Satellite-based assessment of building damage to support improvements such as rapid rescue operations, risk reduction, and enhanced survey efficiency

Events such as earthquakes and tsunamis can cause widespread damage, including the collapse of buildings over large areas. During such disasters, it is crucial to rapidly assess the situation to support rescue and relief efforts and mitigate secondary damage. Satellites enable wide-area, continuous monitoring, allowing for a swift and comprehensive understanding of the extent of the damage. This facilitates risk reduction for secondary disasters, faster rescue operations, the expedited issuance of disaster certificates, and efficient planning for recovery and reconstruction.

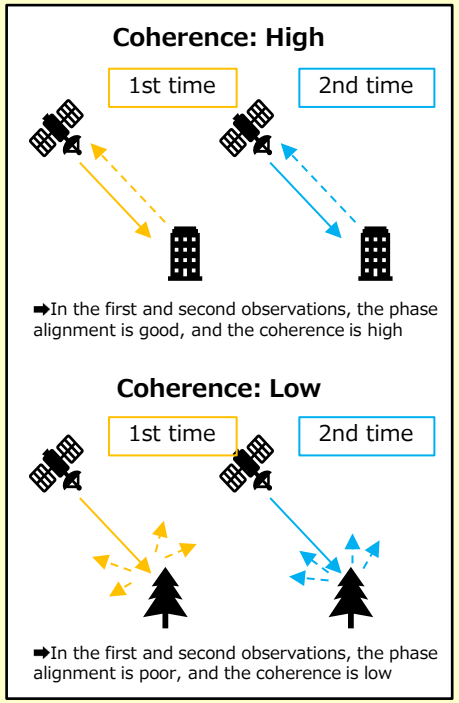
Service

■ Service Overview

- Satellite technology is used to observe building damage caused by earthquakes and other disasters, enabling rapid assessment of the damage.
- By overlaying building registries, land use maps, and other relevant data for the target area, and utilizing AI and other technologies, efforts are being made to enhance detection accuracy.

■ Observation Mechanism by Satellite

- Using optical satellites, the target area and surrounding environment are captured in images. Research is also being conducted on methods to streamline the comparison of images before and after a disaster using AI.
- Methods are being developed to assess the extent of damage after a disaster by utilizing pre- and post-disaster SAR imagery to analyze coherence values. Areas with low coherence values are identified as locations where changes in the surface occurred, indicating building collapse.

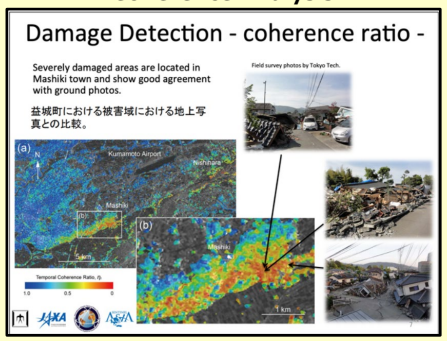


■ Comparison with Conventional Information Gathering Methods

Conventional Methods (Aerial photography, On-site surveys)	·Point or areal observations ·Possible unavailable observation due to weather or local conditions ·access or aircraft required during observations ·Past observations via archive data ·High accuracy (on-site surveys)	**Satellite**	·Wide-range, areal observations ·Observation unaffected by ground obstacles ·Regular observation over an extended period ·Past observations via archive data ·Lower accuracy than on-site surveys

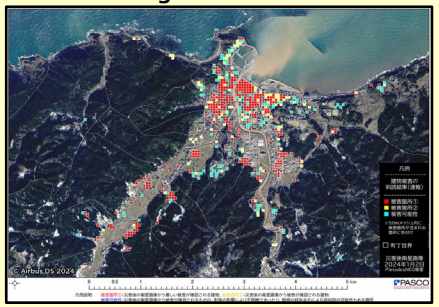
■ Example of Provided Service

Building Damage Estimation Using Coherence Analysis



Source: JAXA

Optical Satellite-based Building Damage Assessment



Source: PASCO

Optical Satellite-based Building Damage Imaging

Source: PASCO

Target Users and Applications

- **Government agencies, Private companies**: By quickly assessing the damage, they can **make accurate decisions aimed at evacuation, rescue, and the reduction of secondary damage.**
- **Local authorities**: By quickly assessing the extent of building damage, they can **reduce the time required to issue disaster certificates.**
- **Research firms, etc.**: By leveraging wide-area or areal surveys, along with remote observation of inaccessible regions, they can **enhance operational efficiency and reduce survey costs.**

Companies Providing Similar Services: Satellite analysis companies, University of Yamanashi, Hiroshima University, etc.

Satellite-based flood status assessment to support improvements such as rapid rescue operations, risk reduction, and enhanced survey efficiency

In recent years, the effects of climate change have led to the occurrence of massive typhoons and linear rainbands, resulting in widespread flooding around the world. During disasters, it is crucial to quickly assess the situation in order to support rescue and relief efforts and mitigate secondary damage. By utilizing satellites for broad and continuous monitoring, a rapid understanding of the overall impact is enabled, facilitating risk reduction for secondary disasters, prompt rescue operations, expedited issuance of disaster certificates, and the formulation of recovery and reconstruction plans.

Service

■ Service Overview

- Flooded areas can be identified using satellite data.
- By combining this information with 3D maps and elevation data, it is possible to determine flood depth, affected buildings, damaged roads, and more. Additionally, some services enhance efficiency by using AI to extract flooded areas.
- There are also cases where accuracy is improved by integrating data from local sources, such as social media updates.

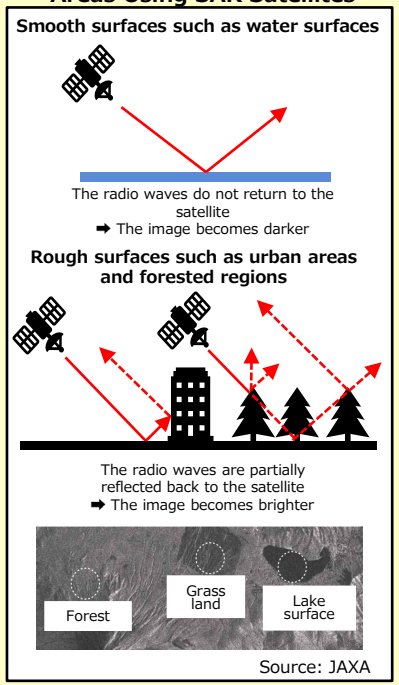
■ Observation Mechanism by Satellite

- Flooded areas are captured using optical satellites.
- SAR satellites emit radio waves that are minimally reflected by smooth surfaces, such as water, resulting in lower signal intensity and appearing dark in imagery, which enables the identification of flooded regions.
- Research is also being developed on mapping flooded areas using the Normalized Difference Water Index (NDWI), based on data observed by the multispectral sensors of optical satellites, for floods caused by events such as tsunamis, except under rainy conditions.

■ Comparison with Conventional Information Gathering Methods

Conventional Methods (Aerial photography, On-site surveys, etc.)	・Point or areal observations ・Possible unavailable observation due to weather or local conditions ・Access or aircraft required during observations ・Past observations via archive data ・High accuracy (on-site surveys)
Satellite	・Wide-range, areal observations ・Observation unaffected by ground obstacles ・Regular observation over an extended period ・Past observations via archive data . Lower accuracy than on-site surveys

Methods for Determining Flooded Areas Using SAR Satellites



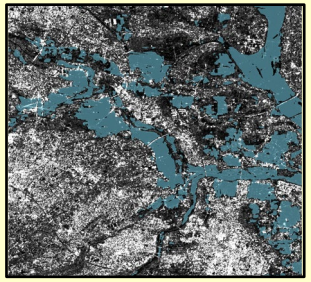
Source: JAXA

■ Example of Provided Service

Flooded Areas and Flood Depth, Roads, and Buildings

Source: Synspective

Flooded Area Analysis Based on SAR Satellite Data



Source: SPACE SHIFT

Target Users and Applications

- **Government agencies/Infrastructure firms, etc.:** By rapidly assessing the damage, they can **make informed decisions to facilitate evacuation, rescue efforts, and the reduction of secondary damage.**
- **Research firms:** By leveraging wide-range, areal surveys and remote monitoring of hard-to-reach areas, they can **enhance operational efficiency and reduce survey costs.**
- **Local authorities:** By quickly assessing the extent and impact of flooding, they can **reduce the time required to issue disaster certificates.**

■ Example of Application

Disaster Response Based on Flood Situation Assessment

Source: Document of Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Companies Providing Similar Services: Spectee/RESTEC, Synspective, Nippon Koei, Ridge-i, SPACE SHIFT, Orbital Insight/ Abeam Consulting/ Tokio Marine & Nichido Fire Insurance, Kokusai Kogyo/ General Insurance Association of Japan, etc.

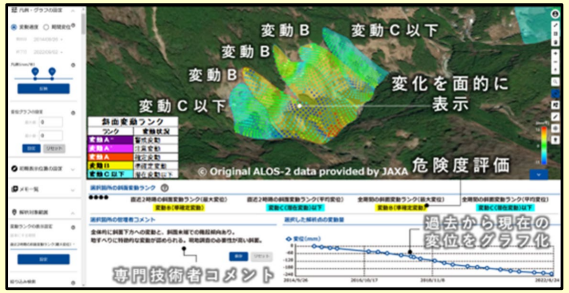
Satellite-based ground deformation monitoring to improve efficiency, reduce risks, and support other improvements in surveying operations

To ensure the safety of social infrastructure and facilitate the early detection of disasters such as landslides, it is essential to monitor ground conditions over the long term to understand their variations. This approach enables the development of effective inspection plans and the implementation of necessary countermeasures. By utilizing satellites for comprehensive and regular monitoring, and visualizing the results, we can effectively monitor hard-to-access areas, improve surveying accuracy, and identify sites that require detailed investigations. Furthermore, this methodology contributes to cost reduction and increased efficiency through the assessment of countermeasure effectiveness. Additionally, it helps mitigate risks by enabling timely maintenance and repairs.

Service

■ Service Overview

- The changes in the distance between the satellite and the ground surface at two different time periods or time series are measured to visualize the ground surface fluctuations.
- Some services also provide risk assessments for ground movements, such as landslides, based on the analysis of the measured ground surface displacement trends.

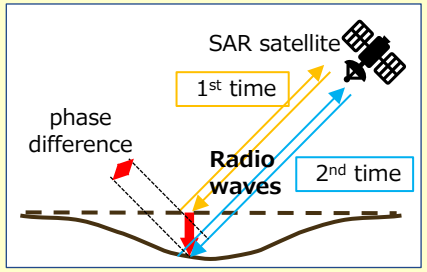


Source: Nippon Koei

■ Observation Mechanism by Satellite

- The distance changes between the satellite and the ground surface are measured by performing an interferometric analysis of two images taken at different times, using the radio waves emitted by the SAR satellite, and calculating the phase difference (shift in the cycle).
- Leveraging a time series of satellite images allows detection of anomalies caused by ground deformations with centimeter-level accuracy.

The Phase Difference Measurement Using InSAR

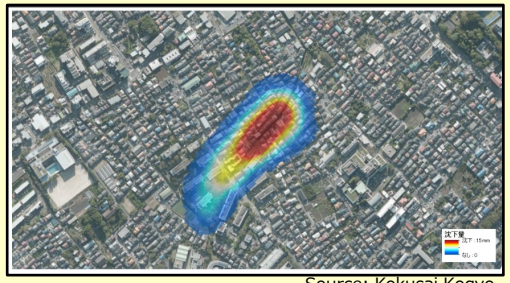


■ Comparison with Conventional Information Gathering Methods

Conventional Methods (On-site surveys, GNSS Sensors)	・Millimeter measurements ・Pinpoint measurements ・On-site measurements ・Measurements with access required ・Measurements after implementation/installation of equipment ・High accuracy (on-site surveys, GNSS)	→	**Satellite**	・Centimeter-level accuracy observations ・Wide-range, areal observations ・Space-based observations free from ground obstacles ・Regular observations on long-term basis ・Past observations via archive data ・Lower accuracy than on-site surveys, GNSS sensors

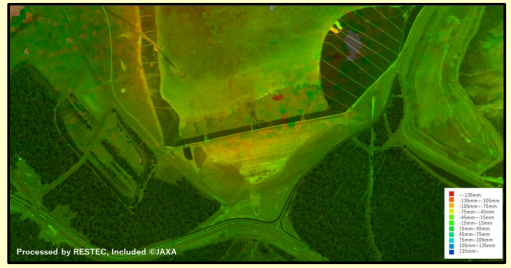
■ Example of Provided Service

Areal Ground Deformation Monitoring



Source: Kokusai Kogyo

Displacement Monitoring in Dams



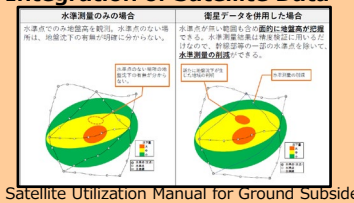
Source: RESTEC

Target Users and Applications

- **Research firms, etc.**: The use of remote observation for wide range and areal surveys, targeting areas that are difficult to access, and the reduction of leveling surveys through the integration of satellite data, can help **improve operational efficiency and reduce survey costs.**
- **Government agencies, Other firms**: By periodically and areal monitoring changes in and around large-scale infrastructure and facilities, such as airports, roads, bridges, dams, and ports, as well as construction sites and landslide prevention areas, they can **establish foundational data for inspection and repair planning, reduce risks through damage prevention measures, and improve operational efficiency by assessing the effectiveness of remedial work**.

■ Example of Application

Reduction of Leveling Through the Integration of Satellite Data



Source: Satellite Utilization Manual for Ground Subsidence Observation, Summary Supplement Edition

Companies Providing Similar Services: Sky Perfect JSAT/ Nippon Koei/ ZENRIN, Synspective, PASCO, RESTEC, Kokusai Kogyo, NEC, OYO, TRE ALTAMIRA, 3vGeomatics, etc.