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Monitoring of crustal activities using oceanfloor network system for disaster resilience

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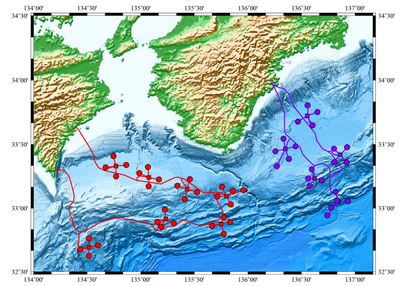
ABSTRACT

Recently, there are many disasters related earthquakes and tsunamis in the world, for example, the 2011 off Tohoku and 2018 Palu Indonesia. These sources are located in the sea, therefore it is important to utilize data of seafloor observations for disaster resilience. We have considered how to use real-time data by oceanfloor network systems like the Dense Oceanfloor Network system for Earthquakes and Tsunamis (DONET) to reduce these damages. We have two strategies, which are monitoring crustal activities using statistical technique for long term evaluation of huge earthquakes with a magnitude over eight, and real-time tsunami prediction considering tsunami propagation. DONET has ability to determine focus of small earthquakes with a magnitude 0.8 and we understand in situ stress field around the subduction zone using temporal- spatial seismicity map. We consider that real-time tsunami prediction based on the propagation is effective, because it is easy to reflect the real-time amplitude of the seafloor pressure data of coming tsunami to the coast on the prediction. It is useful to use it for tsunami by seafloor landslide. Convenient forward tsunami modeling is helpful for far field tsunami. In this presentation, we introduce our attempt using the oceanfloor network system for disaster prevention.



Outline of DONET. DONET consists of DONET1 installed around the Tonakai earthquake rupture area (Blue), and DONET2 installed around the Nankai (Red). Normally, it is known that the seismicity is extremely low. Therefore, the aim is to observe many types of broadband phenomena on the seafloor with high dynamic range, which are crustal deformation, slow slip, long term strong motion, high frequency event signals, tsunami , and acoustic signals..

Objectives of oceanfloor observation using DONET

Ground motion sensing system

Strong motion sensor

Broadband seismometer

Pressure sensing system

Pressure gauge

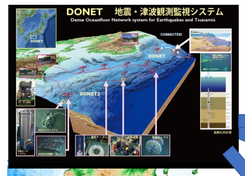
Precise thermometer

Hydrophone

Differential pressure gauge

TARGET	**Long term ground motion**	**0.001 - 0.1 Hz; 1×10^{-9} m/s² - (at 0.05Hz)**	**0.001 ～ 0.1 Hz; > 1 Pa**
	Microseismicity	**0.1 - 100 Hz; 1×10^{-7} m/s² – (at 10Hz)**	**0.1 ～ 100 Hz; > 1 Pa**
	Huge earthquake	**0.01 - 100 Hz; - 39.2 m/s² (at 10Hz)**	**0.01 ～ 100 Hz; > 3 MPa**
	Crustal deformation		**～ 100 sec; >1 Pa**
	Tsunami		**1 day ～ 100 sec; >1 Pa**

Data transmission of DONET/S-net for disaster resilience



Earth LAN

Network for realtime data transmission for earthquakes and tsunamis

Local governments (Wakayama, Mie)
Electrical Power company
DONET
Realtime tsunami prediction

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

防災科研 NIED
DONET/S-net
S-net
Railroad companies
Emergency stop for high speed train, SHINKANSEN
Local government (Chiba)
Realtime tsunami prediction

気象庁 Japan Meteorological Agency
Earthquake early warning
Tsunami warning

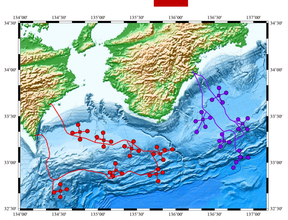
Japanese universities and research institutes

Current status of data utilization for DONET and S-net. NIED implements all network system for earthquakes and tsunamis (MOWLAS), and has responsibility for data transmission. Recently, Japanese railroad companies determined use of DONET and S-net data to stop high speed trains, SHINKANSEN during observation of strong motion. JMA announces earthquake early warnings and tsunami warnings as national government. JAMSTEC has developed realtime tsunami prediction system using DONET and installed local governments and electrical power industry. And the system was expanded to Chiba prefecture using S-net data.

Realtime tsunami prediction system using DONET

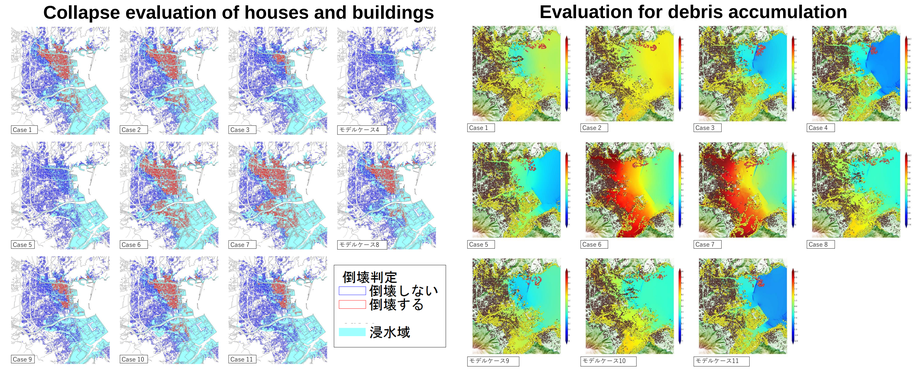
Realtime prediction

Example of the realtime tsunami prediction (Takahashi et al., 2017; 2018; Baba et al., 2013) using Nankai M9 model case 7 (Japan Cabinet Office, 2012). The prediction point is Muroto city located southeastern tip of Shikoku, Japan. In this case, the prediction reached to final prediction after 12 min. from tsunami triggered and before tsunami arrivals.



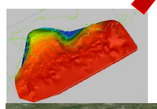
Collapse evaluation of houses and buildings

Evaluation for debris accumulation

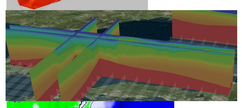


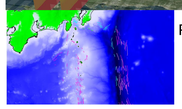
We have considered construction of realtime tsunami damages prediction using technique of tsunami prediction. Using 11 cases of Nankai M9 models (JCO, 2012), we evaluated collapses of houses and buildings, and locations of accumulation points for these debris. (Left) Collapse evaluation of houses and buildings. Brue and red indicate collapse one and non-collapse. Skyblue regions indicate inundation areas. (Right) Evaluation for debris accumulation. Debris and inundation depth have strong correlation.

Long term evaluation



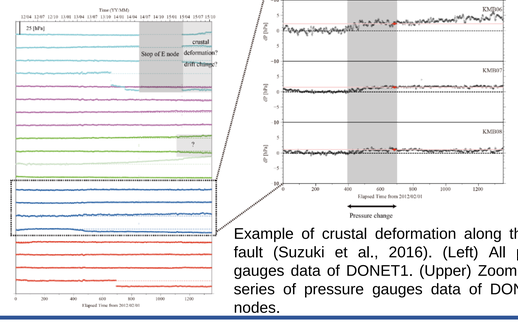
3D velocity volume and precise focus determination





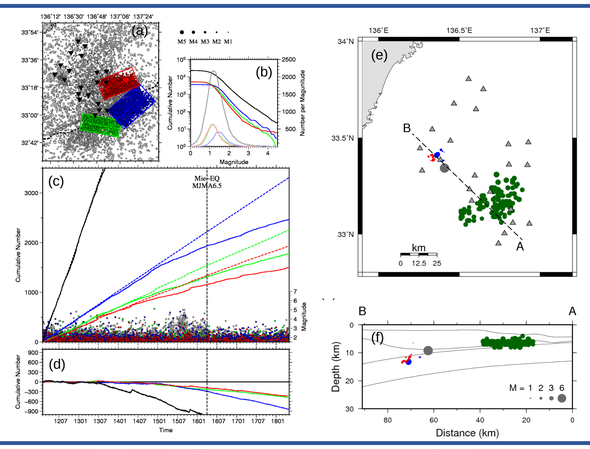
Fault mapping

Crustal deformation monitoring



Example of crustal deformation along the spray fault (Suzuki et al., 2016). (Left) All pressure gauges data of DONET1. (Upper) Zoom up time series of pressure gauges data of DONET1 B-nodes.

Seismicity monitoring

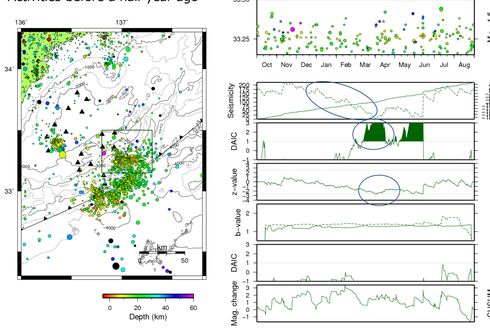


Monitoring of seismic activities beneath the DONET area. Based on the ETAS modeling, recent one has becomes low continuously. The tendency did not seem to be affected by 2016 Mie southeastern earthquake (M6.5). (a) Clusters detected by DONET. (b) Magnitude Cumulative profile. (c) Time series of cumulative profile of each cluster. (d) Time series of difference from the average. (e) Seismic activities of 2016 Mie southeastern earthquake. (f) Vertical profile of the seismic activities.

Long term evaluation of large earthquake using statistical indexes

2016 Mie off southeastern earthquake

Activities before a half year ago



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