4. Challenges and future tasks

4.1 Challenges

Since JAXA's 2005 announcement of its long-term vision, the organization has promoted satellite application to disaster management and verified related technologies in its role as Japan's Space Applications Mission Directorate for pursuing the innovative utilization of space resources. Against this backdrop, the Agency reviewed the current situation and related challenges in the context of the March 2011 earthquake and tsunami — a disaster on a scale never before experienced in the country.

4.1.1 Challenges concerning satellite image provision

JAXA discussed its provision of satellite images in relation to data captured by Daichi based on feedback regarding their use by government ministries and agencies involved in disaster response and other organizations. As a result, the tasks outlined below were identified as challenges to be addressed.

1) Reinforcement of systems for image processing, analysis and other tasks to respond to the government's information collection requirements

JAXA's activities to verify the feasibility of using ALOS in disaster management work are focused on the provision of information to the Cabinet Office and other government ministries and agencies, and its work following the March 11 disaster yielded concrete results. Close collaboration between the Disaster Management Support Systems Office (DMSSO) and the Earth Observation Research Center (EORC) enabled the provision of information that met both the requirements of JAXA's data users and new needs, such as that for the identification of flooded areas and tsunami flotsam.

However, both DMSSO and EORC have manpower-related limitations in terms of processing, analyzing and providing such enormous numbers of images. To support a more timely supply of a wider range of information in the future, it is necessary to establish a structure for image processing, analysis and provision involving not only DMSSO and EORC but also external institutions.

2) Establishment of activity bases to help disaster-stricken local governments

JAXA's activities to help disaster-stricken local governments in the Tohoku region were supported by Iwate University Professor Emeritus Ryuzo Yokoyama, with whom JAXA had built a collaborative relationship over the five years prior to the disaster. In future work, JAXA needs to establish similar activity bases in other regions, and particularly in Kyushu, where it currently has no such facilities.

3) Responses during the blank period until the launch of Daichi's successors

Experience gained from disaster drills and satellite image usage in non-disaster times supported the smooth provision and use of information in the aftermath of the March 11 catastrophe. Now that Daichi's operations are complete, it is imperative to examine responses to user needs during the period until the launch of its successor satellites. It is important for people to use satellite images in non-disaster times, and it is essential for JAXA to maintain its relationships with users based on timely

and specific steps for collaboration with overseas institutions, the utilization of airplanes and other related efforts.

4.1.2 Challenges concerning support for disaster areas based on communication line provision

JAXA provided communication lines in disaster areas using KIZUNA and KIKU No. 8 for use by local government bodies, local residents and people from disaster-related institutions elsewhere. The challenges and lessons outlined below were identified from these activities.

1) Prompt provision of communication lines immediately after the disaster

- Clarification of the basic idea behind the provision of support and criteria for taking action
- Securement of a means of quickly transporting personnel, equipment and supplies to disaster areas
- Establishment of preliminary systems necessary for the above two points and partnerships with disaster and crisis management organizations
- Sharing of information with staff dispatched to disaster areas and clarification of the chain-of-command structure/operational flow

2) Information services in disaster areas

- Ideally, the quality of telephone and Internet services provided should match that of pre-disaster levels.
- As coastal areas suffering tsunami damage experience an immediate digital divide, broadcast communication is important for checking the safety of local residents, sending prompt reports on earthquakes/tsunami, and engaging in other related activities.
- Information and communication lines with different capacities are necessary for different locations and situations.
  - ・Small capacity for disaster victims and evacuation sites
    Phone and Internet environments to enable checking of people's safety
  - ・Medium capacity for dispatched teams
    Dispatch of Disaster Medical Assistance Team (DMAT) members after 100 minutes of the disaster; provision of Internet connections for communication between DMT headquarters or dispatched teams or others and the Emergency Medical Information System (EMIS)
  - ・Large capacity for local governments in disaster areas
    Communication environments for phone calls, Internet access and videoconferencing

3) Autonomous communication equipment

- Communication equipment for quick installation in disaster areas (minimized weight and size)
- Improved ease of installation and operability
- Lower communication equipment prices

4.1.3 Challenges concerning the dispatch of information

The challenges outlined below were clarified in regard to the lack of public awareness of JAXA's activities in the aftermath of the Great East Japan Earthquake.

1) Need for provision of information on JAXA's disaster response efforts as part of its voluntary Corporate Social Responsibility (CSR) initiatives

- JAXA concentrated its efforts on business continuity, including responses to disaster management organizations. On the whole, it is considered that the Agency had only a shallow awareness of the need for active dispatch of information on its responses to the disaster.

2) Securement of adequate manpower and accumulation of knowledge on specific facilities and equipment

- It is necessary to secure sufficient manpower to analyze images, post data and explanations on websites, respond to the media and more. There is also a need to share information regarding image analysis and the dispatch of data.
- Knowledge must be enhanced in relation to image analysis for secondary disasters such as damage to major facilities like nuclear power plants and industrial complexes.

3) Enhancement of information services for stakeholders

- Little information on JAXA's responses to the disaster was dispatched to stakeholders.

4) Reinforced, faster dispatch of information to the media

- On March 12, the day after the disaster, there was high demand for satellite images showing the extent of the devastation caused by the earthquake and tsunami. However, these resources could not be provided on the day.
- The nuclear power plant issues that surfaced in the evening of March 12 gave rise to high demand for nuclear power plant images. Although JAXA's PR staff released images captured by Daichi to the press, the demand was specifically for pictures of the nuclear power plant, regardless of whether or not they were captured by Daichi.
- There was low awareness of the division of roles by which Daichi observed wider areas while overseas high-resolution satellites and airplanes engaged in focused observation.

5) Enhanced collaboration with institutional users and external organizations (dispatch of information, data analysis)

- The Geospatial Information Authority of Japan immediately dispatched information on its utilization of images captured by Daichi after the Great East Japan Earthquake, but such dispatch by other institutional users collaborating regularly with JAXA took time in line with their individual situations.

4.2 Future tasks

4.2.1 Basic idea behind the provision of support for disaster areas

4.2.1.1 Basic stance

In its role as an institution implementing R&D to enhance people's safety and security, JAXA makes constant efforts in non-disaster times to leverage its resources so that the necessary support can be provided when disasters strike.

4.2.1.2 Responses to requests from the government and other institutions

As JAXA is not a designated public institution, it contributes by providing research and development results and other relevant information within the bounds of such institutions' social obligations. It remains committed to its best efforts to engage in support activities in disaster zones once the safety of these areas and the feasibility of such work has been confirmed.

4.2.2 Improvements to be made for satellite image provision

Daichi's observations were unfortunately halted by a power issue on April 22, 2011, and its operation was ended on May 12, 2011. The land-observing satellite had been operated beyond its design lifetime of three years and its target lifetime of five years, and its period of service ended after its important work in observing disaster-stricken areas following the Great East Japan Earthquake. As natural disasters will continue to occur, JAXA plans to take the steps outlined below in order to strengthen its response capabilities based on lessons learned from the March 11 disaster.

- Early launch of Daichi's successors (the Advanced Land Observing Satellite-2 (ALOS-2) with Synthetic Aperture Radar (SAR) and the Advanced Land Observing Satellite-3 (ALOS-3) with optical sensors) for the use of improved wide-ranging and high-resolution observation technologies found to be effective after the March 11 disaster. This is expected to enable greater accuracy in determining the extent of devastation via a combination of SAR and optical data, and in particular to enhance mobility and facilitate detailed JAXA observation over wide regions on the day a disaster strikes － a task that was not possible with the Great East Japan Earthquake.
- Achievement of the following specifications as requested by a disaster management-related goverment organization (at the Space Activites Commission (SAC) on August 17, 2011)
  - ・Observation width of 30－50 km to allow collection of images over the entire disaster zone for monitoring of flooded areas
  - ・Resolution of 1 m to support identification of passable routes
  - ・Resolution of less than 1 m to enable observation of damage to embankments, bridges and houses
  - ・Wide observation width of 40－70 km for monitoring of crustal movement (e.g., earthquakes, volcanic activity, subsidence and landslides) using InSAR analysis
- Continuation of efforts relating to the Data Relay Test Satellite (DRTS) in light of its capacity to support instantaneous observation and data provision

- Promotion of R&D on new earth observation sensors in addition to optical sensors and radars to meet new needs identified through response to the March 11 disaster (e.g., thermal change monitoring and tsunami observation)

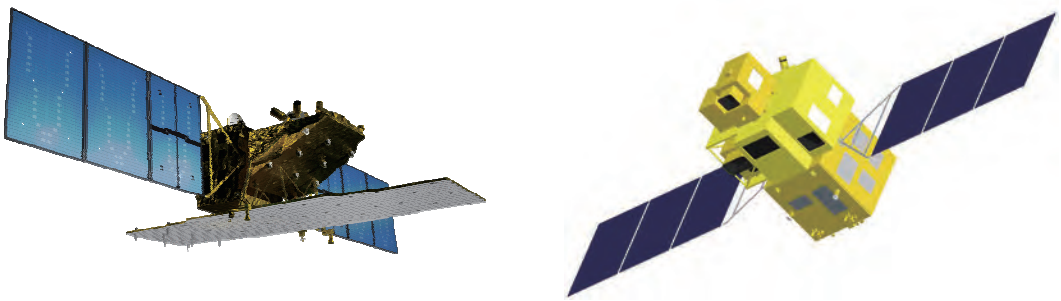

Figure 4.2.1 Successors to Daichi (left: ALOS-2; right: ALOS-3)

The information JAXA provides to disaster areas and other sites using observation satellites must serve the disaster countermeasure efforts of local governments and other organizations, who must be able to interpret and analyze it together with local information. Accordingly, JAXA plans to establish regional bases (at universities and other institutions) in addition to promoting joint efforts with local governments and other organizations.

JAXA will also provide as much information as possible in disaster areas where such bases are not established.

- Development of strategic ties with the Geospatial Information Authority of Japan, the National Research Institute for Earth Science and Disaster Prevention (NIED) and other nationally designated disaster management organizations, and establishment of a structure incorporating private enterprises and universities for a reinforced system of post-disaster work ranging from image processing to image provision
- Establishment of regional bases with Kyoto University (Kinki region), Hiroshima Institute of Technology (Chugoku region) and other institutions similar to the base set up with JAXA collaborative partner Iwate University (northern Tohoku region) toward the launches of ALOS-2 and ALOS-3. Until such bases are established, JAXA will work in disaster areas in response to requests from local governments while ensuring synergies between the operations of earth observation and communications.

It is also important for JAXA to effectively collaborate with overseas satellite operators rather than relying solely on observations by ALOS-2 and ALOS-3, particularly in the event of catastrophic disasters over wide areas.

- Close work with disaster management and related organizations for increased use of the Disaster Charter and Sentinel Asia in the event of domestic disasters. In this regard, JAXA will actively request the activation of related initiatives when disasters strike Japan, and will coordinate with institutions concerned on related matters, including criteria for activation and schemes for image utilization. The Agency will also use airplanes with Polarimetric and Interferometric Airborne Synthetic Aperture Radar (Pi-SAR) and other systems. To support the use of airplanes, a structure of operational planning and management will be established.

4.2.3 Improvements to be made in the provision of communication lines

Outlined below are improvements to be made in providing disaster areas with support using communication satellites. Particular focus is placed on areas to be strengthened in terms of partnerships with local governments and other organizations and requirements to be addressed in the next generation of information and communication satellites. The criteria for the provision of support and the establishment of related systems are described in Section 4.2.5.

- Strengthening of partnerships
  - Further promotion of the benefits of satellite communication line usage to local governments in recognition of the fact that pre-arrangements regarding such provision in affected areas enables smooth action in times of disaster
  - Consideration for the idea of lending communication equipment to nonprofit and other organizations where radiotelephone operator license holders are present to ensure continuous provision of communication lines
  - Advance explanation of criteria and other guidelines for providing support to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Internal Affairs and Communications. This is based on the fact that JAXA will offer support to institutions with which it has not concluded collaboration agreements upon receipt of requests for assistance from MEXT (as was the case with the March 11 disaster).

- Fulfillment of requirements in the next generation of information and communication satellites

  Requirements clarified as a result of support provision are outlined below. It is important to incorporate solutions into the next generation of information and communication satellites. Figure 4.2.2 shows a conceptual image of how such satellites might work.

  - Portable terminals that can be installed by one person
    - ✓ Wireless LAN-capable, portable in a backpack or briefcase
    - ✓ Assembly-free
    - ✓ Capable of automatic satellite alignment and establishment of Internet connection when power is turned on
    - ✓ Compatible with existing terminals (e.g., mobile phones and commercial earth stations)
    - ✓ Unaffected by communication outages
  - Situation-based link capacity
    - ✓ Disaster victims, evacuation sites: best-effort capacity (KIKU No. 8: 768 kbps or more)
    - ✓ Local governments, dispatched-team activity bases: achievements (KIZUNA: 20 Mbps or more)
  - Terminals with specifications appropriate for disaster areas
    - ✓ Ultra-low power consumption and operability with home-use batteries, onboard AC power source or similar
    - ✓ Integrated power supply using solar cells and storage batteries
    - ✓ Durable outdoor equipment protected from water and wind erosion
  - No need for operators
    - ✓ No need for radiotelephone operator license holders
    - ✓ Management and control of terminals at related reference stations

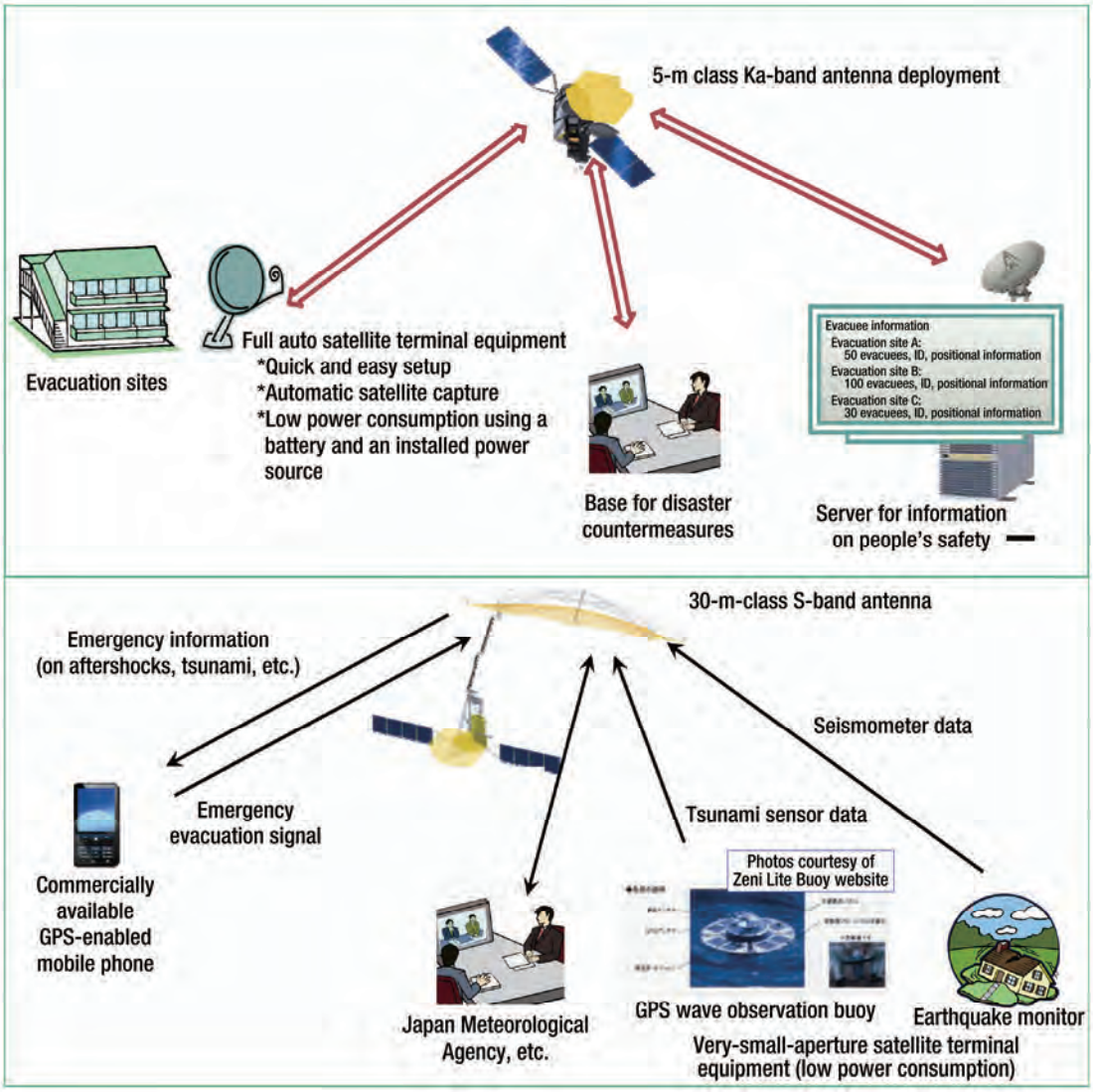

Figure 4.2-2 Conceptual representation of next-generation information and communication satellites

■ Coordination of satellite positioning systems

At times of disaster, information on the geographical locations of those who send data is essential. In the next generation of information and communication satellites, equipment and terminals should be able to receive/use satellite positioning signals. Accordingly, the feasibility of transmitting such information using advanced positioning signals should be examined in line with the direction of plans involving quasi-zenith satellites.

Satellite communication and satellite positioning will play important roles in efforts to upgrade terrestrial sensor networks and improve their robustness. By way of example, ocean-monitoring sensors such as GPS wave meters (buoys) and water-pressure gauges will be upgraded for the establishment of tsunami early warning systems. However, to allow the detection of displacement and changes via installed offshore sensors, satellite communication and satellite positioning capability should be upgraded to support related infrastructure.

4.2.4 Improvements to be made concerning information dispatch

- Public provision of appropriate and timely news on JAXA's social contribution activities in response to disasters as part of its obligations to society. The Agency firmly positions such public communication (including development of the related organizational climate) as part of its CSR.
- Prompt and widespread dispatch of information following large-scale disasters. For such provision, staff in charge assemble in a dedicated disaster response control room immediately after the disaster and share information.
- Securement of sufficient manpower (including backup personnel) for data analysis and website posting/updating
- Close collaboration with the Ministry of Education, Culture, Sports, Science and Technology (MEXT) — particularly concerning nuclear power stations
- Enhancement of knowledge regarding possible disasters that could cause large-scale damage to facilities and the like, and examination of possible simulations and other related matters
- Examination of steps for dispatching information to stakeholders
- Enhancement of interest in and understanding of JAXA disaster response activities among journalists through provision of regular lectures. (At times of large-scale disasters, presentations will be provided frequently to support the active dispatch of information.)
- Active dispatch of information on activities such as those implemented after the March 11 disaster using KIZUNA, KIKU No. 8, airplanes and the like, as opposed to simple provision of satellite observation results
- Implementation of arrangements for media communications (e.g., notices on information posted on websites) to enable the immediate dispatch of information, such as allowing the provision of data through simple procedures or with ex post facto reports at times of large-scale disasters
- Efforts to encourage JAXA's institutional users to raise public awareness of their work with the Agency so that partnerships with such users will further develop into sustainable activities (with focus on the successors to Daichi and KIZUNA)
- Examination of the following considerations as efforts to collaborate with external organizations for faster image analysis and speedier/wider provision of information:
  - Establishment of a structure to support the mobilization of personnel for data analysis from academic societies, universities and other organizations based on agreements and similar arrangements. Anticipated effects include the development of high-quality information products that cannot be produced by JAXA alone, further expansion of the satellite data user base, and the dispatch of information from researchers.
  - Reinforcement of the structure for online delivery of emergency observation results to further promote the dispatch of data in conjunction with private information providers based on confirmation of the effectiveness of web-based provision
  - Requests for Japanese and international image analysis organizations to perform analysis for JAXA on a chargeable basis

4.2.5 Development of disaster response manuals

JAXA plans to clarify the criteria for triggering disaster response activities in consideration of the scope of large-scale disasters and the extent of damage to its own facilities. Disaster response manuals will then be developed with patterns tailored to suit levels of devastation (including plans to secure manpower) based on