Ideas on the future of Early Warning Systems in vulnerable cities

Stefano Parolai
GFZ-German Research Centre for Geosciences
Sec 7.1 Centre for Early Warning Systems
Approaches
There are two main approaches to EEW systems: Regional (or network-based) and Onsite (or single-station).

from Satriano et al., SDEE, 2011
State of the art

Important achievement for rapid source location and magnitude determination

Rydelek and Pujol (2004)

Cua and Heaton (2007)

Wu and Kanamori (2008):

Colombelli et al. (2014):
Emerging questions

Improving the tools for tackling the challenges of aftershocks and local site response, while including uncertainties.

Hoshiba and Aoki (2015):

Pilz and Parolai (2016)

Stefano Parolai – GFZ German Research Centre for Geosciences
Emerging questions

No magnitude and location estimation

Rapid magnitude and location estimation

Lead Time: 17 sec

Lead Time: 14 sec

Event estimated, compatible scenario selected, warning

Pittore et al. (2014), Stankiewicz et al. (2015)

Loss-based Early Warning: pre-calculated scenarios

Damage probability of exceedance

Stefano Parolai – GFZ German Research Centre for Geosciences
Real time risk assessment and rapid response

- Better emergency management
- Integrated with early warning systems
- Goal: reliable information provided to decision-makers within minutes of an event

Stefano Parolai – GFZ German Research Centre for Geosciences

Pittore et al. (2017)
Real-time acceleration

Event detection

P-waves

Peak displacement over (maximum) first 3s of the P-wave arrival

Alert protocols based on PGV thresholds and expected damage levels.

Alert protocols based on PGV thresholds

Empirical model

logPGV(S) = a + b * logPGD(P)

from early P-wave (measurement) to S-wave (prediction)

Stefano Parolai – GFZ German Research Centre for Geosciences
Emerging questions

On Site Early Warning

Real time shaking forecast

Aftershock hazard: take actions independent from models of aftershock rates.

Cumulated damage effect: from building monitoring to incremental damage assessment, to updated vulnerability models.

Stefano Parolai – GFZ German Research Centre for Geosciences
Emerging questions

Aftershocks early warning and monitoring: time-dependent vulnerability

Non-structural damage: induced seismicity

Empirical model
\[ \log \text{PGV(S)} = a + b \log \text{PGD(P)} \]

Developed for Drift Sensitive Brittle Non-Structural Components of URM buildings.
Bishkek: 8 buildings

Advanced Remote Sensing – Ground Truth Demo and Test Facilities

ACROSS
a real time strong motion network for Central Asia
Emerging questions

Multi Hazard Early Warning System

- Permanent or temporary ("task force")
- Two-way flux of information. Continuous scenario update

Stefano Parolai – GFZ German Research Centre for Geosciences
Emerging questions

Understanding the effect of city-soil interaction by real data sets:

Implication for seismic hazard assessment and mitigation

Stefano Parolai – GFZ German Research Centre for Geosciences
Efforts should concentrate on:

- **Improving the reliability of rapid forecasting and loss assessment** → enhanced confidence of the public and private sectors in embracing these technologoes and contributing to wider ranging schemes of disaster risk mitigation.

- **Improving the real time estimation of spatial distribution of damage** → optimization of alarm issuing procedures (time-dependence), better organisation of response.

- **Focus on Multi-Hazard Early Warning Systems.**
Thank you!

Acknowledgements: Iunio Iervolino and Dino Bindi have contributed with ideas and discussion.