies!
Rapid Testimony Collection: First 30 minutes

M7.3 May 12: 490 testimonies
M4.2 May 22: 700 testimonies
Wearable & Networked Devices

% of UP wearers awake

- SAN FRANCISCO, OAKLAND, SANTA ROSA
- NAPA, SONOMA, VALLEJO, BERKELEY
- SACRAMENTO, SAN JOSE
- MODESTO, SANTA CRUZ

0-25 mi
25-50 mi
50-75 mi
75-100 mi

Munich
Internet as the Digital Nervous System of our Planet!

TED tweets by radius from epicentre

EMSC website traffic by radius from epicentre

Munich
## Interpretation of Website Traffic Patterns

<table>
<thead>
<tr>
<th>Time Evolution of the number of visitors</th>
<th>Non-exclusive conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Graph" /></td>
<td>Not felt, or severe loss of Internet connectivity, or significant widespread damage, or severe perception of danger</td>
</tr>
<tr>
<td><img src="image2.png" alt="Graph" /></td>
<td>Felt and no significant loss of Internet connectivity and no significant damage</td>
</tr>
<tr>
<td><img src="image3.png" alt="Graph" /></td>
<td>Felt and, local or temporary, loss of Internet connectivity, or, locally significant damage or, locally severe perception of danger</td>
</tr>
<tr>
<td><img src="image4.png" alt="Graph" /></td>
<td>Felt and, local or temporary, loss of Internet connectivity, or, locally or widespread significant damage or, locally or widespread severe perception of danger</td>
</tr>
<tr>
<td><img src="image5.png" alt="Graph" /></td>
<td>Significant loss of Internet connectivity, or significant damage, or severe perception of danger</td>
</tr>
</tbody>
</table>

**Example of blackout detection**

EGU 2015
Identification through IT
Exploitation by crowdtasking
Towards Risk Reduction

1. What happens?
Offer very rapid information through various channels

2. What does this mean for my family and friends?
I am safe button

3. What should I do now?
Popping up do/don’t do visual items:
– Move away from buildings
– Do not call emergency service except if people are injured
Concluding Remarks

- LastQuake info tools work at global scale & covers a time period where seismology is the unique source of information
- Smartphones, app & visual com. essential
- Fulfilling the immediate needs of eyewitnesses

- Smartphone based EQ detection

Napa eq recorded by a smartphone at 38 km distance  
(Courtesy Qingkai Kong, Berkeley Univ.)

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