Satellite Infrastructure Observations for Improvements such as Enhanced Inspection Efficiency and Disaster Risk Reduction

In Japan, the disaster risks associated with infrastructure built during the period of rapid economic growth (1955~1973) are increasing due to aging, and there is a growing need to reduce the costs of maintaining and managing infrastructure that requires regular maintenance. By using satellites to conduct wide-area and regular monitoring, the condition of large-scale infrastructure facilities such as roads, bridges, and airports, as well as the surrounding ground, can be visualized. This enables cost reduction and efficiency through high-precision surveying, narrowing down survey locations, and evaluating the effectiveness of remedial measures, while also reducing risks through repair work.

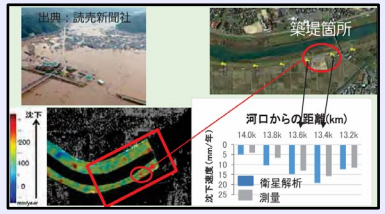
Service

■Service Overview

- By measuring the changes in the distance between satellites and the ground surface at two different points in time or over a timeline, the fluctuations of infrastructure such as roads, bridges, river embankments, and airports, as well as changes in the ground surface, can be visualized.

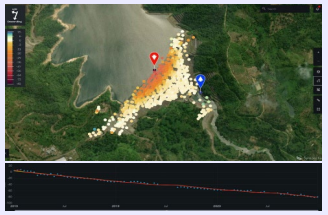
■Example of Service Provided

Ground Deformation Analysis of River Embankments



Source: JAXA

Top: Analysis of ground deformation around the dam gate
Bottom: Settlement trend at the red pin location

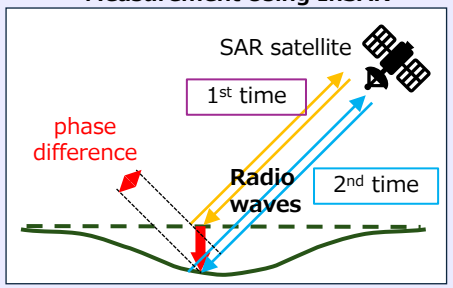


Source: Synspective

■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).
- By leveraging a time-series of satellite images, infrastructure and ground surface deformations can be detected with precision in the millimeter to centimeter range.

The Phase Difference Measurement Using InSAR



■Comparison with Conventional Information Gathering Methods

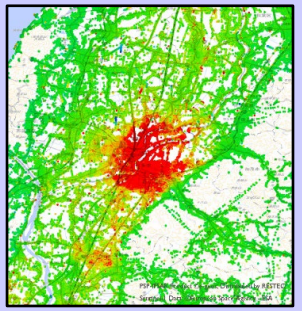
Conventional Methods (On-site surveys, measurements, GNSS sensors)	・Millimeter-accurate measurement ・Pinpoint measurements ・On-demand observations ・Observation after implementation/ installation of equipment ・Measurement of absolute changes between two periods ・Affected by terrestrial conditions (e.g., forests, disasters) ・High accuracy (On-site surveys, GNSS sensors)	**Satellite**	・Observation at millimeter to centimeter accuracy ・Wide-range, areal observations ・Regular observations over a long period ・Past observations via archive data ・Observation of relative changes between two periods ・Observation from space, unaffected by terrestrial conditions ・Lower accuracy than onsite-surveys/sensors

Target Users and Applications

- **Research firms, etc.**: By utilizing remote observation for wide-range and areal surveys, as well as for infrastructure that is difficult to access, they **can improve survey efficiency and reduce survey costs.**
- **Governments, Local authorities, Infrastructure-related companies**: By regularly and areally monitoring the changes in infrastructure and facilities, such as airports, roads, bridges, dams, and ports, including their surrounding areas, this **contributes to the development of foundational materials for inspection and repair plans, risk reduction through damage control measures, and improvements in business efficiency by evaluating the effectiveness of countermeasures.**

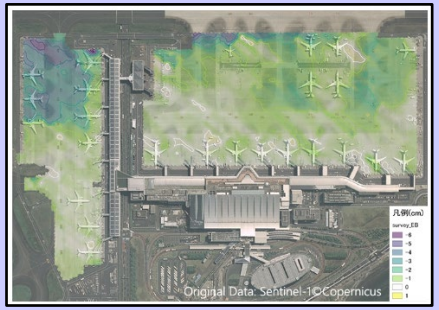
■ Example of Application

Assessment of Ground Deformation around Roads and Railways



Source: RESTEC

Assessment of Ground Deformation around Airport Aprons



Source: Nippon Koei

Companies Providing Similar Services: NTT Data, NEC, Kyushu Electric Power/Institute for Q-shu Pioneers of Space/JAXA, Synspective, Sky Perfect JSAT/Zenrin/Nippon Koei, Kokusai Kogyo, PASCO, RESTEC, etc.

Satellite-based Digital 2D and 3D Mapping for Improvements such as Enhanced Efficiency and Advancement in Surveying and Analysis

By leveraging satellites for wide-area and regular observations through stereoscopic imaging, it is possible to create digital 3D maps enriched with height information for land and buildings. These 3D maps can serve as a foundation for various surveys, assessments, and designs, enabling cost reductions through improved operational efficiency and the enhancement of value-added activities such as simulations. Additionally, the use of satellite imagery allows for the creation and updating of 2D maps, such as basic urban planning maps, at a lower cost compared to conventional methods.

Service

■Service Overview

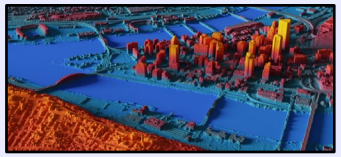
- By overlaying multiple optical images, it is possible to determine three-dimensional coordinates for any location worldwide and create 3D maps.
- Optical imagery can also be utilized to generate 2D maps.

■Example of Service Provided

3D Surface Model

Source: Maxar technologies

DSM

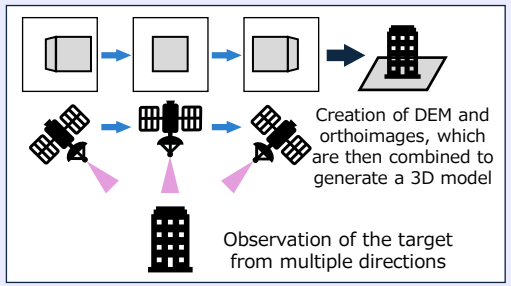


Source: Maxar technologies

■Observation Mechanism by Satellite

- Using optical satellites, targets are observed from multiple angles, and the parallax of each image is utilized to measure the height of the target and create a Digital Elevation Model (DEM). In addition, orthoimages are generated by correcting distortions in the captured images. These are then combined to produce 3D maps.
- Research is also being conducted on generating 3D terrain information using a combination of small optical satellites and altimeter LiDAR satellites.

Creation of 3D maps through multi-directional imaging



■Comparison with Conventional Information Gathering Methods

Conventional Methods (Aerial photography)	・Limited to specific regions for map creation ・Aerial observation required for each update ・Observation only during the survey period	→	**Satellite**	・Global map creation through wide-area observations ・Regular observations and updates possible ・Past observations via archive data

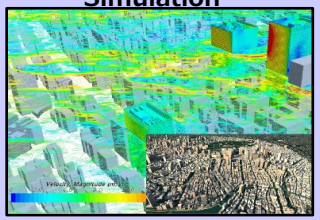
Target Users and Applications

- **Government agencies, Other firms**: Digital 3D maps can **be leveraged to enhance efficiency and sophistication across various industries**, including assessing the status of urban planning and development areas, monitoring urban greening and forest conditions, selecting suitable construction sites, creating visual content, and conducting simulations for mobile signal analysis, tower installation, and wind conditions. Furthermore, 2D maps, such as base maps for urban planning, which serve as foundational resources for city development, can be created and updated at a lower cost compared to conventional methods.

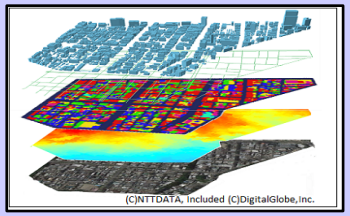
■Example of Application

Urban Green Space Analysis

Wind Environment Simulation

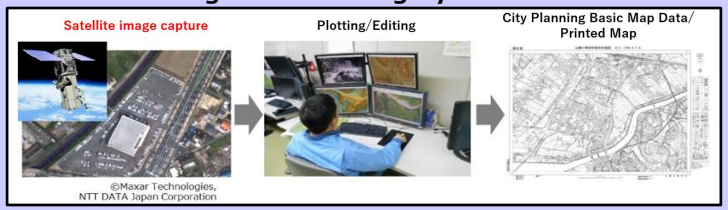


Telecom 3D Dataset



Source: AW3D

Creation of Base Maps for Urban Planning Using Satellite Imagery Data



Source: NTT Data, RESTEC, Nakanihon Air Service

Companies Providing Similar Services: NTT Data/RESTEC, Maxar technologies, Creotech Instruments S.A., etc.

Satellite-based Leakage Risk Analysis for Improving Survey Efficiency and Reducing Risks

The aging of water pipes is a challenge faced by local authorities (municipalities) in Japan, and since most water pipes are buried underground, significant costs and time are required for leakage surveys, maintenance, and repair work. By using satellites to identify areas with high leakage risks or where water pipes are leaking, it becomes possible to streamline the costs and efforts of on-site inspections, while also reducing damage and risks through early detection of leaks.

Service

■Service Overview

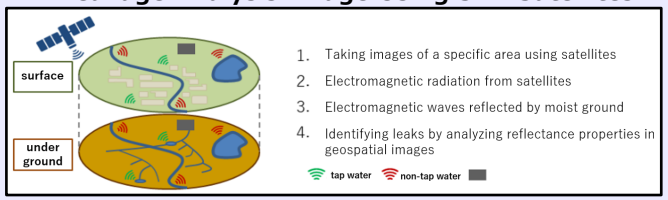
- Through analysis using satellite data, areas with potential leakage risks are identified and visualized.
- There are services that detect water leaks from satellite data, as well as services that assess leak risks by combining satellite data with information of water pipe attributes, terrain, soil, and other related data.

■Observation Mechanism by Satellite

- Leakage risks are assessed using pipeline data, along with environmental factors such as surface temperature, weather, vegetation, topography, and ground deformation, derived from optical and SAR imagery.
- Underground leakage is identified using L-band SAR data through electromagnetic reflection characteristics and soil moisture measurements.

■Example of Service Provided

Leakage Analysis Image Using SAR Satellites

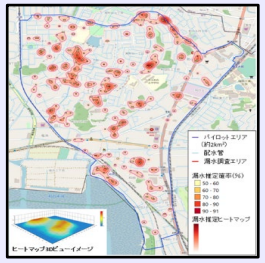


Source: NEC Networks & System Integration

Surface Temperature Observation Using Thermal Infrared Sensors

Source: Orora Technologies

Estimated Leakage Map Image



Source: RESTEC

■ Comparison with Conventional Information Gathering Methods

Conventional Methods (On-site surveys, Leakage sensors)	・Observations are limited to specific survey points ・Extensive and time-consuming survey area ・On-site surveys/observations are necessary whenever required ・High sensor cost for covering the entire target area ・High accuracy (on-site surveys/sensors)	**Satellite**	・Wide-range and areal observation in a single time ・Regular observations over a long period ・Past observations via archive data ・Low cost per unit area ・Lower accuracy than on-site surveys/sensors

Target Users and Applications

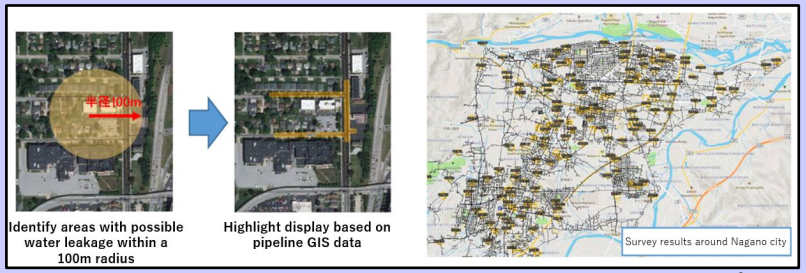
- **Local authorities, Research companies, etc.**: By screening areas with high leakage risk using satellite image analysis, they can **efficiently conduct leakage surveys only in high-risk areas. This significantly reduces both the cost and time required for surveys, while early detection of leaks helps minimize damage and risks.**

■Example of Application

Leakage Risk Visualization Service via Web UI

Source: Tenchijin

Image for Extracting Potential Leakage Areas



Source: Nagano Prefecture

Companies Providing Similar Services: Tenchijin, RESTEC, Yokogawa Electric, NEC Networks & System Integration, ASTERRA, etc.

Satellite-based Agricultural Land Use Surveys for Improvements such as Enhanced On-site Survey Efficiency

Local authorities (municipalities) conduct surveys on agricultural land use, including cropping conditions, the water coverage of rice paddies, and abandoned farmland mainly in mountainous and hilly areas. However, the on-site surveys impose a significant burden on local staff and other involved parties, presenting a challenge. By utilizing satellite data to comprehensively monitor cropping and land use across large areas, priority locations for on-site surveys can be identified, thus reducing the time and cost associated with these surveys.

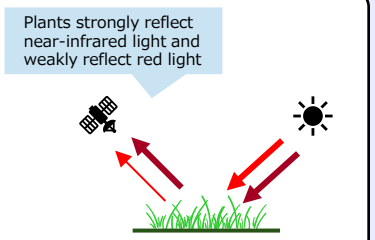
Service

■Service Overview

- Satellite data is analyzed to visualize crop classification by field, identify fields potentially abandoned due to increasing fallow land, and display the water coverage of rice paddies.

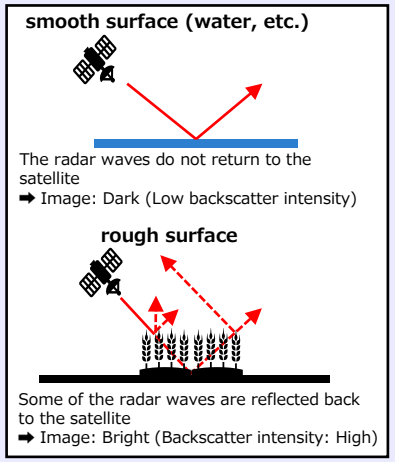
■Vegetation Index

- An index that reflects the quantity and vitality of vegetation, derived from optical satellite data by utilizing the light reflection characteristics of plants. A common example is the NDVI (Normalized Difference Vegetation Index).



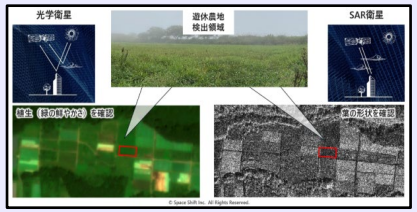
■ Observation Mechanism by Satellite

- Crops in fields are classified using optical satellite images, which can obtain vegetation indices.
- Vegetation is analyzed using optical satellite data, and fallow land is identified by analyzing leaf shape based on backscatter characteristics from SAR satellite data.
- Water coverage in rice paddies is identified based on infrared reflection characteristics from optical satellite data and backscatter characteristics from SAR satellite data.



■ Example of Service Provided

Differences in How Farmland Appears by Satellite Type



Source: SPACE SHIFT

■ Comparison with Conventional Information Gathering Methods

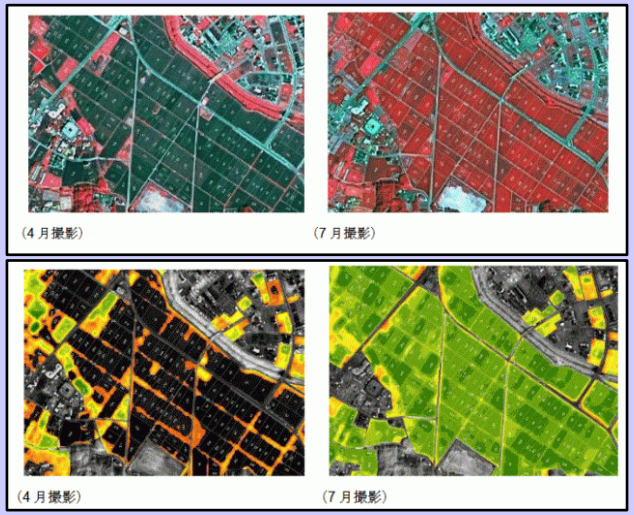
Conventional Methods (On-site surveys)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・Surveys are needed for each assessment ・High accuracy (on-site surveys) ・Information from the time of the survey only	**Satellite**	・Better efficiency than on-site surveys ・Wide-range, areal observations ・Regular observations ・Lower accuracy than on-site surveys ・Past observations via archive data

Target Users and Applications

- **Local authorities**: By assessing agricultural land use over a wide range and areally, it is possible to prioritize areas for on-site surveys, significantly **reducing time, costs, and the burden on local guides, especially as the population ages.**

■Example of Application

Top: Near-infrared images representing the presence or absence of vegetation at two different time points
Bottom: A leaf color map indicating the vitality of the vegetation



Source: PASCO

Companies Providing Similar Services: Sagri, PASCO, LAND INSIGHT, RESTEC/New Japan Knowledge, SPACE SHIFT, Nesty, SkymatiX, etc.

Satellite-based Farming Support such as Agricultural Efficiency Improvement and Others

In light of the declining number and aging of agricultural workers in Japan, as well as global concerns over food security, there is a growing demand for smart agriculture to enhance efficiency and sophistication in farming. Through wide-scale and periodic satellite observations, it is possible to perform soil analysis, visualize crop growth conditions, and determine optimal harvest timing. This enables the efficient and stable production of high-quality crops, streamlines surveys and operations, and supports business decisions based on objective data.

Service

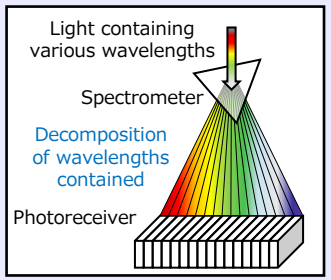
■ Service Overview

- Using satellite imagery, crop growth conditions, flavor quality, and optimal harvest timing are estimated.
- Satellite imagery is also used to analyze soil, visualizing soil chemical properties and fertility.

■ Observation Mechanism by Satellite

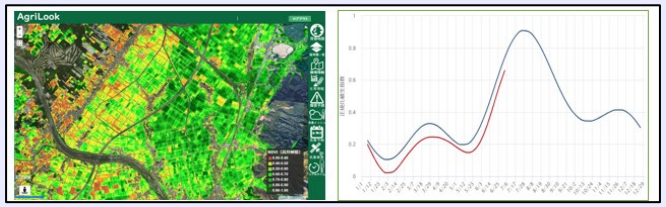
- Using multispectral and hyperspectral images from optical satellites, information such as soil chemical properties (e.g., nitrogen levels and pH), as well as crop attributes like water content, protein content, and leaf color, can be estimated.

Mechanism of hyperspectral sensors

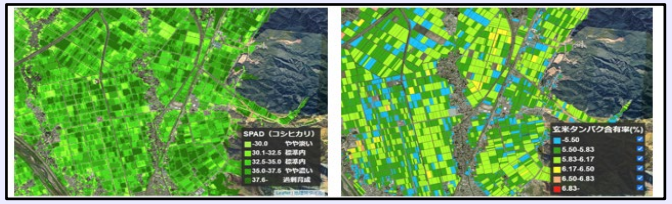


■ Example of Service Provided

NDVI Map | **Time-series NDVI Map**



Leaf Color Estimation Map | **Flavor (Protein) Estimation Map**



Source: VisionTech

■ Comparison with Conventional Information Gathering Methods

Conventional Methods (On-site surveys, drones, aerial photography)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・Surveys are needed for each assessment ・High accuracy (on-site surveys) ・Information from the time of the survey only	→	**Satellite** ・Better efficiency than on-site surveys ・Wide-range, areal observations ・Regular observations ・Lower accuracy than on-site surveys ・Past observations via archive data

Target Users and Applications

- **Farm producers**: By responding to growth conditions and harvesting at the optimal time, as well as using soil analysis to apply fertilizers efficiently and effectively, **crops can be produced with higher quality and greater efficiency and stability.** This is especially beneficial for elderly farmers who cannot invest significant labor, as well as large-scale producers. Additionally, younger farmers can use the data to enhance their skills and expertise.
- **Local authorities, Agricultural cooperatives**: They can monitor the growth conditions of producers' fields, **streamline producer visits and guidance, support new farmers, and maintain and enhance the technical standards within the region.**
- **Buyers**: They can monitor the growth conditions of contracted crops, **reducing labor, travel, and time costs associated with on-site visits, while making business decisions based on objective data.**

■ Example of Application

Left: Management of crop growth by field and timing
Right: management of soil chemical properties

Source: Sagri

Companies Providing Similar Services: RESTEC, Kokusai Kogyo, Sagri, Space Agri, VisionTech, Japan Manned Space Systems, SPACE SHIFT, DATAFLUCT, Kubota, Agriee, BASF, etc.

Satellite-based Forest Monitoring for Efficient Forest Management and Other Related Purposes

As global population growth drives increased demand for timber and the expansion of solar panel installations due to rising electricity needs, deforestation is progressing both domestically and internationally. This has led to a growing need for continuous forest monitoring and management for purposes such as security, disaster prevention, and conservation. By using satellites for wide-range, areal forest monitoring, it becomes possible to streamline on-site surveys and forest management, while also enabling use in carbon credit projects.

Service

■Service Overview

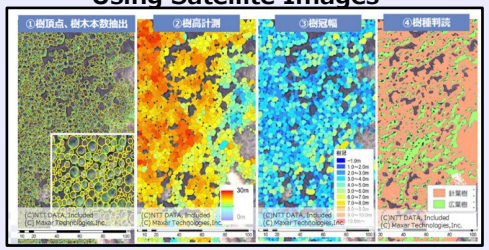
- Satellites monitor forests and visualize changes in forest conditions, such as deforestation, reforestation, landslides caused by natural disasters, and degradation.
- Additionally, they can analyze various information, including tree species, tree height, and greenhouse gas (GHG) emissions and absorption.

■Observation Mechanism by Satellite

- Using optical and SAR satellites, the differing light and radar reflection characteristics of materials are leveraged to determine what covers the Earth's surface.
- With SAR satellites, the backscatter characteristics of radar waves vary depending on the smoothness or roughness of the surface, allowing for the distinction between forested and non-forested areas. By comparing observation data from two different time points, changes such as deforestation can be identified.

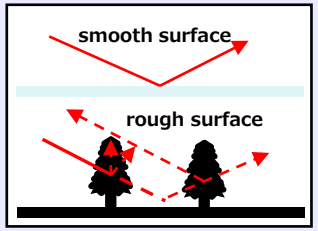
■Example of Service Provided

Example of Forest Analysis Using Satellite Images



Source: NTT Data

Methods for Identifying Forested and Non-Forested Areas with SAR Satellites



■Comparison with Conventional Information Gathering Methods

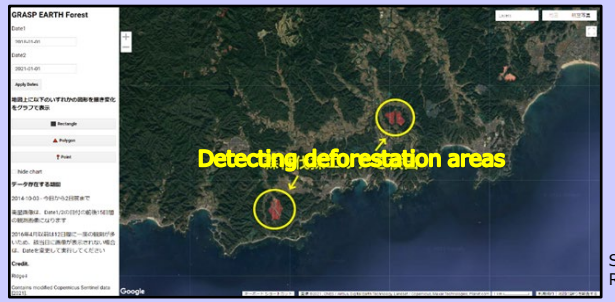
Conventional Methods (On-site surveys, drones, aerial photography)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・Surveys are needed for each assessment ・High accuracy (on-site surveys) ・Information from the time of the survey only	**Satellite**	・Better efficiency than on-site surveys ・Wide-range, areal observations ・Regular observations ・Lower accuracy than on-site surveys ・Past observations via archive data

Target Users and Applications

- **Local authorities**: Without the need to visit observation sites, they can confirm deforested and reforested areas, narrow down specific survey locations, and significantly **reduce the burden of on-site patrols for issues such as illegal logging, landslides, and fallen tree damage.**
- **Forestry workers**: Satellite images enable efficient forest management, **contributing to cost reduction and addressing labor shortages.** Additionally, they can detect areas of degradation and be **used for the investigation and exploration of potential reforestation sites.**
- **Other firms**: By understanding and analyzing forest resource data, it can be utilized for carbon credit projects. (For details, please refer to the carbon credit section of this report.)

■ Example of Application

Visualization Service for Deforestation Using WebUI



Source: Ridge-i

Companies Providing Similar Services: Kokusai Kogyo, Ridge-i, PASCO, Synspective, NTT Data, Remote Sensing Solutions GmbH, ICEYE, etc.

Satellite-based Observations for Visualizing Diverse Urban Environmental Values, such as Natural Capital and Well-being

Traditionally, the value of urban environments has often been evaluated in economic terms, but efforts are underway to visualize these values from more diverse perspectives, such as natural capital and happiness. By utilizing satellites, it is possible to efficiently capture various information such as ecosystems, forests, water resources, and green spaces, leading to research and demonstration projects aimed at creating diverse environmental value indicators through the use of satellite data. Additionally, this information can be utilized in corporate biodiversity disclosures like TNFD.

Service

■Service Overview

- Satellite data can visualize the impact of urban activities on natural capital, including forest plant species, degradation, and events such as fires and logging.
- Research is being conducted to quantify urban characteristics such as natural capital and land use obtained from satellites, aiming to visualize residents' well-being.

■ TNFD (Taskforce on Nature-related Financial Disclosures)

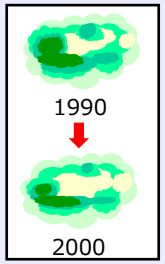
- It is an international organization established with the aim of creating a framework for companies and financial institutions to properly assess and disclose risks and opportunities related to natural capital and biodiversity.
- Ministry of the Environment, Government of Japan has announced that financial support will be provided to companies actively engaged in biodiversity conservation efforts in accordance with the TNFD framework.

■ Observation Mechanism by Satellite

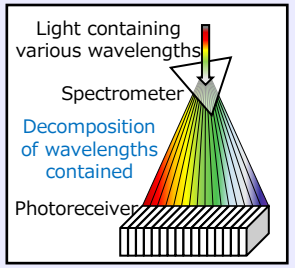
- By comparing with past images from SAR satellites and optical satellites, it is possible to assess the extent of fire damage and confirm the presence of illegal logging.
- The identification of plant species is carried out using optical satellites.
- Vegetation is observed using hyperspectral sensors on satellites, and the health condition of the vegetation can be assessed based on differences in visible and near-infrared reflectance.

■ Example of Service Provided

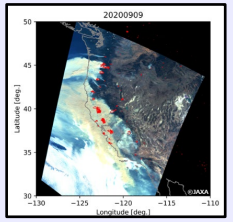
Comparison with Past Images



Mechanism of hyperspectral sensors



Visible Images of Hotspots



Source: JAXA

■ Comparison with Conventional Information Gathering Methods

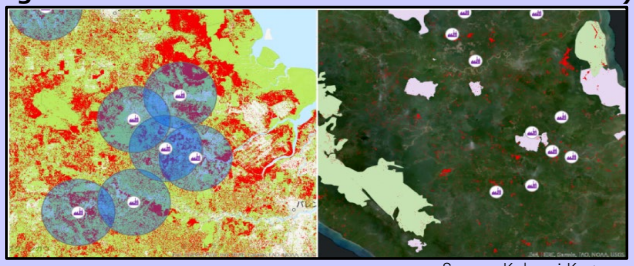
Conventional Methods (On-site surveys, drones, aerial photography)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・Surveys are needed for each assessment ・High accuracy (on-site surveys) ・Information from the time of the survey only	→	**Satellite** ・Better efficiency than on-site surveys ・Wide-range, areal observations ・Regular observations ・Lower accuracy than on-site surveys ・Past observations via archive data

Target Users and Applications

- **Local authorities, Research firms** : Using satellite data to **visualize urban natural capital and well-being (well-being indicators) can enhance the attractiveness and value of cities, contributing to more value-added urban planning.**
- **Private companies** : By utilizing satellites, they can assess environmental risks over vast areas and **reduce the cost and time required for monitoring natural capital for TNFD-based disclosure.**
- **Financial institutions** : By utilizing satellite monitoring, they can **conduct environmental due diligence to assess the extent of environmental risks at low cost and in a short period of time.**

■Example of Application

Satellite Data and GIS Analysis/Visualization Images (Left: Understanding of deforestation risks, Right: Visualization of natural conservation areas)



Source: Kokusai Kogyo

Companies Providing Similar Services: Kokusai Kogyo/Mizuho Research & Technologies, Think Nature/MS&AD Insurance Group Holdings, Keio University/Mitsubishi Electric, 3Bee, Frontierra, GlobalTrust, etc.

Satellite-based Atmospheric Environmental Observation for Visualizing Pollution Levels to Reduce Air Pollution

PM2.5 is one of the main air pollutants in Japan, referring to particles that are 2.5μm or smaller in size and suspended in the atmosphere. Due to their small size, these particles remain in the air for a long time and, when inhaled, can penetrate deep into the bronchial tubes and lungs, causing harmful effects on the respiratory and circulatory systems. The government is leading efforts to consider measures to reduce PM2.5, and there is a need to understand the widespread concentration distribution. The use of satellites enables easy observation areally across broad areas and extensive regions.

Service

■Service Overview

- Aerosol Optical Depth (AOD), which represents the dispersion of aerosols in the air, along with the Normalized Difference Vegetation Index (NDVI) used to measure plant quantity and vitality based on light reflection characteristics, as well as land use conditions, are observed via satellite.
- Ground sensors measure meteorological data such as PM2.5 concentration, temperature, humidity, and atmospheric pressure, which are used as training data. By combining these with satellite data, the spatial distribution of PM2.5 concentrations can be inferred.

■What is optical thickness?

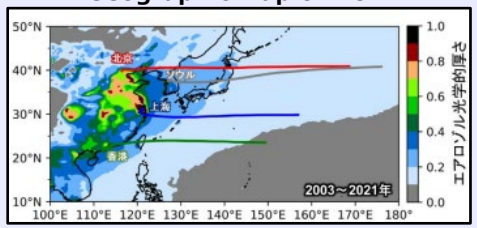
- It represents the attenuation rate of light until it reaches the ground.

■Observation Mechanism by Satellite

- AOD is calculated using a medium-resolution imaging spectrometer.
- NDVI is measured based on the characteristic of plants strongly reflecting near-infrared light and absorbing red light.
- Wide-area observations are made with optical sensors to monitor land use conditions.

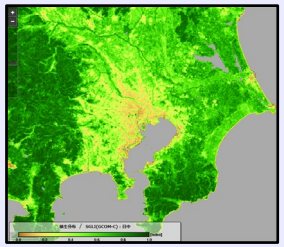
■Example of Service Provided

Geographic Map of AOD



Source: Chiba University

NDVI



Source: JAXA

■Comparison with Conventional Information Gathering Methods

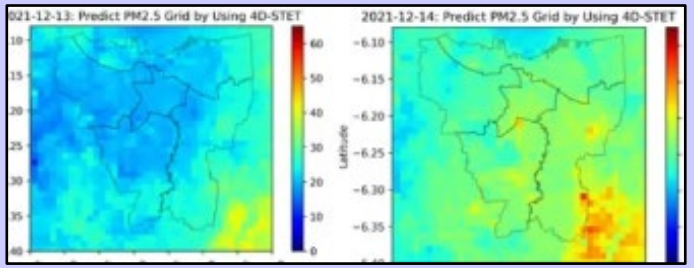
Conventional Methods (Terrestrial IoT sensors)	・High cost by installing multiple sensors ・Specific points observations limited to sensor locations ・High measurement frequency based on sensor capabilities ・High accuracy (sensors) ・Measurements after installation	**Satellite**	・Affordable and easy access to data ・Wide-range, areal observations ・Lower observation frequency compared to sensors ・Lower observation accuracy compared to sensors ・Past observations via archive data

Target Users and Applications

- **National/Local authorities**: By understanding the wide-scale distribution of air pollution concentrations, **they can implement efficient air pollution countermeasures.**
- **Air quality monitoring companies**: Traditional sensors observe at specific installation points, requiring additional sensor locations to expand the observation range, which incurs high costs. By using satellites, they can **conduct wide-area observations, enabling cost-effective monitoring.**

■Example of Application

Visualization of PM2.5 Concentration and its Variation Over Time



Source: sorano me

Companies Providing Similar Services: Mitsubishi UFJ Research and Consulting/sorano me/MUFG Bank/NaFas, Geospatial Insight, Bable, etc.

Satellite-Based Urban Morphology and Temperature observation for Visualizing the Heat Island Effect to Improve Urban Environments

The heat island effect is strongly correlated with urban morphology and surface temperatures, making surface temperature measurement essential to understand the phenomenon. However, conventional AMeDAS observations cannot directly measure surface temperatures and instead rely on estimates derived from data such as air temperature and wind speed. Additionally, measuring the temperature difference between urban and suburban areas is crucial for analyzing the heat island effect, but AMeDAS is limited to data from specific observation points. The use of satellites enables wide-area and easy areally comprehensive surface temperature measurements, overcoming these limitations.

Service

■Service Overview

- Satellites are used to observe land use patterns, as well as measure plant quantity and vitality through the normalized difference vegetation index (NDVI), based on the characteristics of light reflection from plants, and to observe surface temperature over a wide range and areally.

■Observation Mechanism by Satellite

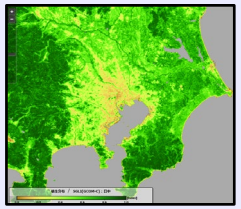
- Thermal infrared sensors are used to measure surface temperatures.
- Optical sensors observe wide areas to assess land use conditions.
- NDVI is calculated based on the characteristic of vegetation strongly reflecting near-infrared light and absorbing red light.

■What is the Urban Heat Island Effect?

- The Urban Heat Island effect refers to the phenomenon where urban areas experience higher temperatures compared to their surrounding areas due to factors such as heat emissions from vehicles, buildings, and the paving of surfaces.
- It is known to be strongly correlated with vegetated areas like grasslands and forests, as well as artificial surfaces such as asphalt and concrete.
- By understanding land use patterns, this information can be used to analyze and address the Urban Heat Island effect.

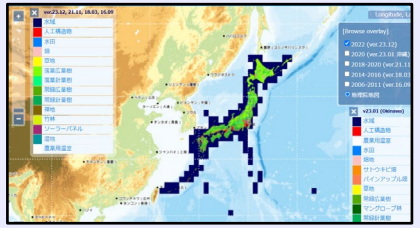
■Example of Service Provided

NDVI



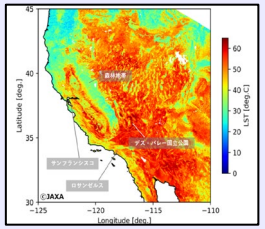
Source: JAXA

Land Use and Land Cover Map



Source: JAXA

Average Surface Temperature



Source: JAXA

■Comparison with Conventional Information Gathering Methods

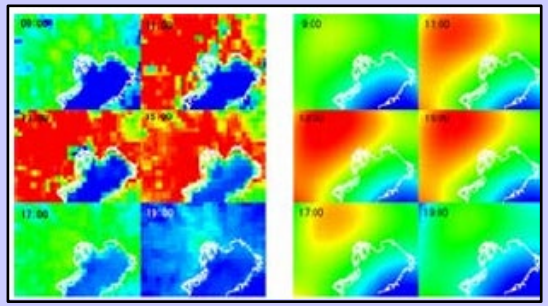
Conventional Methods (AMeDAS)	・High cost by installing multiple sensors ・Specific points observations limited to sensor locations ・High measurement frequency based on sensor capabilities ・High accuracy (sensors) ・Measurements after installation	→	**Satellite** ・Affordable and easy access to data ・Wide-range, areal observations ・Lower observation frequency compared to sensors ・Lower observation accuracy compared to sensors ・Past observations via archive data

Target Users and Applications

- **National/Local authorities**: Visualizing the urban heat island effect can help them to **streamline the implementation of heat island mitigation policies**, such as rooftop greening, wall greening, high-reflectivity paints, and water-retentive building materials.
- **Developers**: By visualizing the urban heat island effect, measures such as strengthening drainage systems in areas prone to heat islands to prepare for sudden heavy rainfall, and implementing mitigation strategies to reduce the heat island effect, can **be taken as part of ESG efforts to protect urban living environments.**

■Example of Application

Visualization of the Urban Heat Island Effect in Tokyo



Source: Nihon University

Companies Providing Similar Services: IFMC/Tenchijin, Nihon University, Geospatial Insight, Latitudo 40, etc.

Satellite-based Land Use Assessment for Improvements such as Optimal Urban Planning

Ensuring safety, disaster prevention, resource management, and the development of sustainable, livable cities requires a thorough understanding of land cover, land use, and their changes. Satellite-based wide-area and periodic monitoring enables efficient tracking of urban usage and transformations, facilitating the creation of advanced urban plans, effective progress management, and the assessment of illegal developments.

Service

■Service Overview

- By comparing land use and land cover maps at different time points using optical and SAR satellite imagery, changes can be extracted, allowing for the visualization of urban transformation from a macro perspective.
- Specifically, this includes visualizing large-scale changes such as recovery from disasters or the increase/decrease of major facilities, as well as detailed changes such as the rise or fall of buildings and the number of parked vehicles in parking lots.

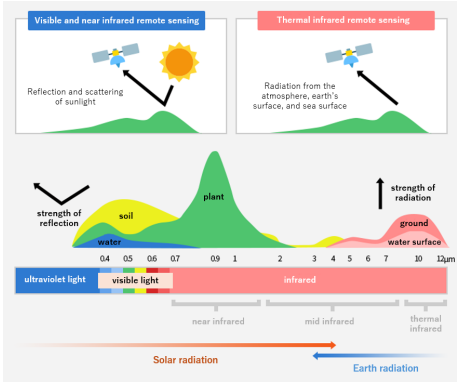
■Observation Mechanism by Satellite

- Land use and land cover conditions are analyzed using the reflection and radiation characteristics of surface materials captured by multispectral sensors on satellites.
- Additionally, there are methods that utilize the backscatter properties of surface materials obtained from SAR satellites.
- For more efficient analysis, AI-based classification techniques are also employed.

■Land Use and Land Cover Classification

- It categorizes and maps the land surface based on its coverage (land cover) and usage (land use).

Reflection and Radiation Images for Each Land Cover Type



Source: JAXA

■Comparison with Conventional Information Gathering Methods

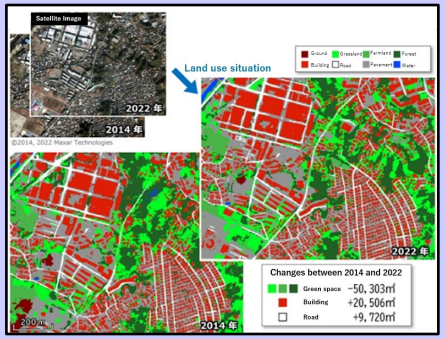
Conventional Methods (On-site surveys, drones, aerial photography)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・Surveys are needed for each assessment ・High accuracy (on-site surveys) ・Information from the time of the survey only	**Satellite**	・Better efficiency than on-site surveys ・Wide-range, areal observations ・Regular observations ・Lower accuracy than on-site surveys ・Past observations via archive data

Target Users and Applications

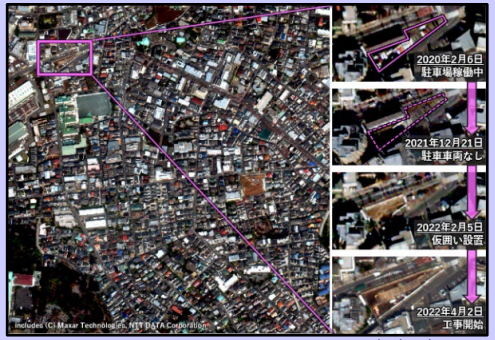
- **Local authorities, Research firms, etc**: By analyzing land use and its changes, they can **contribute to more advanced urban planning**, infrastructure development, and disaster/environmental management. Regular, wide-area observations also **enable monitoring of illegal activities such as unauthorized development, illegal logging, and illegal dumping**. Additionally, with long-term satellite data, such as that from Landsat since the 1970s, it is possible to **analyze long-term trends in urban development**, including urban sprawl, spanning several decades.

■Example of Application

Quantitative Assessment of Land Cover and its Changes



Time-series Changes in Land Use Status



Source: Mitsubishi Electric

Companies Providing Similar Services	RESTEC, PASCO, Ridge-i, Sakura internet/ABEJA, SPACE SHIFT, DATAFLUCT, JAPAN SPACE IMAGING, Esri, Simularity, etc.

Satellite-based 3D Terrain Data for the Development and Updating of Urban Digital Twins

The urban digital twin is gaining recognition as a tool for enhancing the efficiency and sophistication of urban activities in the real world. A wide range of city-related information is integrated into a digital space, enabling the simulation of various aspects of urban life, such as human movement, disaster scenarios, automated driving, and more, through virtual city models. By leveraging satellites for regular, high-precision urban observation, it becomes possible to develop and update the 3D topographic data of urban digital twins more frequently and efficiently than with conventional methods.

Service

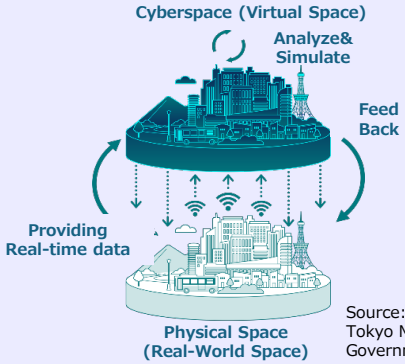
■Service Overview

- Satellite observations provide the 3D terrain data essential for the development and updating of urban digital twins.
- By integrating satellite data with weather and climate models in the urban digital twin, simulations of damage caused by events such as flooding become possible

■Observation Mechanism by Satellite

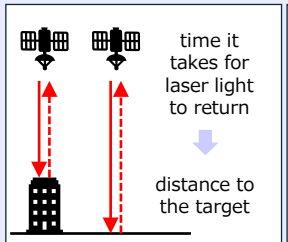
- Optical satellites observe targets from multiple directions, using the parallax of each image to measure target heights and create a Digital Elevation Model (DEM). Additionally, orthoimages are generated by correcting distortions in the captured images.
- By combining these with LiDAR data, research is advancing toward the creation of world-class, high-precision 3D terrain data.

Conceptual Image of Urban Digital Twin

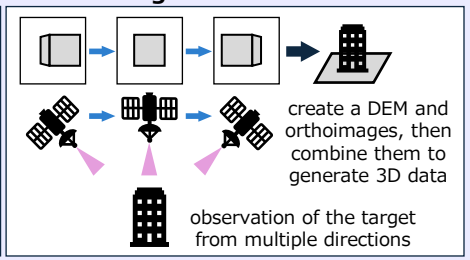


Source: Tokyo Metropolitan Government

Principle of LiDAR



Creation of 3D Terrain Data through Multidirectional



■ Comparison with Conventional Information Gathering Methods

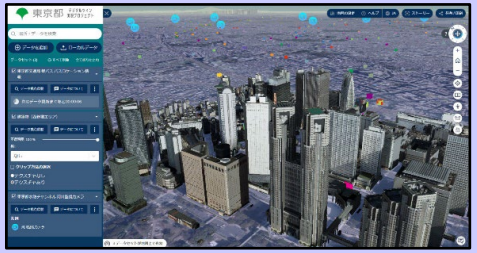
Conventional Methods (On-site surveys, drones, aerial photography)	・On-site surveys are time- and cost-intensive ・Observations are limited to specific survey points ・On-demand survey and observations ・High spatial resolution ・Observations after implementation ・High accuracy (on-site surveys)	**Satellite**	・Easier and more cost-effective data acquisition than conventional methods ・Wide-range, aerial observations ・Regular observations ・Low spatial resolution ・Past observations via archive data ・Lower accuracy than on-site surveys

Target Users and Applications

- **National/Local authorities** : By utilizing satellites, **it is possible to streamline the development and updating of 3D terrain data**, such as the Ministry of Land, Infrastructure, Transport and Tourism's PLATEAU, which is a pioneer of urban digital twins in Japan. Additionally, satellite-based models are **effective for the global expansion of digital twin infrastructure.** By utilizing urban digital twins, it becomes possible to **enhance urban monitoring and improve efficiency and sophistication in urban planning through simulations** of natural disasters (flooding, earthquakes, landslides) and urban policies (public transportation, landscape, crime prevention).
- **Private companies**: Urban digital twins can contribute to **a wide variety of economic activities**, including entertainment services such as games and VR content, simulations for autonomous driving and drone operations, and environmental analyses such as building wind studies.

■Example of Application

3D Viewer for Urban Digital Twin



Source: Tokyo Metropolitan Government

Application to 3D spaces in video games

Source: SpaceData

Companies Providing Similar Services: NTT Data/RESTEC, SpaceData, PASCO, TIS, Spectee, FUKUYAMA CONSULTANTS, Eukarya, Spiral Blue, etc.