The role of Sensors (network) in Earthquake Early Warning and Rapid Response applications

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Earthquake Early Warning and Rapid Response
Earthquake **Early Warning** and Rapid Response

Transmission of earthquake signal (speed of light)

Sensor

Target

Transmission of earthquake early warning message (speed of light)

Seismic stations

Blind Zone

Hypocenter / seismic focus

S-waves (approx. 3.5 km/s)

P-waves (approx. 6 km/s)
Test applications: **Turkey** and **Kyrgyzstan**
ACROSS - Network optimization

Performance-based optimization based on statistical learning

Stankiewicz et al., 2015

Geospatial Sensor Webs Conference 2018
ACROSS – Strong Motion Network

Network geometry has been optimized for EEW applications
The Kyrgyzstan **Regional Early Warning System**

The ~20 real-time sensors are linked to a centralized system.
Performance of regional EEW Systems

Parolai et al., 2017

„blind“ zone

Parolai et al., 2017
Custom sensor node development

MP (Multi-Parameter) wise

Battery and power mngm.

Sensor node
Custom sensor node development

MP (Multi-Parameter) wise
Real-time building monitoring and EEW

SOSEWIN & MP-WISE Sensor platform
Performance-based decentralized EEW

- Each sensor performs EEW autonomously
- Fragility models can be embedded

Parolai et al., 2017
Hybrid Early Warning Systems

Regional

Decentralized

Hybrid (combined)

Parolai et al., 2017
From EEW to Rapid Response

Incremental event characterization and Scenario picking

Real-time integration of urban sensors

Picozzi et al., 2013
Pittore et al., 2014
Application: local ad-hoc meshing
Real-time building monitoring

SOSEWIN & MP-WISE
Sensor platform
Test application: Istanbul

(A) Classical Strong Motion Stations
Secondary Centers - Gateways
Kandilli Observatory - Main Center

(B) SOSEWIN nodes
Public SOSEWIN nodes
SOSEWIN Gateways
Central Asia Risk and Vulnerability Analysis Tool

Local Real-time sensor network

- Exposure Vulnerability
- Impact forecasting

Regional Real-time sensor network

- GEOFON Automatic Event characterization
- Shake Map computation
- Alert and dissemination services
- Web interface alerting

Processing modules (Python)

Central Asia Risk and Vulnerability Analysis Tool

Geospatial Sensor Webs Conference 2018
Other applications: analysis of local site effects
Other applications: building & soil-structure analysis

Moment Frame building, Istanbul
Other applications: building & soil-structure analysis

Principal vibration modes

RC Panel building, Bishkek
Other applications: image-based damage detection
Outlook and conclusions

- New concept for EEW and Rapid Response:
  - Distributed
  - De-centralized
  - Optimized network
  - Performance-driven
  - Fault-tolerant, redundant
  - Standard brokering architecture (e.g. activeMQ)
  - Modular, multi-parameter sensors
Selected References


Demos

ACROSS
- Nagvis - ACROSS
- Nagvis - SOSEWIN
- DYNA Db

Early Warning
- PRESTO sw
- GFZ Sentry 1
- GFZ Sentry 2

CARAVAN
- On-line platform
- Eq. 23/12/2015
- FDSN demo