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# Development of wide area displacement monitoring for early detection of deformation or damage of civil engineering structures using satellite SAR

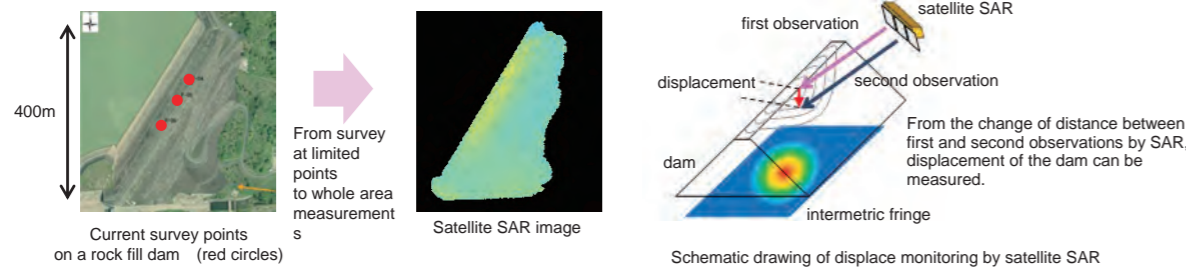


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## R&D Objectives and Subjects

### Objectives

Monitoring displacement of many civil engineering structures both in normal times and after natural disasters by utilizing satellite SAR data covering a wide area without sensors on the ground surface



### Subjects

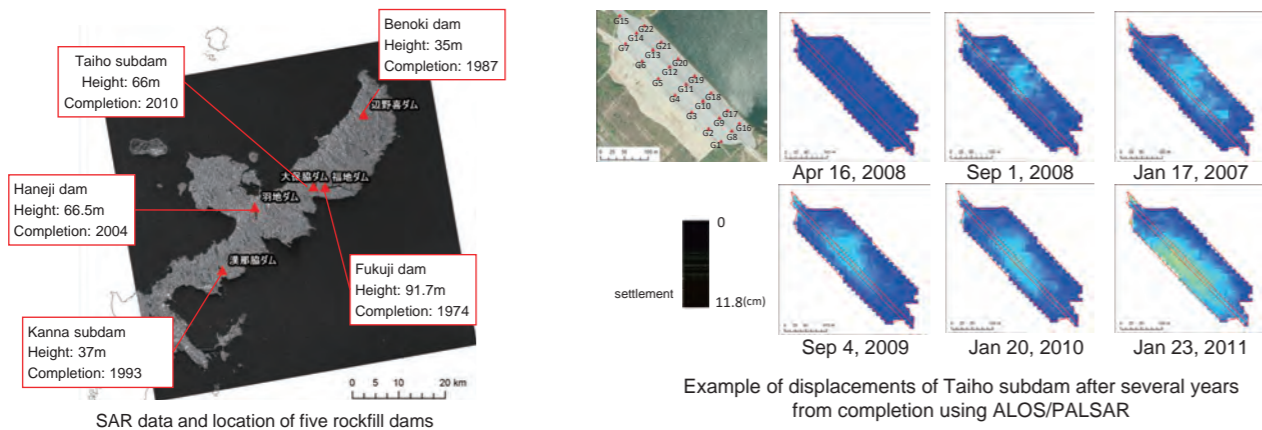
We are conducting the following studies to develop a new displacement monitoring method using satellite SAR as a core technology

- ①Development of a monitoring method for practical application for rockfill dams
- ②Research on applicability for concrete dams or other structures
- ③Development of a reliable monitoring method combining SAR, conventional survey, GPS, etc.

## Current Accomplishments (1/2)

### (1) Trial of displacement monitoring for five rockfill dams in one scene using ALOS/PALSAR data

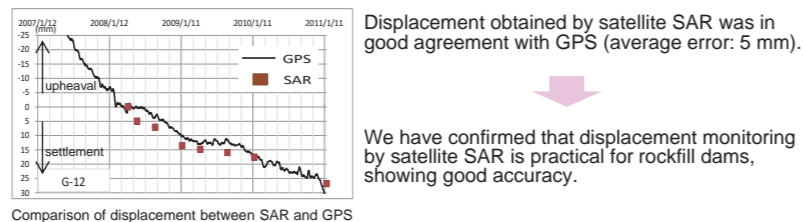
Target dams : Five rockfill dams  
Data used : ALOS/PALSAR (2006-2011) (Spatial resolution:10m, wavelength: 23.6cm (L-band))



Example of displacements of Taiho subdam after several years from completion using ALOS/PALSAR

Difference between SAR and conventional survey / GPS

|              | Current surveying method           | Average error (RMSE) (unit: mm) |
|--------------|------------------------------------|---------------------------------|
| Taiho subdam | GPS                                | 6.0                             |
| Haneji dam   | conventional survey, partially GPS | 4.4                             |
| Fukuji dam   | conventional survey, partially GPS | 4.3                             |
| Kanna subdam | conventional survey                | 5.5                             |
| Benoki dam   | conventional survey                | 6.7                             |



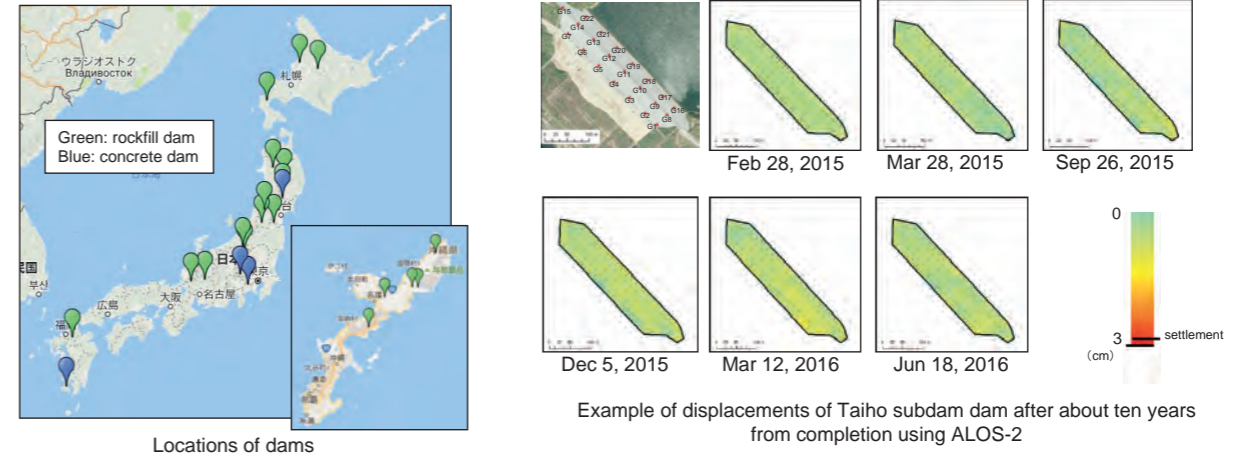
Comparison of displacement between SAR and GPS

Sato et al. : Interferometric SAR time series analysis for external deformation monitoring of five rockfill dams using ALOS/PALSAR data, Journal of JSCE, F3, Vol.73, Jan 2017.

## Current Accomplishments (2/2)

### (2) Trial of displacement monitoring for various rockfill dams across Japan using ALOS-2 data

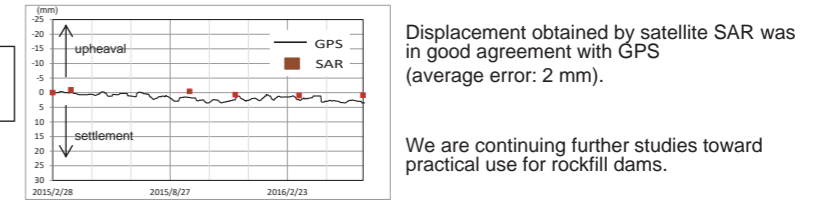
Target dams : Nineteen rockfill dams  
Data used : ALOS-2 (2014-) (Spatial resolution 10m, wavelength 23.6 cm (L-band))



Example of displacements of Taiho subdam after about ten years from completion using ALOS-2

Target dams were selected across Japan for future practical use in many dams

Applicability for concrete dams is under study



Comparison of displacement between SAR and GPS

## Goals

### 【Current progress for final goals】

- ①For practical use of satellite SAR for deformation monitoring of rockfill dams
  - Accurate displacement measurement in normal times
  - Wide and early displacement measurement after earthquakes
- ②Research on applicability for deformation monitoring of concrete dams or other structures
  - Trial measurement for concrete dams (under study)
- ③Development of a reliable monitoring method combining SAR, survey, GPS, etc.
  - Accurate displacement monitoring by satellite SAR at places without displacement data (under study)
  - Reliable monitoring technology combining satellite SAR and other methods (conventional survey, GPS, etc.) (under study)

### 【Final Goals】

- Realization of efficient and effective displacement monitoring by combining satellite SAR and other methods
- Contributing to improvement of monitoring technology for life expansion of civil engineering structures, including dams, by complementary use with conventional methods

