Gigantic high-fidelity geocellular model to prevent and mitigate earthquakes in Japan, leveraging DELFI, Cloud & Petrel Technology

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Introduction

Sustainable Development Goals (SDGs)

Target 11.5:
Reduce the adverse effects of natural disasters

Target 11.B:
Implement policies for inclusion, resource efficiency and disaster risk reduction
Introduction

1997.1.17 Kobe Earthquake (M7.3)

Damages by strong motion, collapses on buildings and houses, fire and liquefaction

We are afraid that these two types disasters come near future along the Nankai Trough area

2011.3.11 Off Tohoku (M9.0)

Damages by huge tsunamis, inundation, debris, tsunami fire, and many drifts
Repeated huge earthquakes and Tsunamis

The worse case earthquake has possible magnitude of maximum 9.1!

Inform increasing risks of huge earthquakes and tsunamis and promote the preparation for them.

A historical record of past repeated Nankai Trough earthquakes
Lessons from 2011 off Tohoku earthquake and tsunami

Various events with different temporal-spatial scale

- Induced event?
- Linked event?
- Tsunami?
- EQ
- Forshock
- Slowslip activated?
- Seismicity change?

\[ b \text{-value (Slope on profile between M and N)} \]

Nanjo et al. (2012)

Seismicity pattern changed before 5-6 years of 3.11
Lessons from 2011 off Tohoku earthquake and tsunami

Various events with different temporal-spatial scale

- Induced event?
- Linked event?
- Tsunami?
- EQ
- Forshock
- Slowslip activated?
- Seismicity change?

Crustal displacement pattern changed before 6 years of 3.11

Suito et al. (2012)
Lessons from 2011 off Tohoku earthquake and tsunami

Various events with different temporal-spatial scale

- Tsunami?
- EQ
- Forshock
- Slowslip activated?
- Induced event?
- Linked event?
- Seismicity change?

~Apr. 8, 2011
Based on JMA catalogue

From Homepage of ERI, U.Tokyo, Japan

DONET
Observation Network for Earthquake, Tsunami and Volcano implemented by NIED

Mar. 12 4:47 M6.4
Mar. 15 22:31 M6.4
Mar. 23 7:12 M6.0
Mar. 12 3:59 M6.7
Mar. 15 22:31 M6.4
Mar. 11 15:08 M7.4
Mar. 11 14:46 Mw 9.0
Mar. 9 11:45 M 7.3
Mar. 11 15:25 M7.5
Mar. 11 15:15 M7.7
Mar. 7 23:32 M7.2
Apr. 11 17:16 M7.1
Mar. 23 7:12 M6.0
Mar. 15 22:31 M6.4
Mar. 11 15:08 M7.4
Concept of integrated researches

- Each task analyzed by researchers in various fields of expertise

Disaster resilience are supported by many fields researches
Integrated data sharing platform embedded with a unified structure, faults and velocity model with other data to be shared among all the stakeholders.
Conceptual image of the new system

Data Sources
- Japan Meteorological Agency
- National Research Institute for Earth Science and Disaster Resilience

Public information
- Hypocenter
- Hazard Maps
- Regional Stress
- Source Mechanism

Integrating Data Sharing Platform
- Universities
- Research institutes
- Local governments
- Infrastructure companies
- Private companies
Workflow to construct the new system

Data source

Convert to json, jpeg files

Web Server

Customizable, 3D Earth, Subsurface, Charts & Dashboard Visualization
Integrated data sharing platform for Disaster mitigation

- Hypocenter, Mechanism
- Stress axis
- Velocity model
- Faults
- Hazard maps
- Filter
- Time player
- Magnitude time series
- b-value
Integrated data sharing platform for Disaster mitigation
Integrated data sharing platform for Disaster mitigation

Time Range (1935/1/1 – 1945/1/1, every 3 months)
Way Forward Development Plan

Automated Workflow
- Fault Picking by AI/ML
- Events Auto Detection

Real time monitoring and analysis
- Monitoring crustal activity
- Forecast of mega earthquakes
- Time evolution of hazard maps

Various events with different temporal-spatial scale:
- 1 year
- 1 month
- 1 day
- 0
- Tsunami?
- EQ
- Forshock?
- Induced event?
- Slowslip?

Public Data Sources
- Earthquakes
- Tsunami
- Crustal movement
- Seismic Survey
- Topography data
- GPS data

Embedding
- Real time update
- Disaster risk information
- People can access to the information they want to know at anytime

People can access to the information they want to know at anytime
Summary

• To maintain social sustainability against huge earthquakes and tsunamis, we
  • Monitor crustal activities around the western Japan and detect their changes
  • Share the activities information with key persons and organizations, which support each local society and life
  • Inform early detections of earthquakes and tsunamis once huge event occur, and predict the damages in real time

Velocity structures, observation of earthquakes, tsunamis and crustal displacement, and prediction of future event occurrence

based on

DELFI, Cloud & Petrel Technology