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

Narumi Takahashi

National Research Institute for

Earth Science and Disaster Resilience

Introduction

Sustainable Development Goals (SDGs)

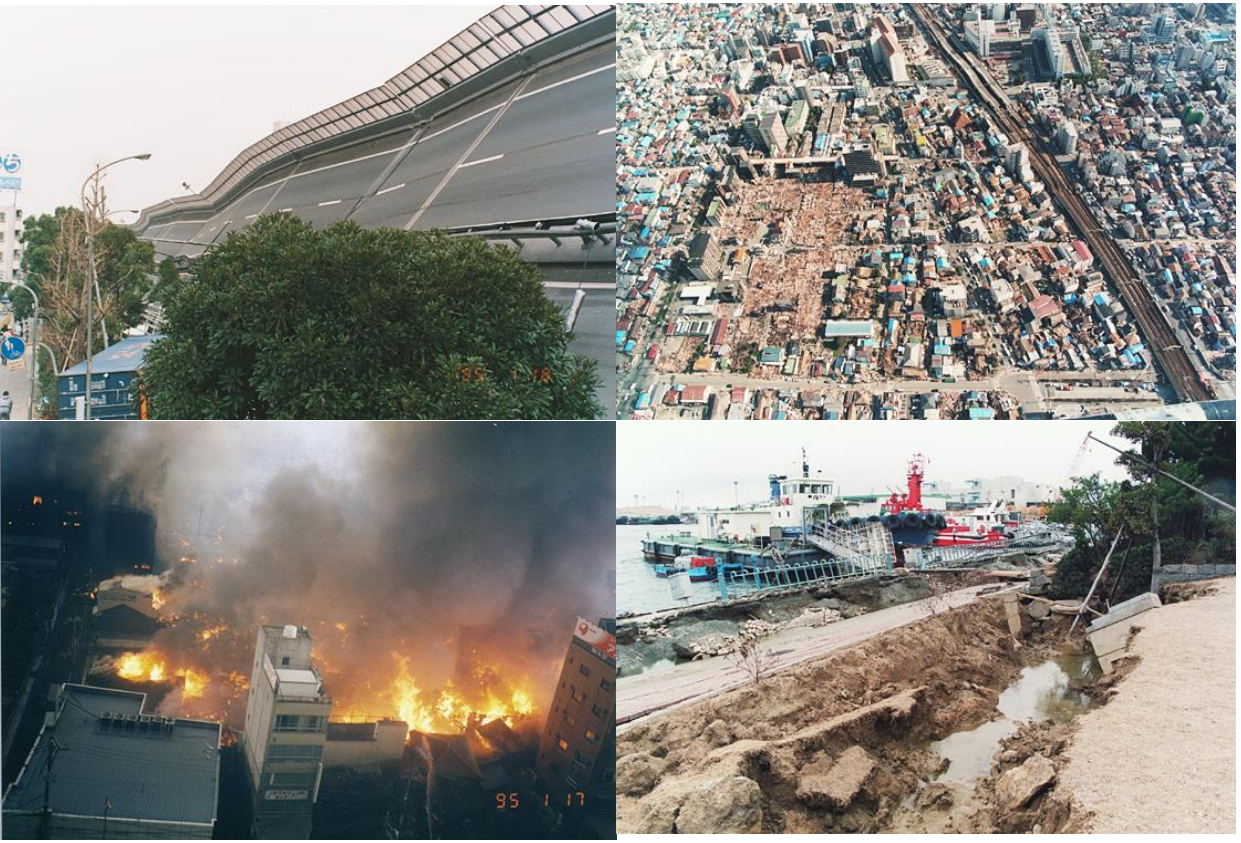
Target 11.5:
Reduce the adverse effects of natural disasters

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

Introduction

SCIENCE FOR RESILIENCE
NIED 防災科研

1997.1.17 Kobe Earthquake (M7.3)



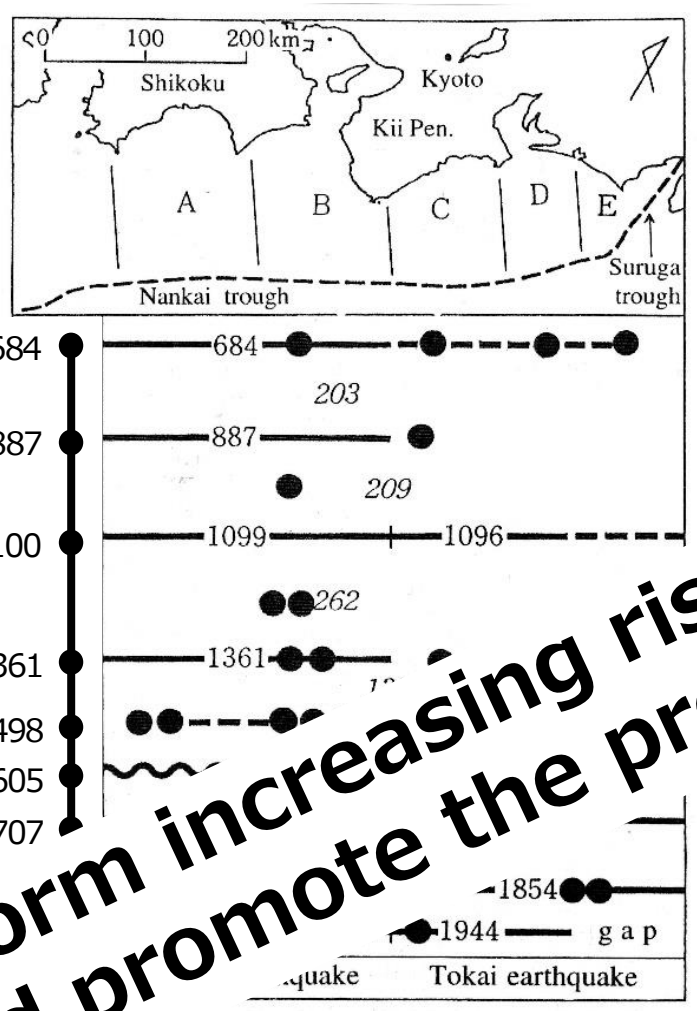
Damages by strong motion, collapses on buildings and houses, fire and liquefaction

2011.3.11 Off Tohoku (M9.0)

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

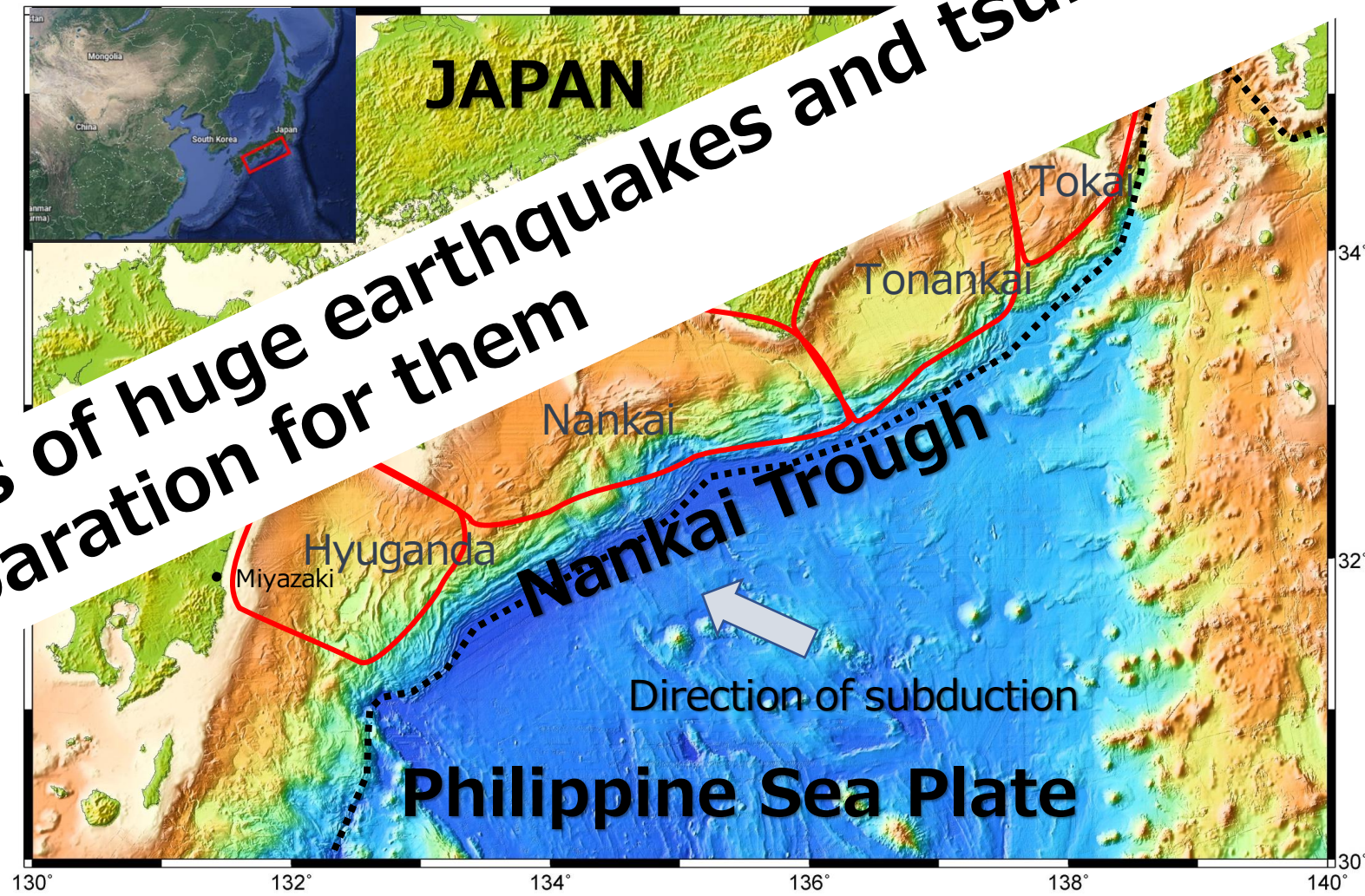
We are afraid that these two types disasters come near future along the Nankai Trough area

Repeated huge earthquakes and Tsunamis



historical record of past repeated Nankai Trough earthquakes

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

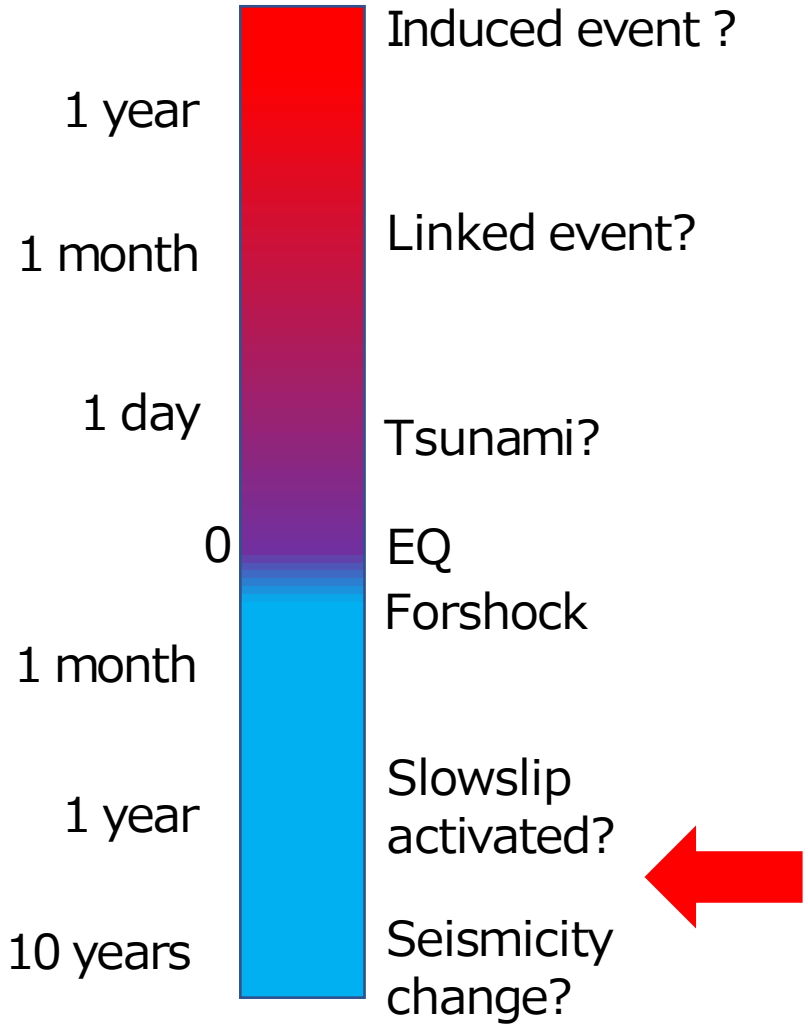


The worse case earthquake has possible magnitude of maximum 9.1!

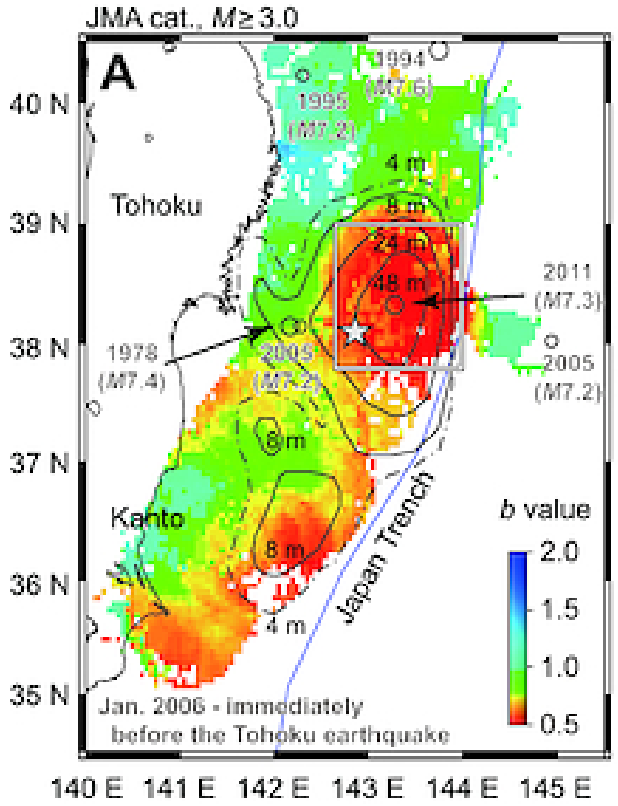
Lessons from 2011 off Tohoku earthquake and tsunami

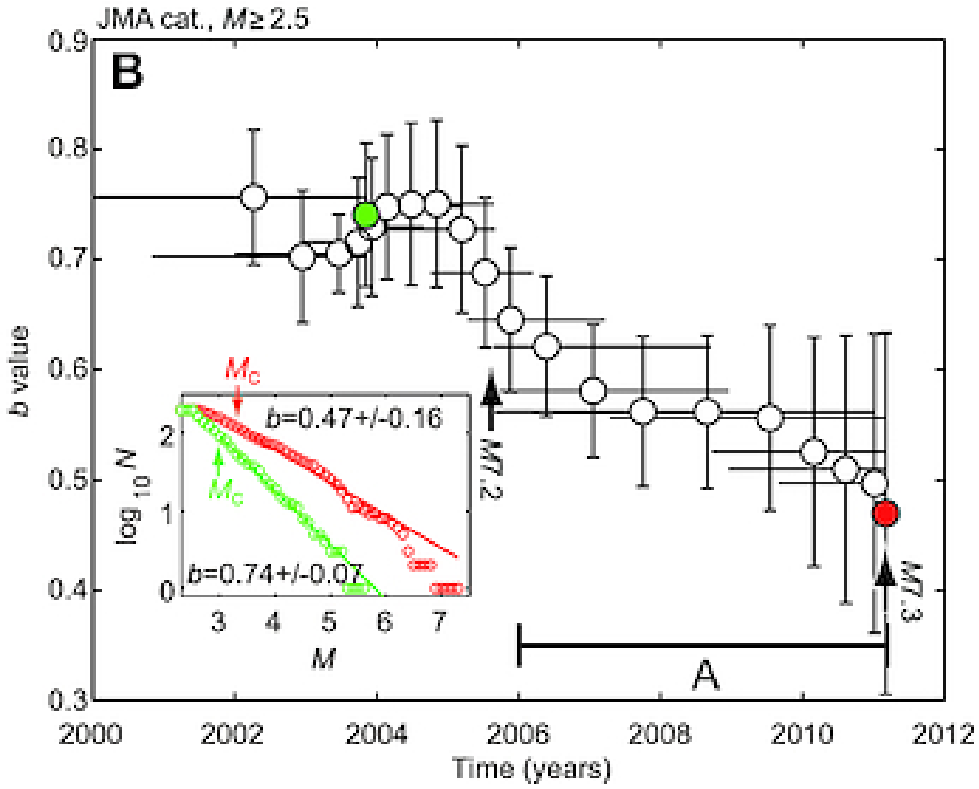
SCIENCE FOR RESILIENCE 防災科研 NIED

Various events with different temporal-spatial scale



b-value (Slope on profile between M and N)





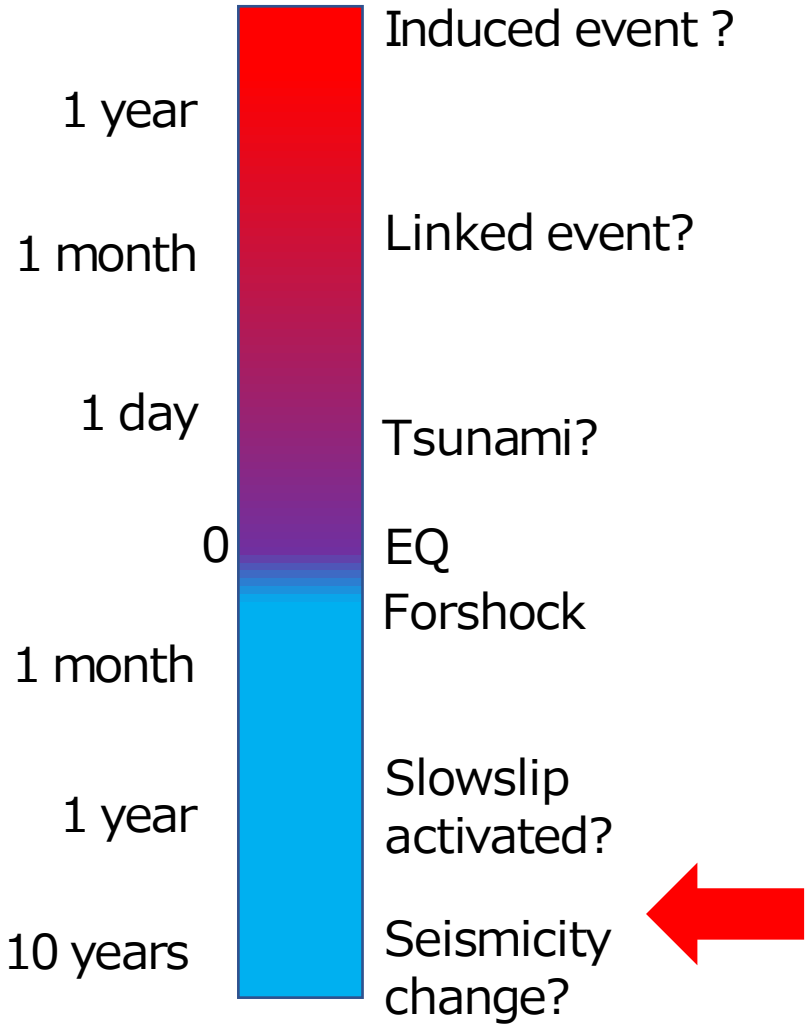
Nanjo et al. (2012)

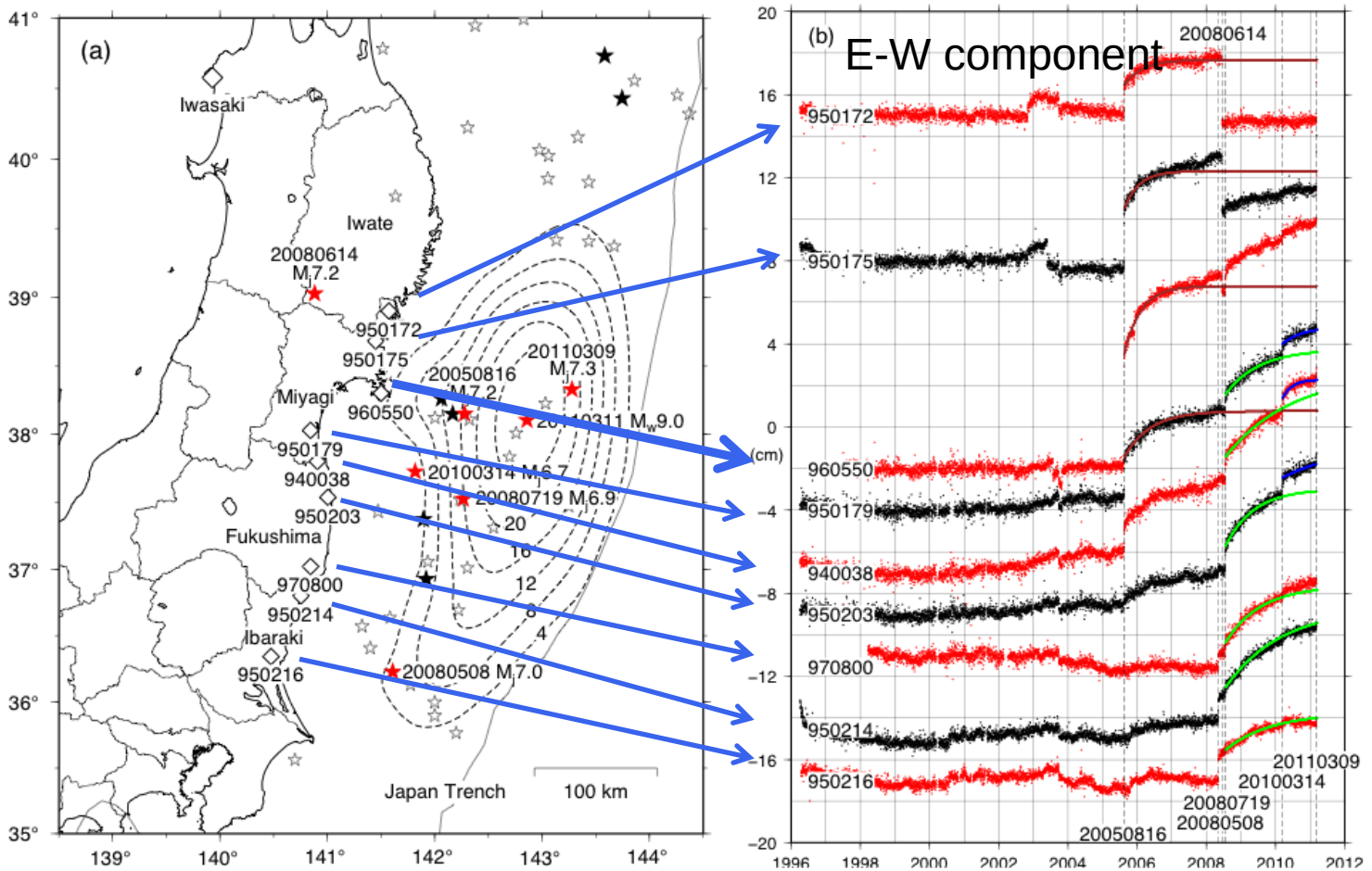
Seismicity pattern changed before 5-6 years of 3.11

Lessons from 2011 off Tohoku earthquake and tsunami

SCIENCE FOR RESILIENCE 防災科研 NIED

Various events with different temporal-spatial scale





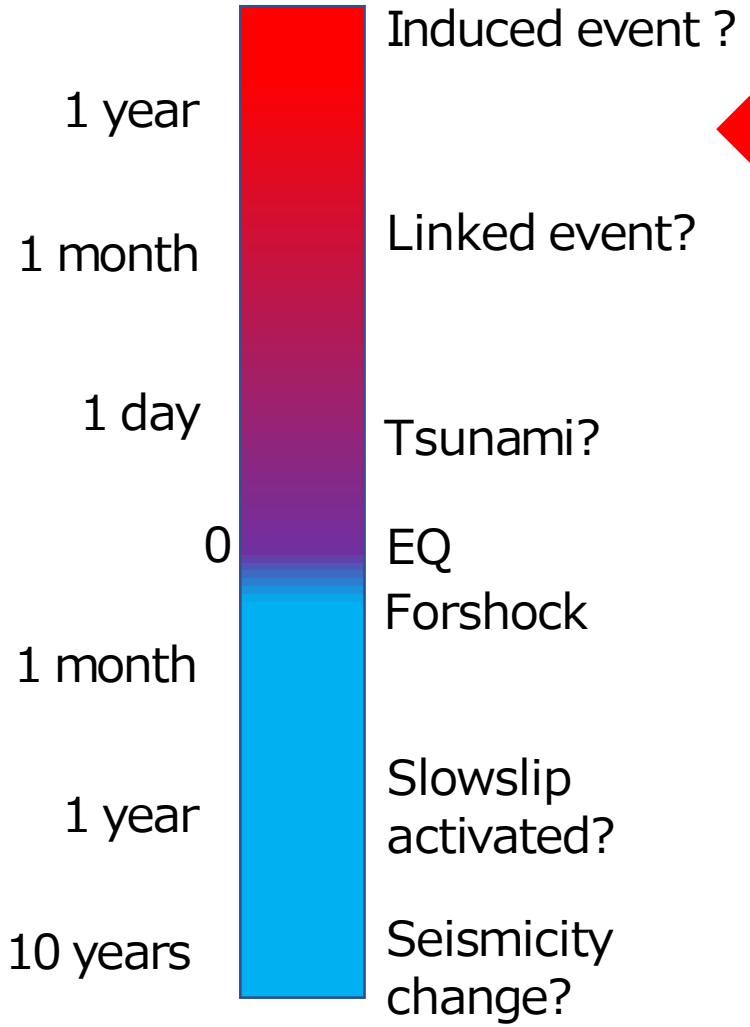
Suito et al. (2012)

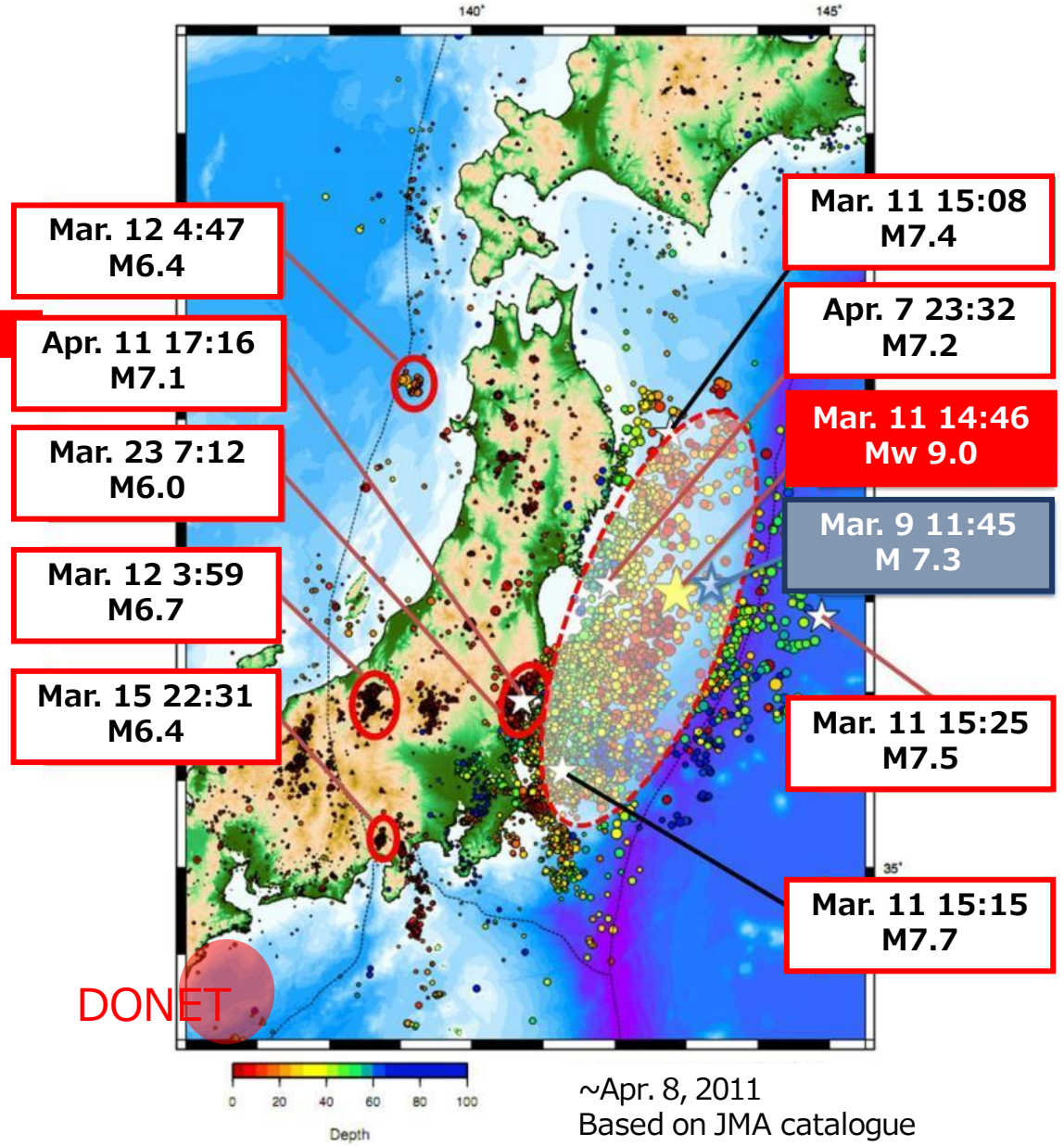
Crustal displacement pattern changed before 6 years of 3.11

Lessons from 2011 off Tohoku earthquake and tsunami

SCIENCE FOR RESILIENCE 防災科研 NIED

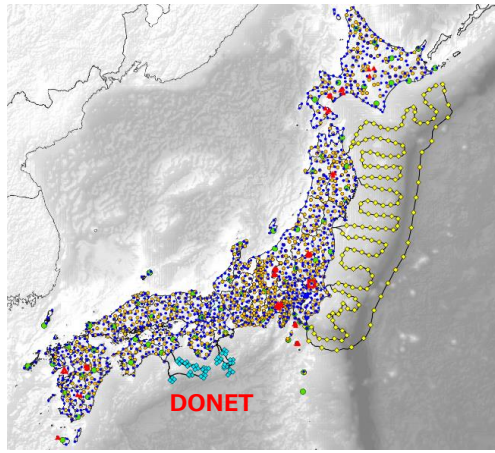
Various events with different temporal-spatial scale





~Apr. 8, 2011
Based on JMA catalogue

Observation Network for Earthquake, Tsunami and Volcano implemented by NIED

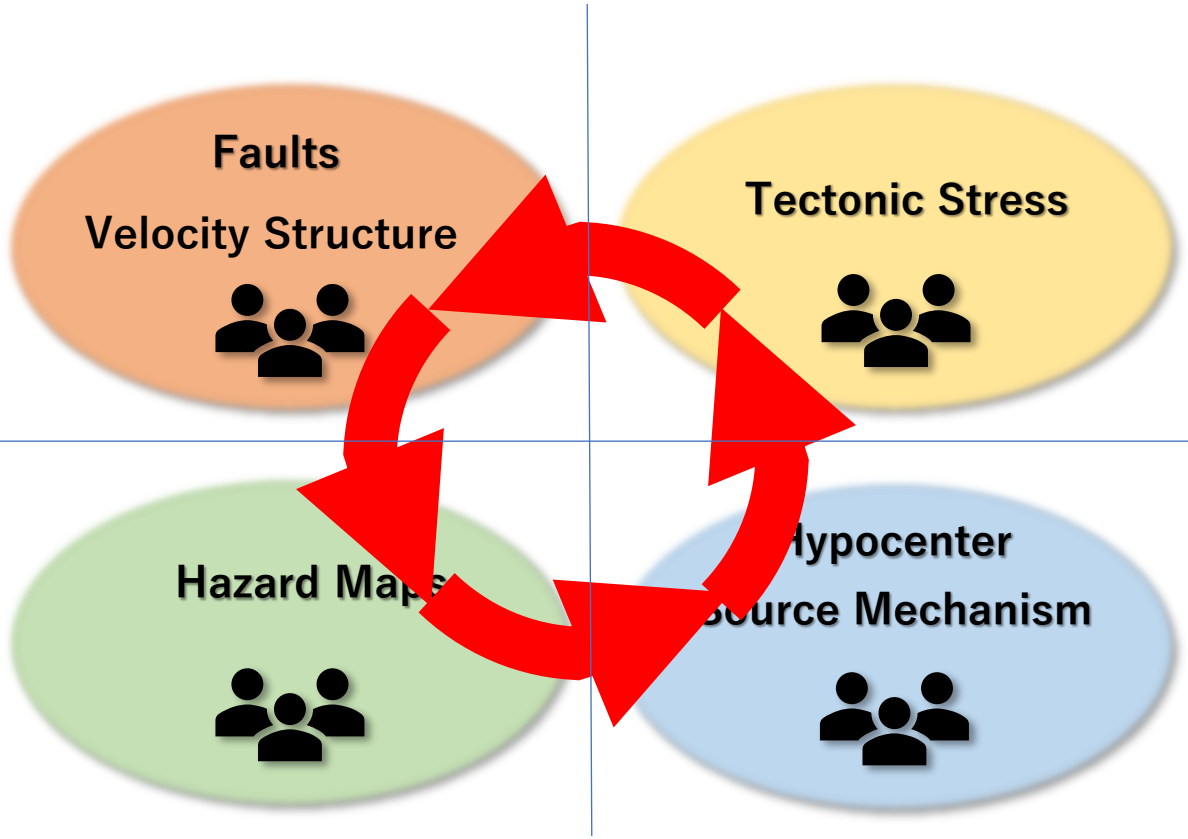


From Homepage of ERI, U-Tokyo, Japan

Concept of integrated researches

SCIENCE FOR RESILIENCE
NIED 防災科研

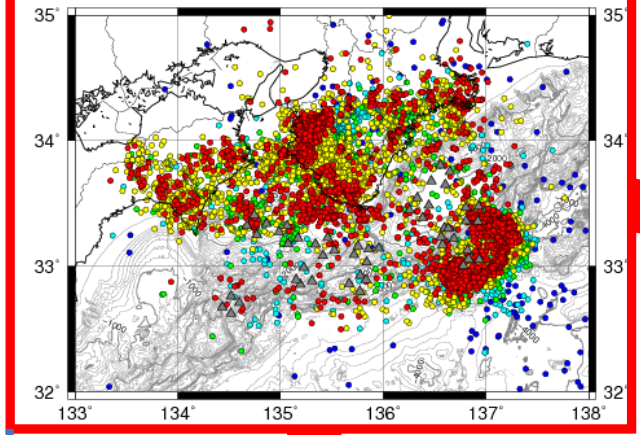
Research Groups



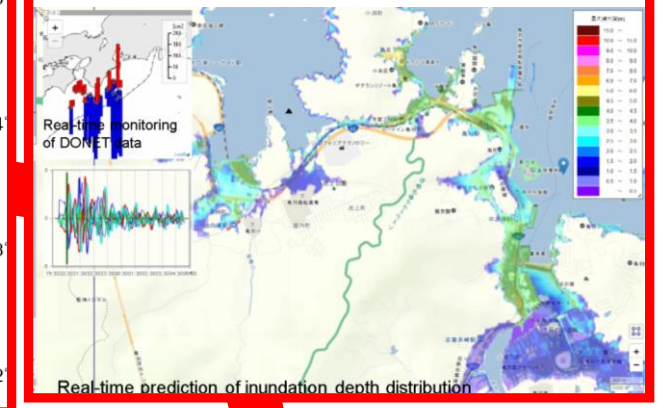
- Each task analyzed by researchers in various fields of expertise

Overall

Seismology



Tsunami



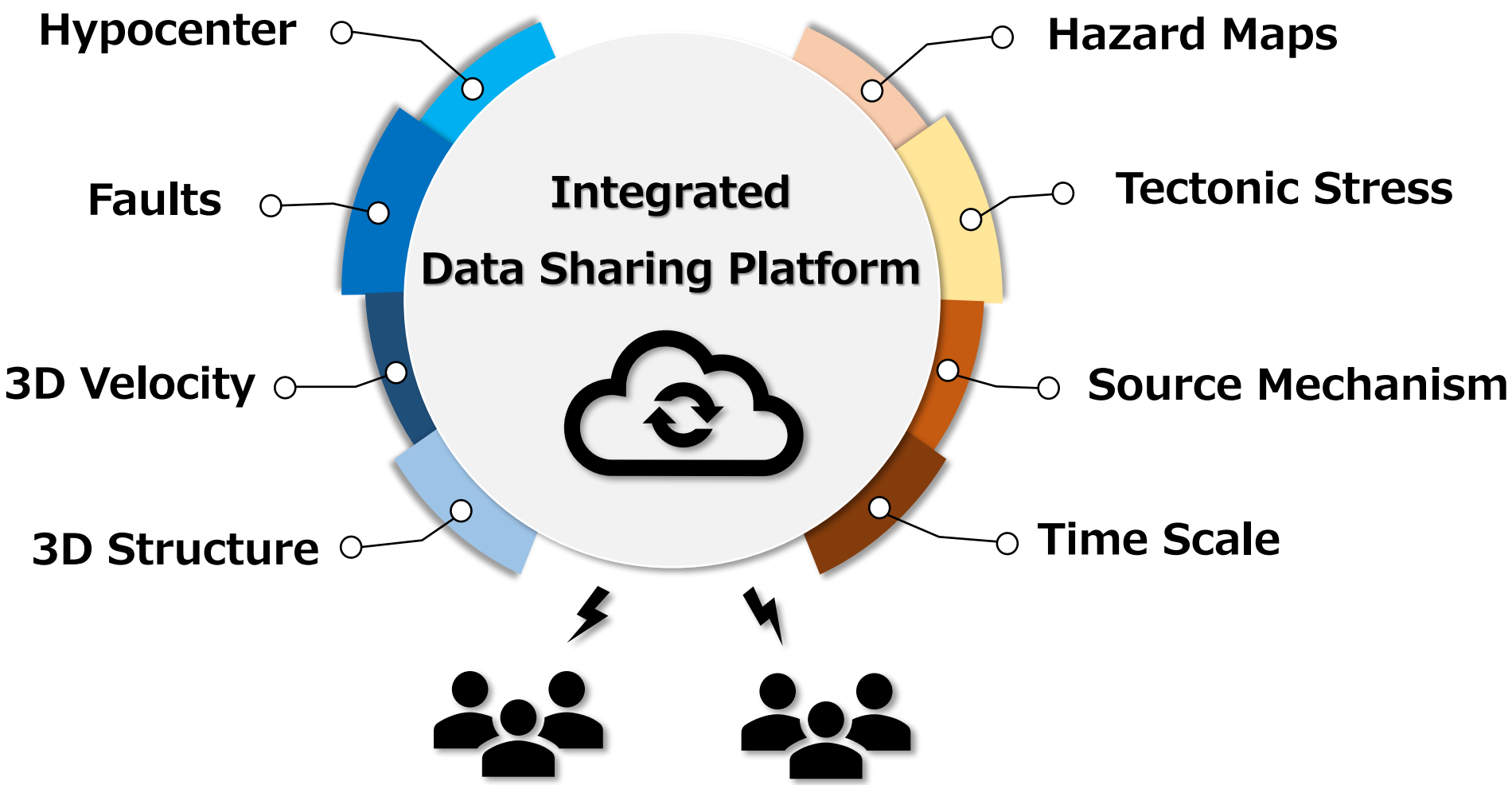
Information science

Crustal displacement

From Kochi prefecture homepage

Disaster resilience are supported by many fields researches

Integrated data sharing platform



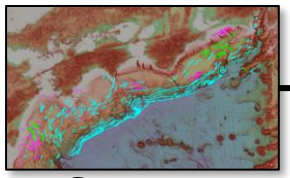
Integrated data sharing platform embedded with a unified structure, faults and velocity model with other data to be shared among all the stakeholders.

Conceptual image of the new system

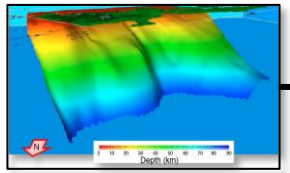
SCIENCE FOR RESILIENCE
NIED 防災科研

3D Model in Petrel

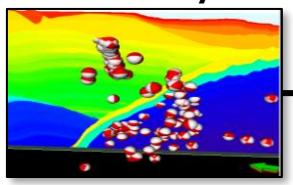
Faults

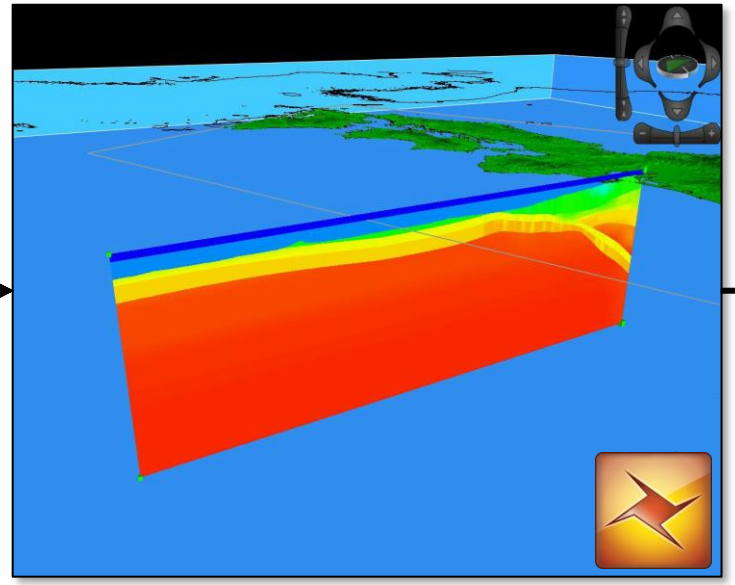


Structure

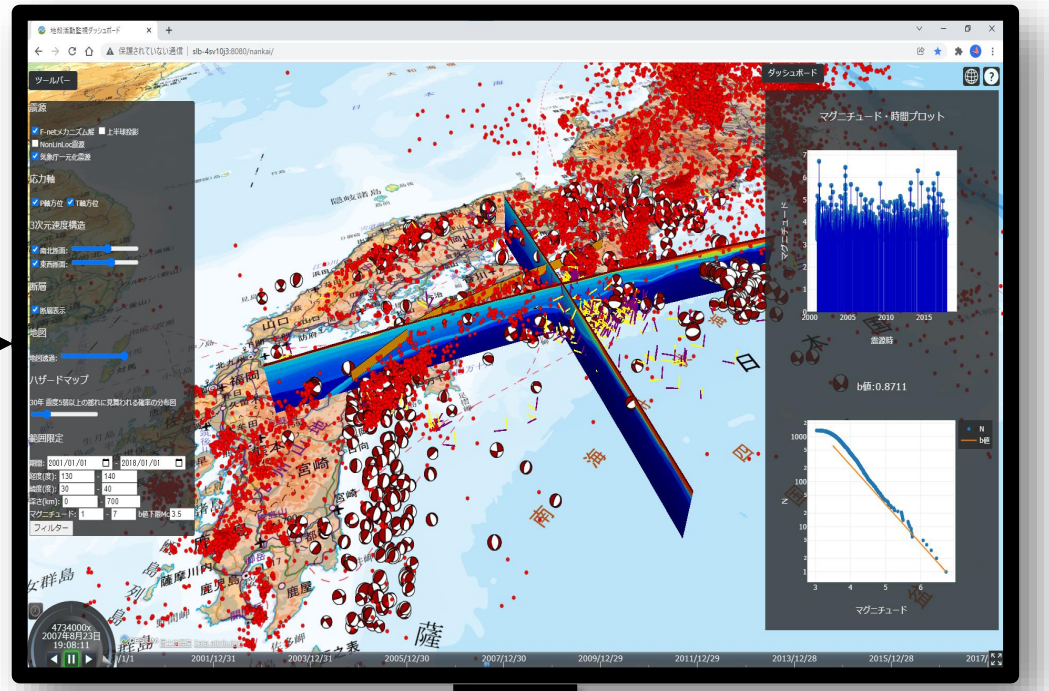


Velocity





Integrated Data Sharing Platform



Public information

- Hypocenter
- Hazard Maps
- Regional Stress
- Source Mechanism

Data Sources

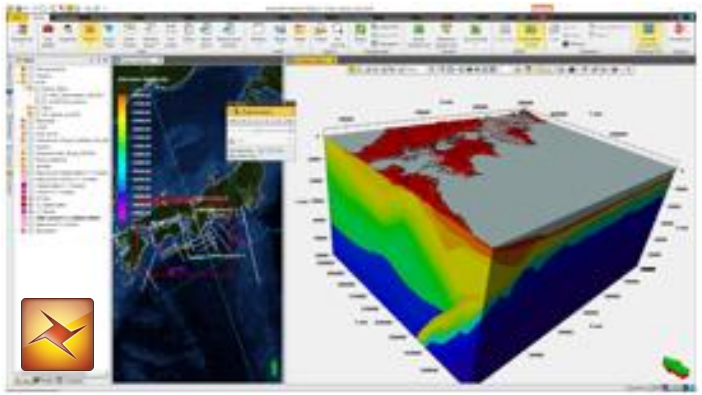
- Japan Meteorological Agency
- JAMSTEC 国立研究開発法人 海洋研究開発機構 JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY
- National Research Institute for Earth Science and Disaster Resilience

- Universities
- Research institutes
- Local governments
- Infrastructure companies
- Private companies

Workflow to construct the new system

SCIENCE FOR RESILIENCE
NIED 防災科研

Data source

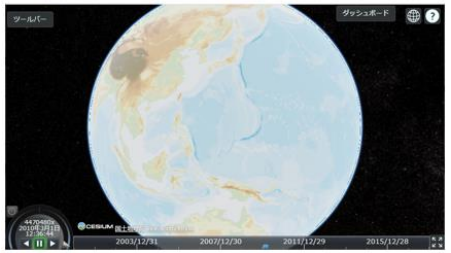


Petrel, CSV, DB etc.

Convert to json, jpeg files

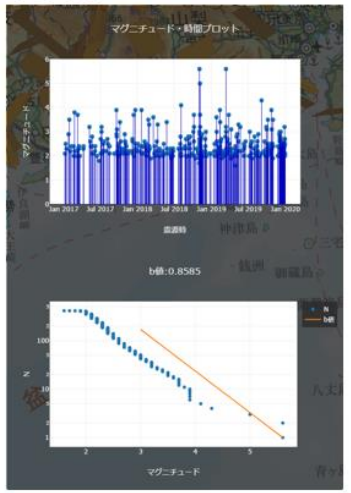
Web Server

CESIUM



3D Earth JavaScript library

plotly



Charts JavaScript library

HTML & JavaScript libraries

Customizable, 3D Earth, Subsurface, Charts & Dashboard Visualization

Integrated data sharing platform for Disaster mitigation

SCIENCE FOR RESILIENCE
NIED 防災科研

Hypocenter, Mechanism

Stress axis

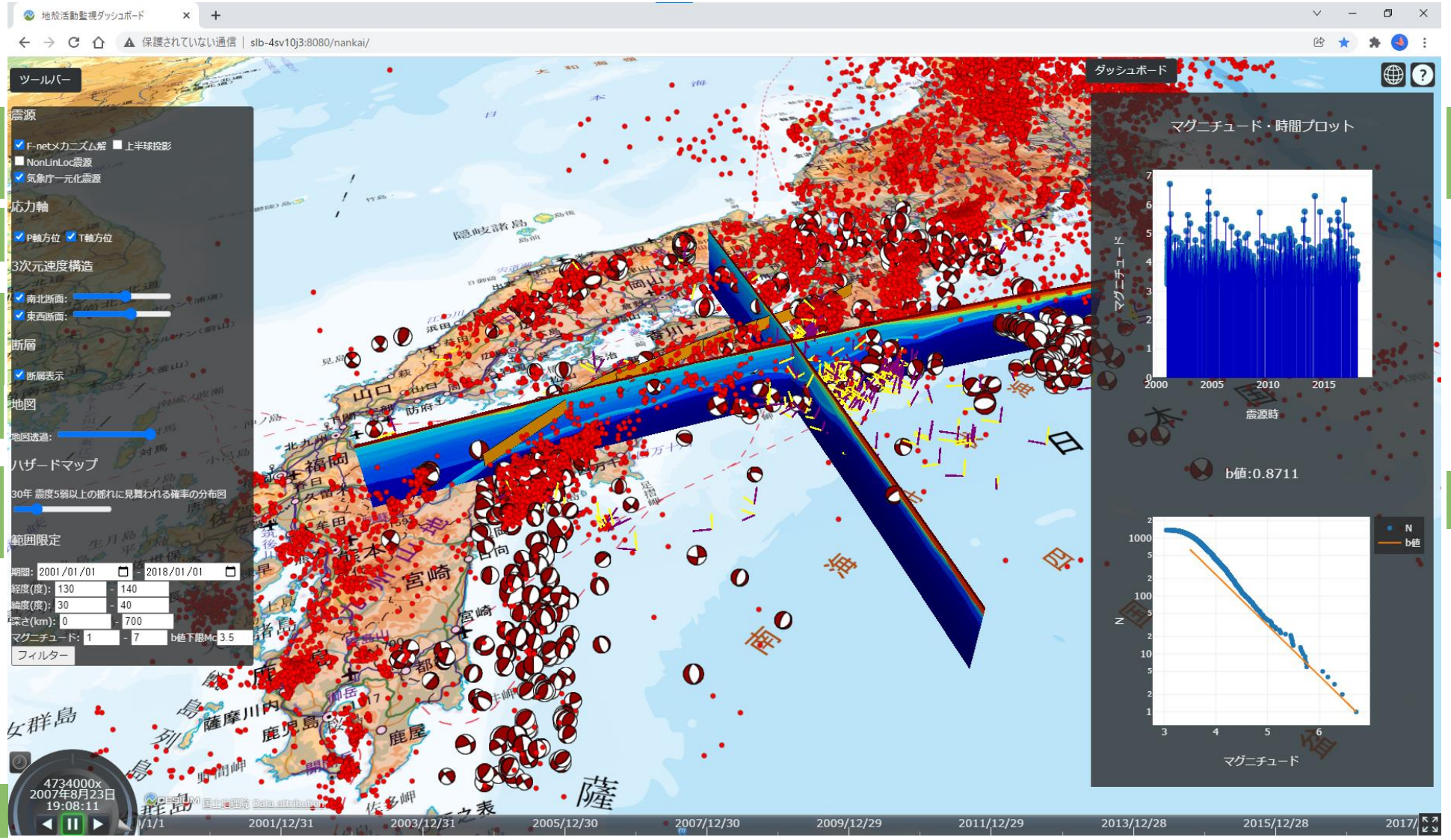
Velocity model

Faults

Hazard maps

Filter

Time player

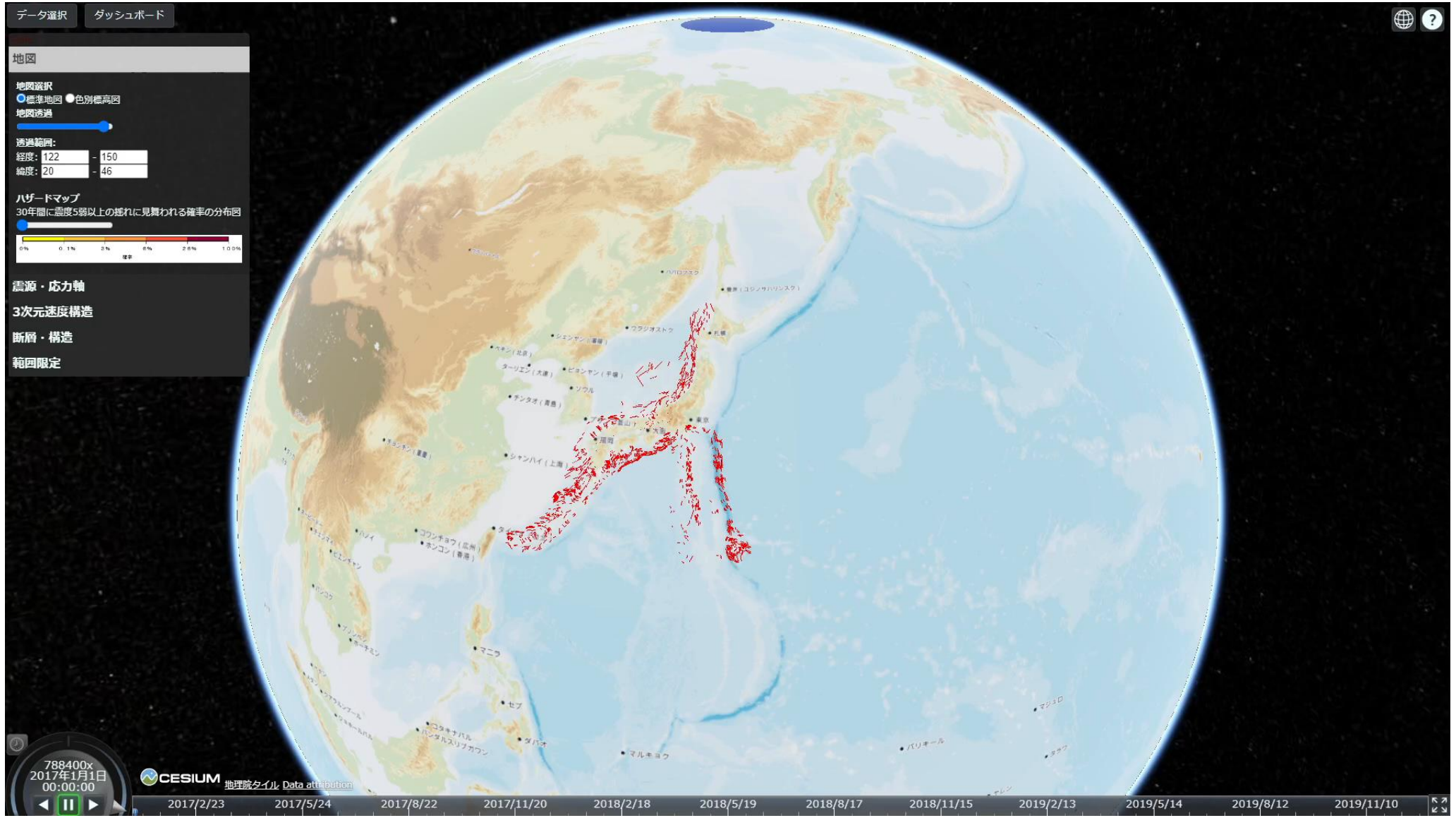


Magnitude time series

b-value

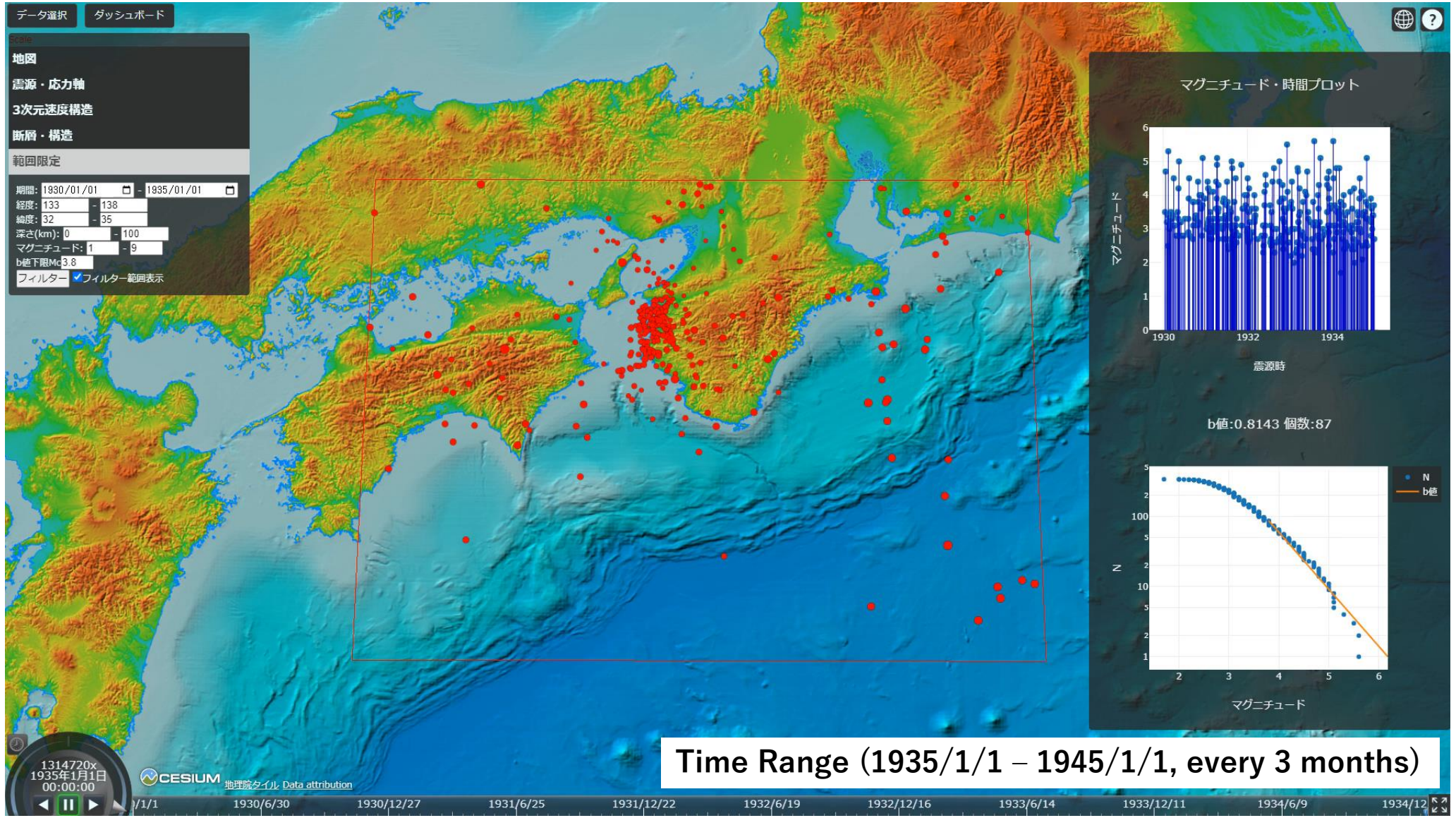
Integrated data sharing platform for Disaster mitigation

SCIENCE FOR RESILIENCE
NIED 防災科研



Integrated data sharing platform for Disaster mitigation

SCIENCE FOR RESILIENCE
NIED 防災科研



Time Range (1935/1/1 – 1945/1/1, every 3 months)

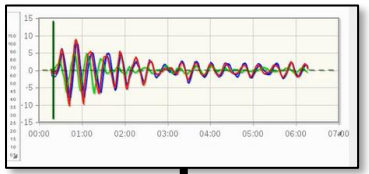
Way Forward Development Plan

SCIENCE FOR RESILIENCE
NIED 防災科研

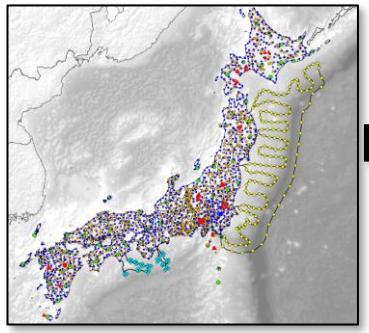
Automated Workflow

Fault Picking by AI/ML

Events Auto Detection

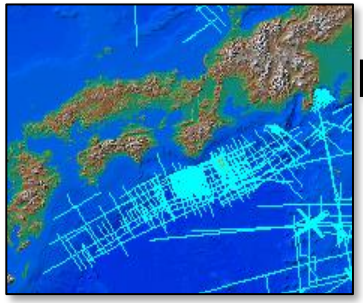


Public Data Sources



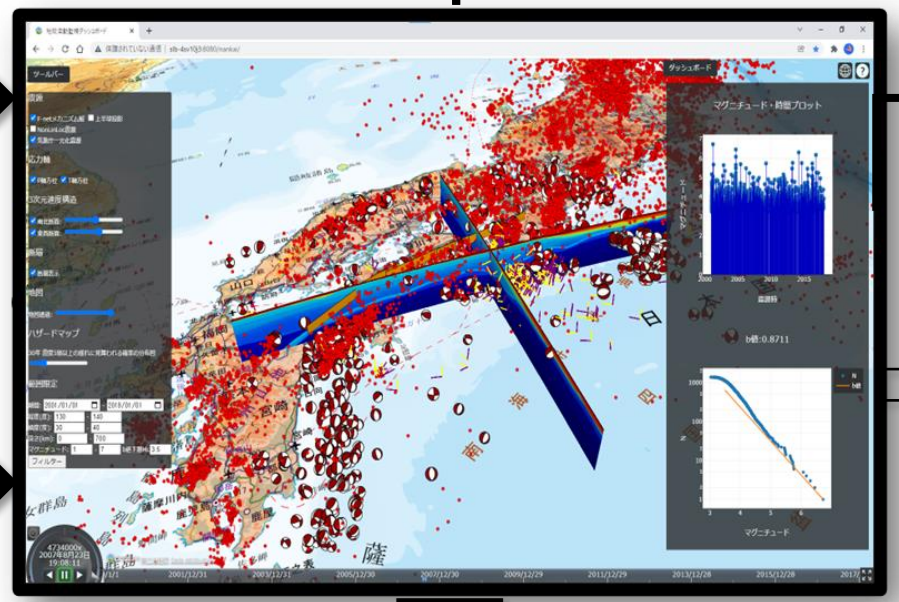
Real time update

- Earthquakes
- Tsunami
- Crustal movement



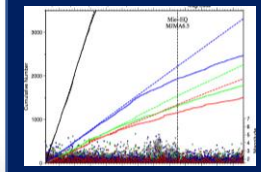
Embedding

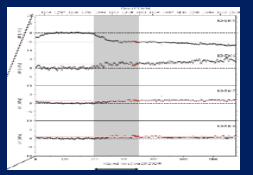
- Seismic Survey
- Topography data
- GPS data



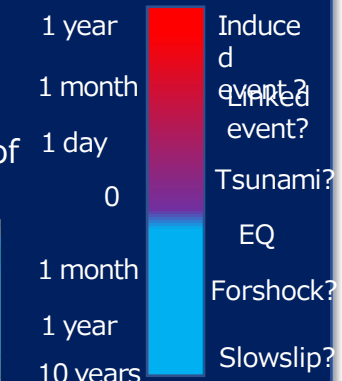
Real time monitoring and analysis

Monitoring crustal activity

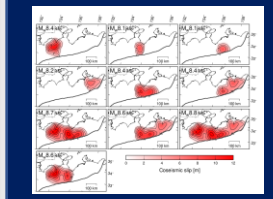




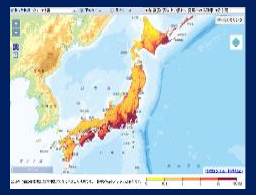
Various events with different temporal-spatial scale



Forecast of mega earthquakes

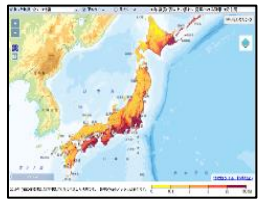


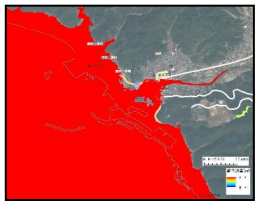
Time evolution of hazard maps

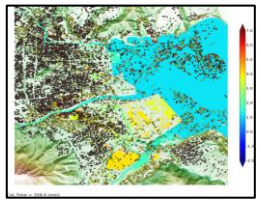


Public release

Disaster risk information







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

Summary

SCIENCE FOR RESILIENCE
NIED 防災科研

- **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