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Disaster Management Satellite System Development and International Cooperation Promotion in Asia

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1 Introduction

Japan is a country that is frequently damaged by natural disasters due to earthquakes. Possible large-scale disasters due to an epicentral or inland earthquake in the Tokyo metropolitan area and due to ocean trench-type earthquakes such as Tokai, Tonankai/Nankai, and near Japan Trench/Kuril Trench earthquakes are one of Japan's most serious concerns. The White Paper on Disaster Management 2007[1] prepared by the Cabinet Office and approved by the Cabinet on June 1, 2007 reports that earthquakes have occurred even in areas where earthquakes had not been considered an imminent threat. Several earthquakes have occurred in Japanese areas following the January 1995 Great Hyogo-Awaji Earthquake: the Chuetsu area of Niigata Prefecture in October 2004, the western offshore area of Fukuoka Prefecture in March 2005, Noto Peninsula of Ishikawa Prefecture in March 2007, and subsequently the Chuetsu offshore area of Niigata Prefecture on July 16, 2007. The last earthquake is presumed to be caused by a submarine active fault. It is said that even though there exist a lot of such active faults in the seas near Japan, these faults have not been studied in detail because of their undersea locations.[2]

Japan also suffers from heavy rains and storms caused by typhoons, and, in recent years, from frequent heavy rainfalls probably due to the global warming. Heavy rain and storm disasters caused by a Baiu seasonal rain front and typhoon No. 4 from June 11 to July 17, 2007 caused severe damages to the Kumamoto, Miyazaki, Kagoshima and other prefectures, and on August 7, 2007, the Japanese government ranked the heavy rain and storm disasters caused by typhoon No. 4 and the disasters caused by the July 2007 Niigata Chuetsu offshore earthquake as severe. [3] Japan is becoming more and more vulnerable to disasters due to its aging population, low birthrate, and depopulation of rural areas, and efforts for disaster management and mitigation are becoming more important than ever.

With regard to Asian areas other than Japan, the large-scale earthquake off Sumatra in Indonesia and the resulting Indian Ocean Tsunami[4] are still fresh in our memory. On December 26, 2004, a magnitude 9.0 earthquake whose seismic focus was off Sumatra Island occurred, triggering huge tsunamis and causing catastrophic disasters in Indonesia, India, Thailand, and other countries. In addition to tsunamis, much of Asia also suffers heavy damages caused by earthquakes, typhoons, floods, and other natural disasters.

Japan is conducting research and development activities on earth observation satellite application to disaster management. Japan's efforts to promote international cooperation in this field with Asian countries that suffer heavy damages caused by natural disasters, and to maintain and strengthen friendly relationships with these countries should serve Japan's national interest.

In Asia, countries that can develop large rockets and satellites, and launch them from their own territories are currently only Japan, India, and China. South Korea, after having acquired the capability to develop satellites, currently endeavors to obtain such a launch capability, and other Asian countries are currently cooperating with the United States, Europe and other nations to develop small earth observation satellites. Japan also could utilize its space technologies as a diplomatic tool, and should actively do so.

2 Priority in the Science and Technology Basic Plan and government study group report

2-1 Priority in the Science and Technology Basic Plan

The Sectoral Promotion Strategy,[5] formulated by the Council for Science and Technology Policy based on the Third Science and Technology Basic Plan, has selected a Technology to Monitor and Manage National Land to Mitigate Disaster, within the social infrastructure field's disaster management part, as one of the strategically prioritizes S&T areas, to which the Japanese government should invest intensively, and one of its elements is a Disaster Monitoring Satellite Application Technology.

The Disaster Monitoring Satellite Application Technology develops satellite disaster monitoring and information utilization technologies as well as promotes quasi-zenith satellite high accuracy positioning experiments, and the reason for this selection is explained as following: since the characteristics of satellites with regard to large-scale natural disasters are wide area coverage, simultaneity, and resilience, autonomous disaster monitoring and risk management information utilization using satellites must be one of the most effective means for disaster mitigation. The technology's cited goal is to establish a satellite observation and monitoring system by JFY2015, and to continuously provide observation data useful for disaster management and mitigation, thereby ensuring the safety and security of the Japanese people.

The "Economic and Fiscal Reform 2007" [6] approved by the Cabinet on June 19, 2007 also establishes a policy to promote research, development, and practical application of such science and technology areas as satellite positioning and monitoring, intelligence capability enhancement, and a disaster information sharing system that contribute to Japan's public security and disaster management .

Since the quasi-zenith satellite, which will complement and augment the Global Positioning System (GPS) of the United States, will provide accurate position and time information, it is expected that the satellite will become an effective tool for emergency disaster response activities in the future. Since earth observation satellites, without being affected by disasters, can quickly observe disaster areas over a wide range, it is expected that their observation data combined with information obtained by such means as aircraft and helicopters will be useful for disaster condition assessment that would make rescue operations more effective. Moreover, since they can visit and observe the same area regularly, they are expected to help us extract topographical information reflecting latest land use changes, and identify disaster risks.

2-2 Government study group report

In February 2006, the Cabinet Office and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) set up a study group on the application of earth observation satellites to disaster management, to which Japanese government ministry, agency and organization officials, and external experts involved in disaster management gathered for deliberation, and in September 2006, published a report entitled "On an Approach to Constructing and Operating an Earth Observation Satellite System for Disaster Management.[7]" After user needs in such fields as earthquakes, volcanoes, windstorm and flood damages, and maritime and coastal disasters having been consolidated, top-level requirements for the next-generation earth observation satellite system were established as shown in Table 1.

Representative observation equipment onboard earth observation satellites are optical sensors and microwave sensors including synthetic aperture radars. Optical sensors receive visible, infrared (IR) and other lights with specific spectral bands to observe the ground surface and other features. Although some optical sensors can conduct meter-order or higher resolution observations, their observations are limited during daytime and are also affected by clouds because they receive sun lights reflected from the Earth's surface. Those with only one single spectral band are called panchromatic optical sensors, while those with more than one band are called multispectral optical sensors. Microwave sensors can conduct

Table 1 : Top-level requirements for the next-generation earth observation satellite system

Sensor	• High-resolution panchromatic optical sensor with target resolution of approximately 1m • Multispectral optical sensor to detect flooded areas, oil spills, vegetation, land coverage, etc. • Synthetic aperture radar for observation at night and in bad weather
Swath width	• Target swath width: 50km or more (approximately 40 to 70km required for earthquakes, approximately 30 to 50km for windstorm and flood damages: the goal is to realize wide-area observation with the high-resolution panchromatic optical sensor.)
Observation frequency	• Within approximately 3 hours after event (the optical sensor and the synthetic aperture radar are carried by different satellites. A four-satellite system consisting of two optical and two radar satellites is under study.)

Source: MEXT, Reference [7]

observations irrespective of day and night, and weather conditions. While synthetic aperture radars emit electromagnetic waves, and receive signals reflected from the Earth's surface, some other sensors passively receive microwaves emitted from the surface.

The report notes as follows: although Japanese national government ministries and agencies involved in disaster management and local governments currently use information such as observation data from aircraft and ground-based equipment to respond to large-scale natural disasters, earth observation satellites, making it possible to assess disaster conditions over a wide range of several tens of kilometers, and to conduct observations at night and under bad weather conditions, are expected to make rescue and relief operations more effective, and to play an active role in the field of disaster monitoring.

3 Natural disasters in Asia

Figure 1 shows the worldwide numbers of natural disasters and their victims from 1990 to 2006. The figure was prepared using the Emergency Events Database (EM-DAT)[8] operated by the Center for Research on Epidemiology of Disasters (CRED) at the Catholic University of Louvain, Belgium. In the figure, earthquakes, floods, slides, volcanoes, windstorms, and tsunamis/surges are considered as natural disasters.

While the number of natural disasters in East Asia, Southeast Asia, and South Asia accounts for approximately 38% of the world total, the number of deaths in these areas about 84%, the number of injured there about 92%, and the number of affected there about 96%. These statistics show that these Asian regions suffer heavily from natural disasters.

Figure 2 shows damage statistics by disaster type such as earthquake, flood, and typhoon/windstorm from 1990 to 2006. The percentages of damages caused by earthquakes, floods, and windstorms are relatively large. The number of deaths caused by the other category is large, but the majority was caused by the Indian Ocean Tsunami in 2004. It may be said that although tsunamis occur not so frequently, they can bring devastating damages once they occur.

Since it is impossible to prevent natural disasters from occurring, quick rescue operations when a natural disaster occurs, and damage mitigation measures are important. Earth observation data can be used to assess the damages caused by earthquakes, floods, typhoons/windstorms and other disasters, and to identify disaster risks. There may be cases in Asia when it is difficult to assess damage conditions, for example, because of being an island country, or because of conditions of infrastructures such as road or communication networks. For such cases, earth observation satellites provide an effective means to assess damage conditions. Also, for areas where map information is not developed adequately, earth observation data may be applied to the creation and dissemination of flood hazard maps.

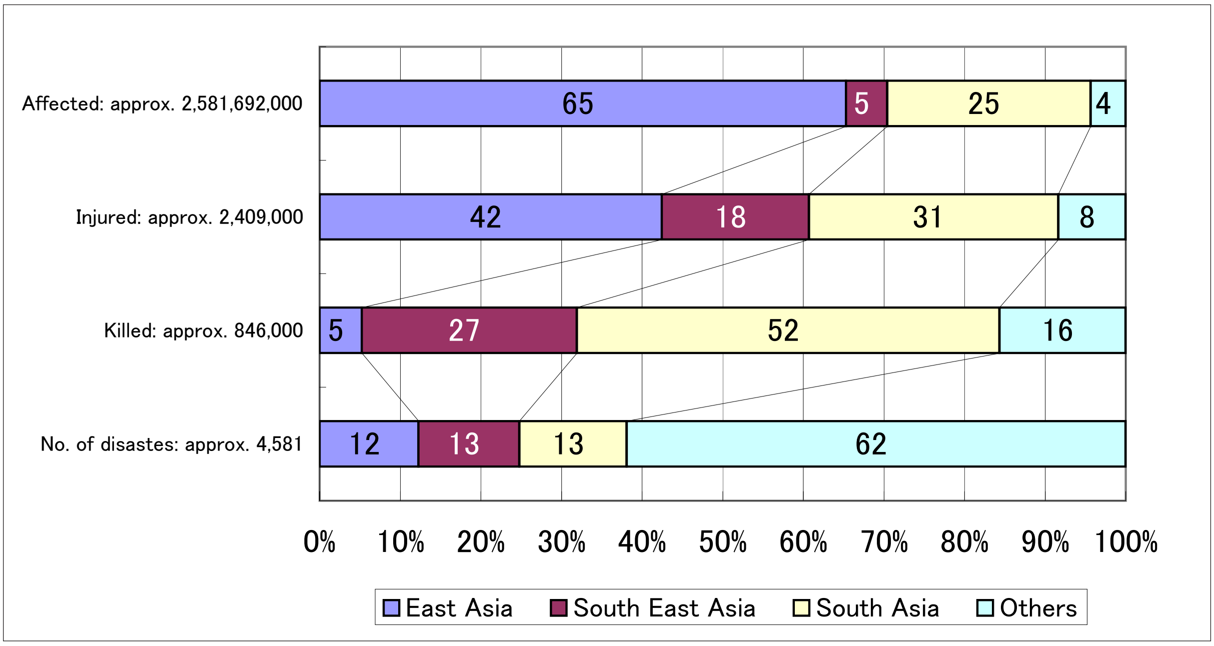

Figure 1 : Natural disasters in the world (1990-2006, by region)

Source: "EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net-Université Catholique de Louvain -Brussels- Belgium"

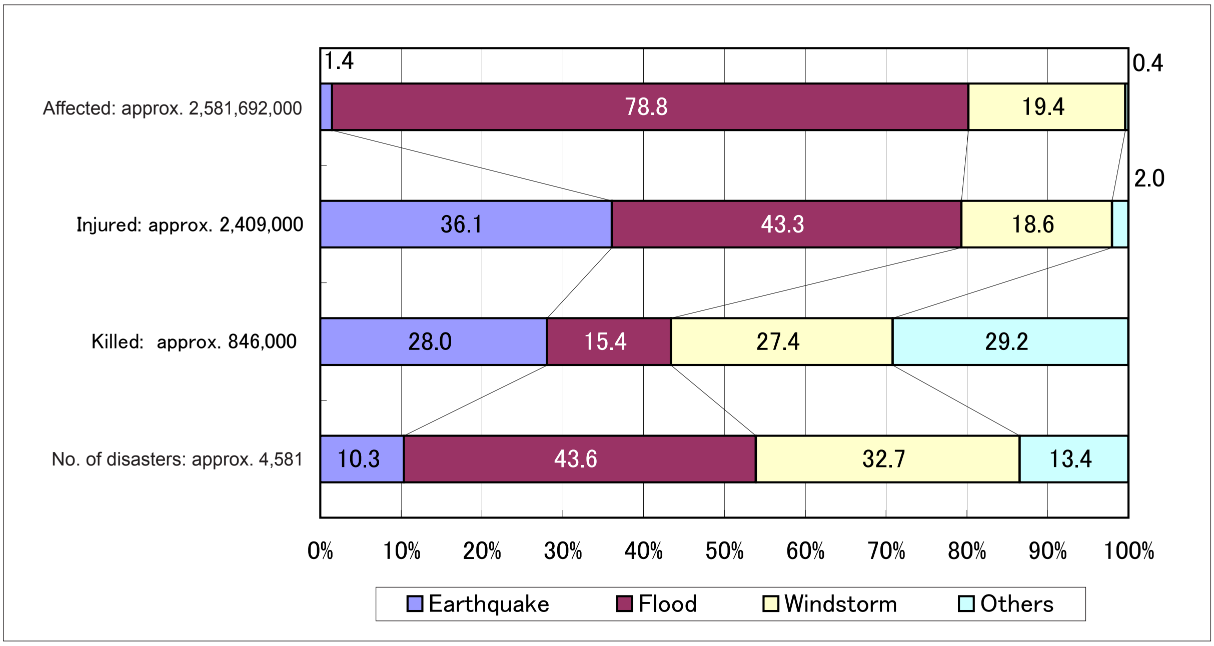

Figure 2 : Natural disasters in the world (1990-2006, by disaster type)

Source: "EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net-Université Catholique de Louvain -Brussels- Belgium"

4 Activities in Japan and abroad to develop disaster management satellite systems

Japan has been conducting disaster management application demonstration activities using the "DAICHI" Advanced Land Observing Satellite (ALOS), and is also studying to utilize the "KIZUNA" Wideband InterNetworking engineering test and Demonstration Satellite (WINDS), a super high-speed internet satellite, for disaster management. The European Union also plans to utilize earth observation satellites for emergency response. Not only Japan but also the European Union is promoting the practical use of earth observation satellites for disaster management.

4-1 Activities in Japan

(1) Disaster management application demonstration activities using "DAICHI"

The "DAICHI" Advanced Land Observing Satellite (ALOS), which was launched on January 24, 2006 by the Japan Aerospace Exploration Agency (JAXA) for disaster damage condition assessment as well as for 1: 25,000 mapping and natural resource surveying, entered into an operational phase on October 24, 2006 after the completion of the satellite's initial functional verification and initial calibration. The satellite's onboard sensors are the Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) and the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), which are optical sensors, and the Phased Array type L-band Synthetic Aperture Radar (PALSAR), which is a microwave sensor. Characteristics of these sensors are shown in Figures 3 to 5, respectively.

The study group described in Section 2-2, to proceed toward the development and operation of a next-generation earth observation satellite system for disaster management, prepared a plan for disaster management application demonstration activities using "DAICHI" to verify improvements in disaster management operations to be realized by using earth observation satellites, and proposed

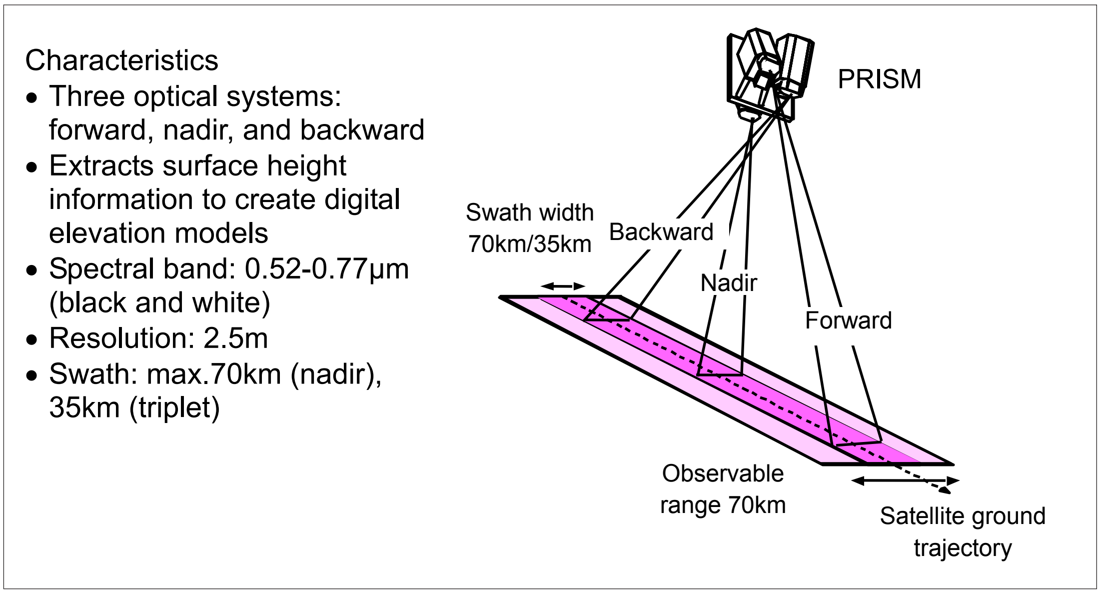

Figure 3 : Panchromatic Remote sensing Instrument for Stereo Mapping (PRISM)

Source: JAXA

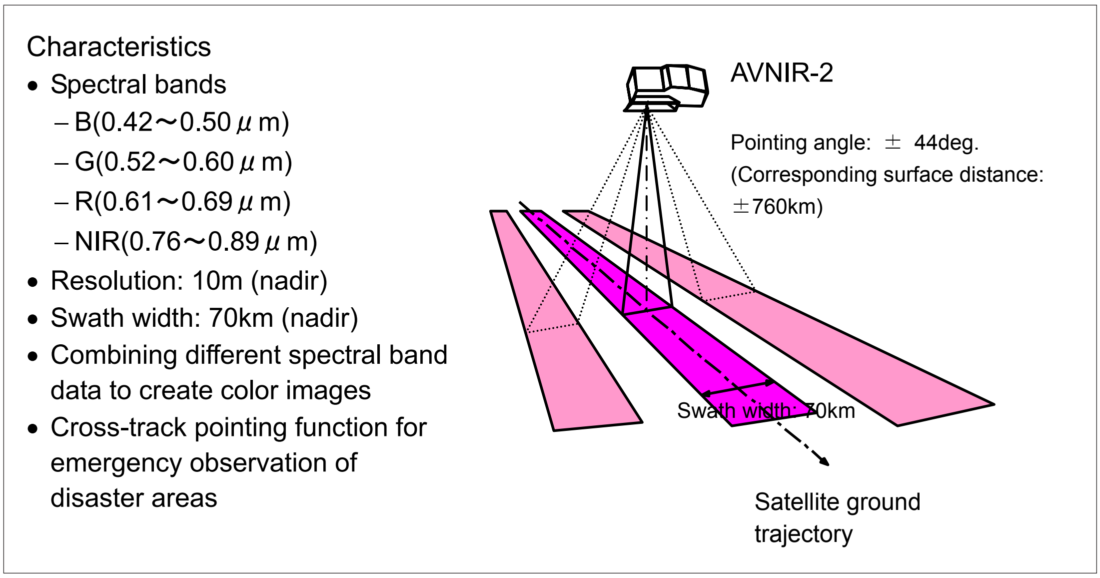

Figure 4 : Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2)

Source: JAXA

to set up working groups by subject[7] (Table 2).

The plan also includes studies on demonstration activities to assess windstorm and flood damages and to utilize satellite image maps for various disaster management activities of local governments, and Gifu Prefecture and the Construction Research Center of Gifu Prefecture as well as Shimanto City in Kochi Prefecture, and Sanjo City and Mitsuke City in Niigata Prefecture concluded memoranda with JAXA to conduct

Characteristics

- Uses L-band of approx. 24cm wavelength (C-band of about 4cm wavelength is typically used overseas.)
  - Enables observation of ground surface and other features without being affected by vegetation
- Radar sensor enables all-weather day and night observation
- Multifunction and high performance
  - Variable off-nadir angle
  - Polarimetry (HH, HV, VH, VV)
  - High-resolution mode (resolution: 10m, swath: 70km)
  - ScanSAR mode (resolution: 100m, swath: 350km)

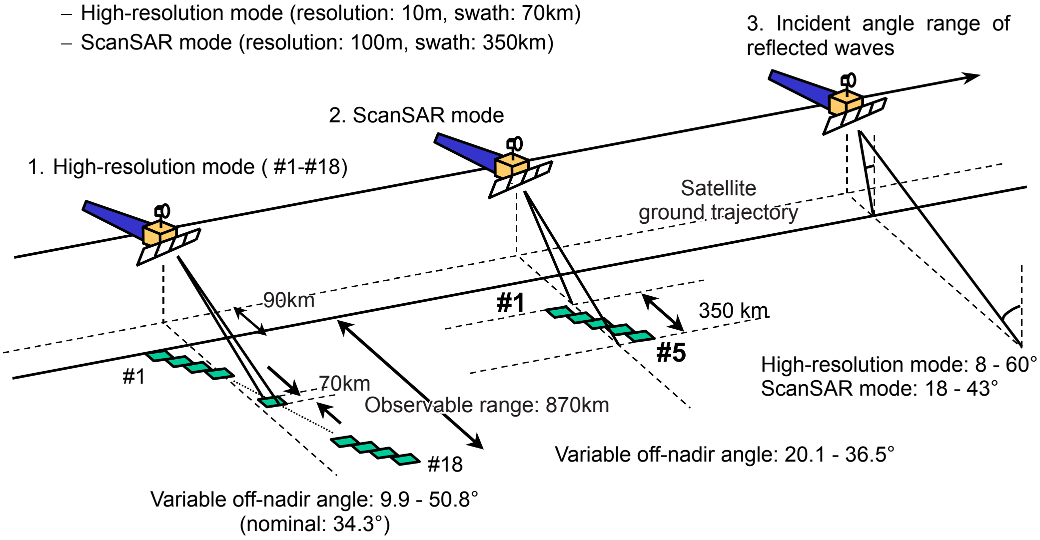

Figure 5 : Phased Array type L-band Synthetic Aperture Radar (PALSAR)

Source: JAXA

Table 2 : Disaster management application demonstration activities using ”DAICHI”

No.	Theme	Activities
1	Satellite image map development and its application to disaster management	To integrate ”DAICHI” observation data with standard maps to create satellite image maps, and to apply created satellite image maps to disaster mitigation, damage condition assessment after event, and other disaster management activities
2	Volcano activity assessment and eruption monitoring	To study methods to monitor volcanoes and detect their anomalous events using “DAICHI” observation data, and to utilize the data to assess volcano activities
3	Crust/ground movement and damage assessment	To utilize “DAICHI" observation data to detect crust/ground movements
4	”DAICHI” data application to RAS	To apply “DAICHI” observation data to the “Real Damage Information Analysis System (RAS)” developed to assess disaster damage conditions caused by large-scale earthquakes and other natural disasters
5	Maritime/coastal disaster condition assessment	To utilize “DAICHI” observation data to assess oil spill and other disaster damage conditionss
6	Slide disaster sign monitoring and damage condition assessment	To study technical feasibility of detecting slide (mudflow, landslide, etc.) signs and assessing slide disaster damage conditions in areas designated as prone to slide disaster damage

Source: MEXT, Reference [7]

disaster management application demonstration activities using "DAICHI".

The 1: 25,000 scale topographic maps provided by the Geographical Survey Institute (GSI) are the most comprehensive national base maps covering whole Japan, and are prepared and updated using aerial photographs. However, due to cost, time and other constraints, the maps are currently updated approximately every three years for urban areas and approximately every ten years for mountainous areas.[9]

On the other hand, combining observation data from PRISM and AVNIR-2 onboard "DAICHI" with Digital Map 25000 compiled by GSI produces topographic map information called "satellite image maps.[10]" Since "DAICHI" can visit and observe the same area regularly, and this satellite image map can provide topographic map information reflecting latest land use changes, application of the satellite image map to disaster management is being studied as described in the "preparation of satellite image map and its application to disaster management" theme in Table 2. To use Digital Japan, or Denshi Kokudo in Japanese, developed by GSI to create satellite image maps is also under study, and satellite image maps with various scales may become available through the internet.[11]

In case of large-scale disasters that exceed the response capabilities of affected local governments, which local fire and police departments alone cannot deal with, emergency response teams are dispatched from the National Police Agency, the Fire and Disaster Management Agency, and furthermore the Self-Defense Forces, and region-wide support operations are carried out.[12] Since these external support operators are unfamiliar with local areas, the satellite image maps that reflect latest land use changes there can play a significant role in quickly implementing rescue and relief operations, relief supply transportation, and other emergency response activities. It would contribute to realizing effective emergency response operations if satellite image maps were integrated with the on-site observation data obtained by aircraft, helicopters, on-site operators, and other means to provide the latest topographic map information.

Stereographic or three-dimensional topographic map information called "digital elevation models" can be created using the data obtained by PRISM or PALSAR onboard "DAICHI", which may be used for forecasting flooding caused by floods, tsunamis, and typhoons, and can be useful when making hazard maps.[13] Since Asia suffers from heavy damages caused by floods, tsunamis, and typhoons, it would contribute to disaster management activities in this region if such hazard maps were developed and used there.

(2) Super high-speed internet satellite

The geographical information systems of local governments contain their own specific information on roads, railroads, evacuation areas, medical facilities, the addresses of aged and other people requiring assistance during disaster, and lifelines such as power, gas, water supply, and telephone lines. If emergency responders dispatched by the Japanese national government can access and use the geographical information systems of disaster-affected local governments, they can obtain information when needed as required, and this will make emergency response activities more efficient. Although currently such information becomes inaccessible and unavailable if ground information networks in a disaster area are damaged, the "KIZUNA" super high-speed internet satellite, to be launched in the winter season of JFY2007,[NOTE1] will help construct an internet network, and solve this problem in the future. "KIZUNA" will realize super high-speed data communications: approximately 1.5-6Mbps transmission and approximately 155Mbps reception when using a ground terminal with an antenna of about 45cm in diameter, and approximately 1.2Gbps transmission and reception when using a ground terminal with an antenna of about 5m in diameter.[14]

"KIZUNA" will cover almost whole Japan with its nine beams (eastern Hokkaido, western Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku/Shikoku, Kyushu, and Okinawa), enabling two-way internet communication within the same beam, for example, two-way internet communication between the geographic information systems of local

[NOTE1]
"KIZUNA" was successfully launched on February 23, 2008 (JST).

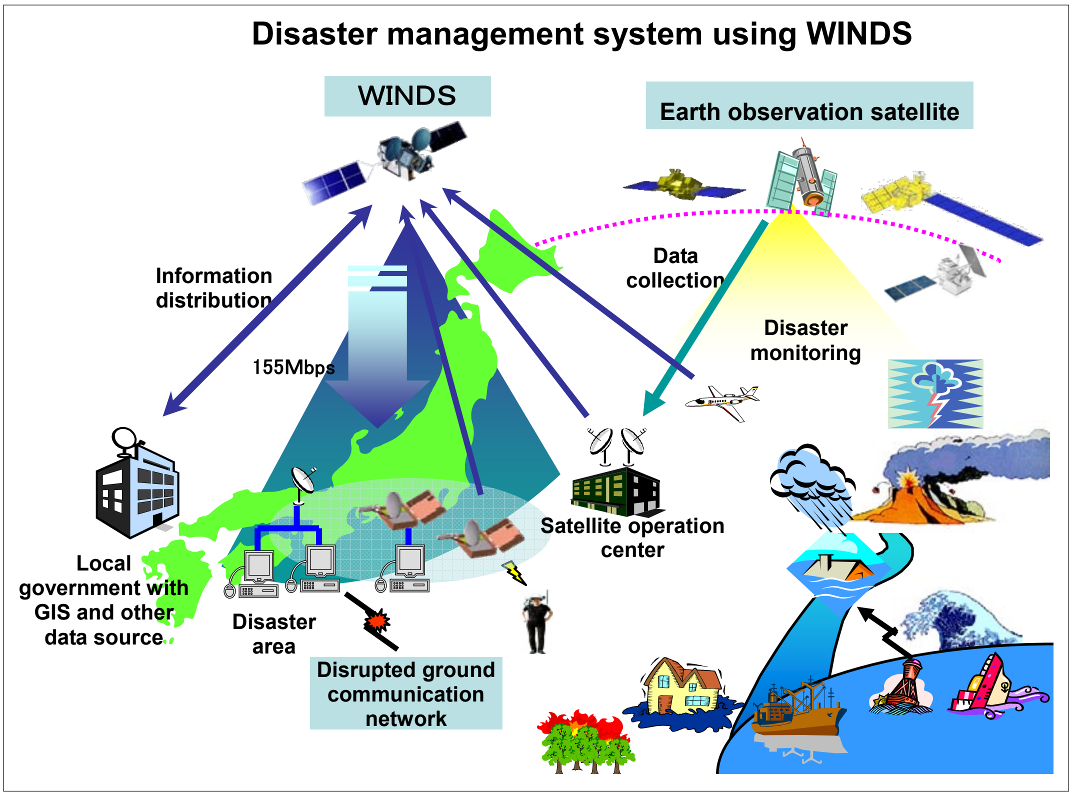

Figure 6 : Application of "KIZUNA" (WINDS) to disaster emergency response activities

Source: JAXA

governments and terminals in disaster areas, and two-way internet communication between different beams, for example, two-way communication between terminals in disaster areas and the national government's disaster management headquarters. Digital information such as e-mail messages and digital camera images will also be exchanged quickly (Figure 6).

4-2 Activities in Europe

In cooperation with the European Space Agency (ESA), the European Union (EU) is developing a system for collecting and distributing earth observation data to help national and local governments of EU member states perform disaster management and other services. The system, which is called the Global Monitoring for Environment and Security (GMES), is currently planned to start three core services of land monitoring, marine monitoring, and emergency response by about 2008.[15] GMES is deemed as a European contribution to the Global Earth Observation System of Systems (GEOSS), and also aims to assist humanitarian aids to developing countries in regions such as Asia and Africa.

The European Commission is responsible for GMES user requirement studies and for setting up its governance structure, whereas ESA develops a series of satellites called Sentinel and their ground operations facilities. The data obtained by European national government and private-sector earth observation satellites will also be used to meet diverse data requirements. In the EU's 7th Framework Programme (EP7: 2007-2013), approximately 1.43 billion euros are to be funded to the space field, about 1.2 billion euros, or about 85%, of which are appropriated for GMES. Of this amount, about 780 million euros are provided to ESA for the Sentinel satellite development.[16] On the other hand, within the framework of ESA, transition to the next-phase of the Sentinel satellite development was approved in September 2007, resulting in the contribution of about 500 million euros from its member states to ESA.[17]

The Sentinel 1 series satellite will carry a C-band synthetic aperture radar, and be used for the land monitoring, marine monitoring, and emergency response services.[18,19] The Sentinel 2 series satellite will carry a multispectral optical sensor, and be used for the land monitoring and emergency response services. The first satellites of the Sentinel 1 and 2 series will be launched around 2011 and

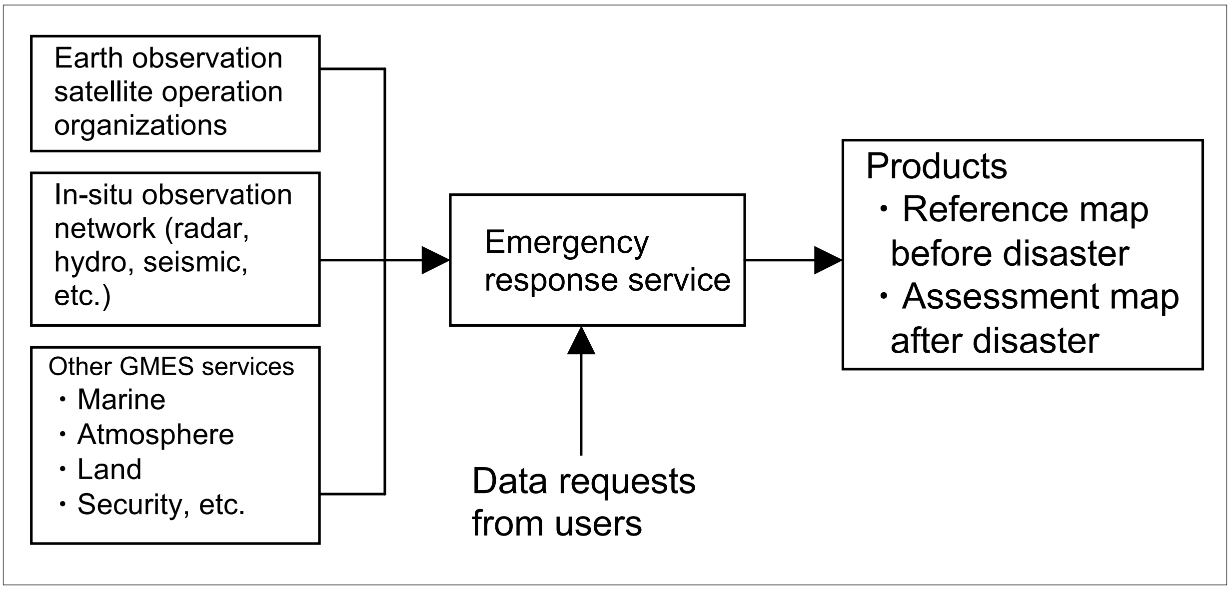

Figure 7 : GMES emergency response service

Source: Reference [15]

2012, respectively.

The emergency response service, when disasters such as earthquakes and floods occur, will integrate earth observation data with in-situ observation data to provide map information for damage condition assessment, rescue operations support, and other activities. Map information, before disasters occur, will be used to identify disaster risks, and updated when earth observation data are obtained or at other appropriate times. When disasters occur, post-disaster earth observation data will be integrated with in-situ observation data to provide map information daily for damage condition assessment, rescue operations, and other activities (Figure 7).

5 International cooperation activities in Asia

Through the framework called Sentinel Asia, earth observation data of “DAICHI” are provided to Asian countries for damage condition assessment. Through the framework called the International Charter “Space and Major Disasters” initiated by the European Space Agency (ESA) and other space agencies, such observation data are also provided. Furthermore, a United Nations project has been launched to provide UN member states with opportunities to use space technologies for disaster management and capacity building, and thus, through various frameworks, the application of space technologies to disaster management is being promoted.

5-1 International Charter “Space and Major Disasters”

As was introduced in the Topics section of the July 2006 issue of Science and Technology Trends,[21] the European Space Agency (ESA), the French space agency (CNES: Centre National d’Études Spatiales), and the Canadian Space Agency (CSA) established the International Charter “Space and Major Disasters” in October 2000 to utilize earth observation satellites to assess disaster damage conditions.[22] Space agencies operating earth observation satellites are eligible to join the International Charter, and JAXA that operates “DAICHI” became an International Charter member from Japan.

Charter member agencies provide observation data on a voluntary basis, and no funds are exchanged between them. The Indian Space Research Organization (ISRO), the National Oceanic and Atmospheric Administration (NOAA) of the United States, the Argentine space agency (CONAE: Comisión Nacional de Actividades Espaciales), the United States Geological Survey (USGS), and the China National Space Administration (CNSA) are also Charter members, and the total number of current Charter member agencies is 10.

Disaster management offices or other public

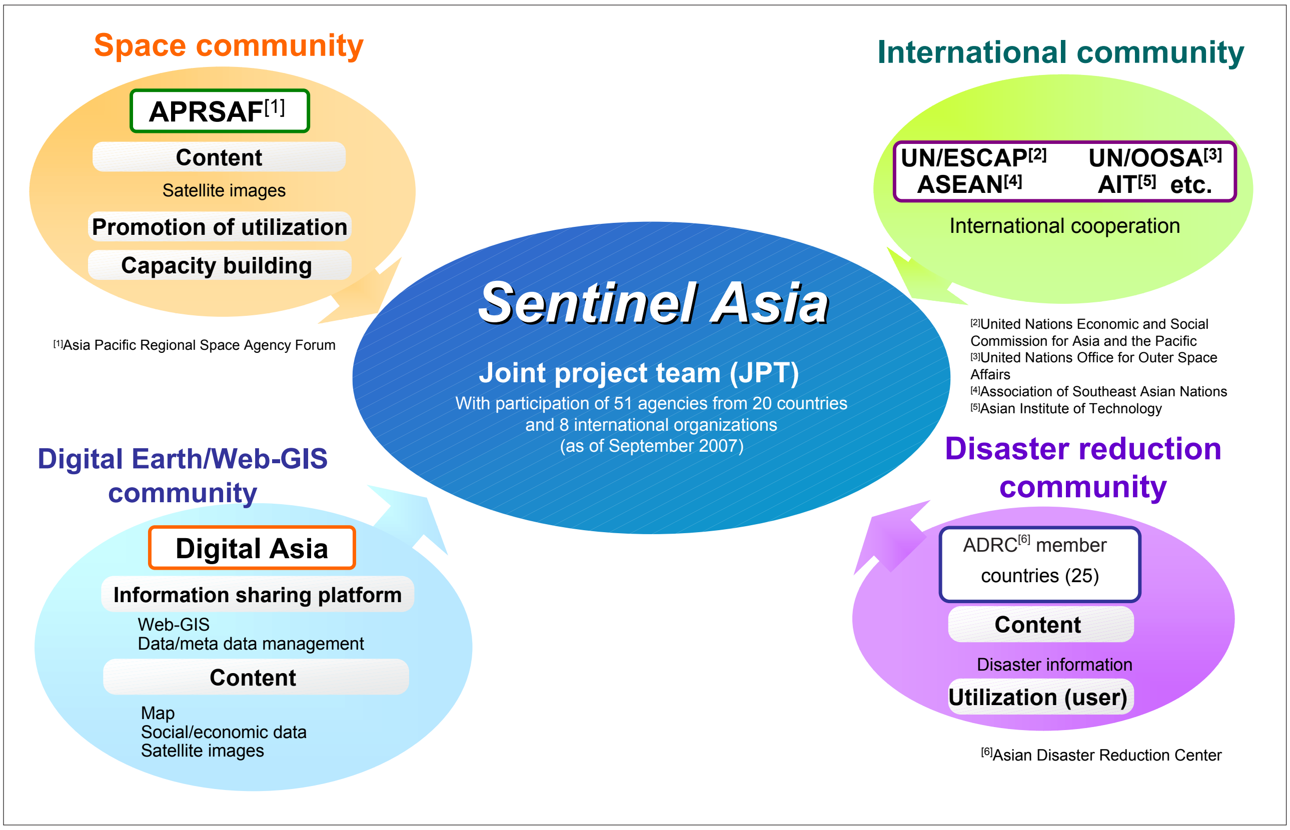

Figure 8 : Framework of Sentinel Asia

Source: JAXA

authorities of national governments of countries to which Charter member agencies belong are eligible to become Authorized Users who can request data acquisition to the Charter. Japan's Authorized User is the Cabinet Office.[23] There are cases where the United Nations or other international organizations request data acquisition to the Charter when disasters occur in countries other than those to which Charter member agencies belong, and indeed the Charter was activated to respond to such natural disasters occurred in Asia.

In addition to directly providing earth observation data, the Charter, using earth observation data, also provides damage map information that shows damage conditions of affected areas. Although creating such map information requires additional processing time compared with directly providing earth observation data, such map information is very useful for assessing damage conditions.

5-2 Sentinel Asia

At the Asia-Pacific Regional Space Agency Forum (APRSAF)[Note2] meeting held in October 2005, when JAXA proposed an initiative to establish an Asian disaster management satellite system and proposed, as a first step, to develop a Sentinel Asia system that would distribute via the internet images obtained by earth observation satellites operated by participating members,[24] many agencies attending the meeting endorsed the proposal, and a joint project to develop Sentinel Asia was launched. For readers' information, Japan has contributed to the training of remote sensing engineers in Asia, and is now assisting disaster management capacity building there through Sentinel Asia.

Sentinel Asia has been operational since October 2006, providing images obtained by "DAICHI" and related geographic information via the internet. The fact that 51 agencies from 20 countries and 8 international organizations in Asia and Oceania are participating in the Sentinel Asia joint project as of September 2007[25] suggests that Asian and Oceania countries are very much interested in this joint project (Figure 8). A website has been set up to provide information on Sentinel Asia (http://dmss.tksc.jaxa.jp/sentinel/).

The Asian Disaster Reduction Center (ADRC) serves as the contact point to receive and accept emergency observation requests from the ADRC

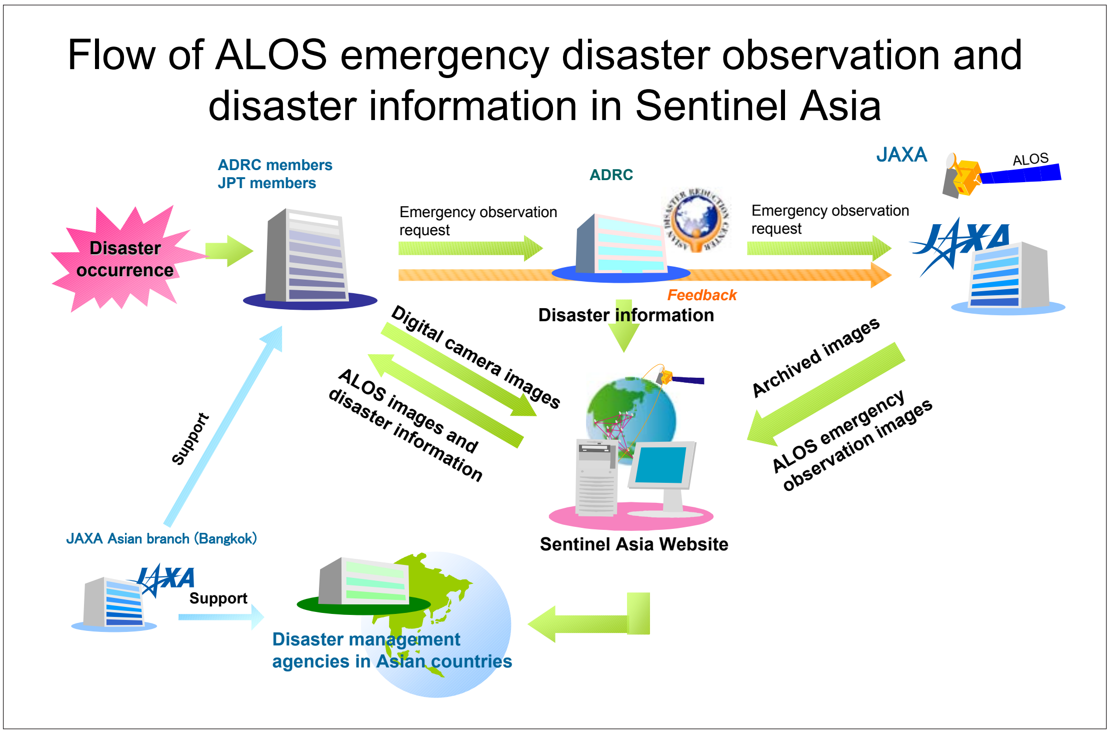

Figure 9 : Flow of emergency observation and disaster information when using "DAICHI"

Source: JAXA

member countries and the joint project member agencies, and requests JAXA to implement accepted emergency observations. JAXA conducts requested emergency disaster observations, and enters the observation data in a dedicated Sentinel Asia server (http://arrs.adrc.or.jp/adrc/MyMap/adrc/index.jsp). The ADRC member countries and the joint project member agencies retrieve image data and other disaster information from this server via the internet (Figure 9). If "DAICHI" alone were available for emergency observations of disaster areas, such observations could be done within three days with AVNIR-2 if the effects of clouds are ignored, and within five days with PALSAR that can conduct observations without being affected by clouds. A single satellite system has limited observation capabilities, and a multiple satellite observation system is required to realize seamless and immediate observations of areas affected by disasters soon after they occur.

Since it is difficult, in Asian regions where broadband services are not available, to download large volumes of image data quickly, low-resolution image data are also provided through Sentinel Asia

[NOTE2]

Asia Pacific Regional Space Agency Forum (APRSAF): An international forum for exchanges of information on the space activities and future plans of the participating counties, and discussion of the construction of actual cooperative activities under the participation of space agencies in the region, concerned administrative bodies, and international organizations having space use needs, which was established with the objective of promoting the use of space in the Asia-Pacific region. Based on a proposal from Japan in the closing declaration of the Asia-Pacific International Space Year Conference (APIC) in 1992, it has been held almost every year since 1993. The 13th forum was held in Jakarta, Indonesia, in December 2006 under the joint sponsorship of Japan's Ministry of Education, Culture, Sports, Science and Technology and the Japan Aerospace Exploration Agency (JAXA), and the Ministry of Research and Technology (RISTEK) and National Institute of Aeronautics and Space (LAPAN), both of Indonesia. The 14th forum was held in India in November 2007 cosponsored by the Indian Space Research Organization (ISRO), MEXT and JAXA.

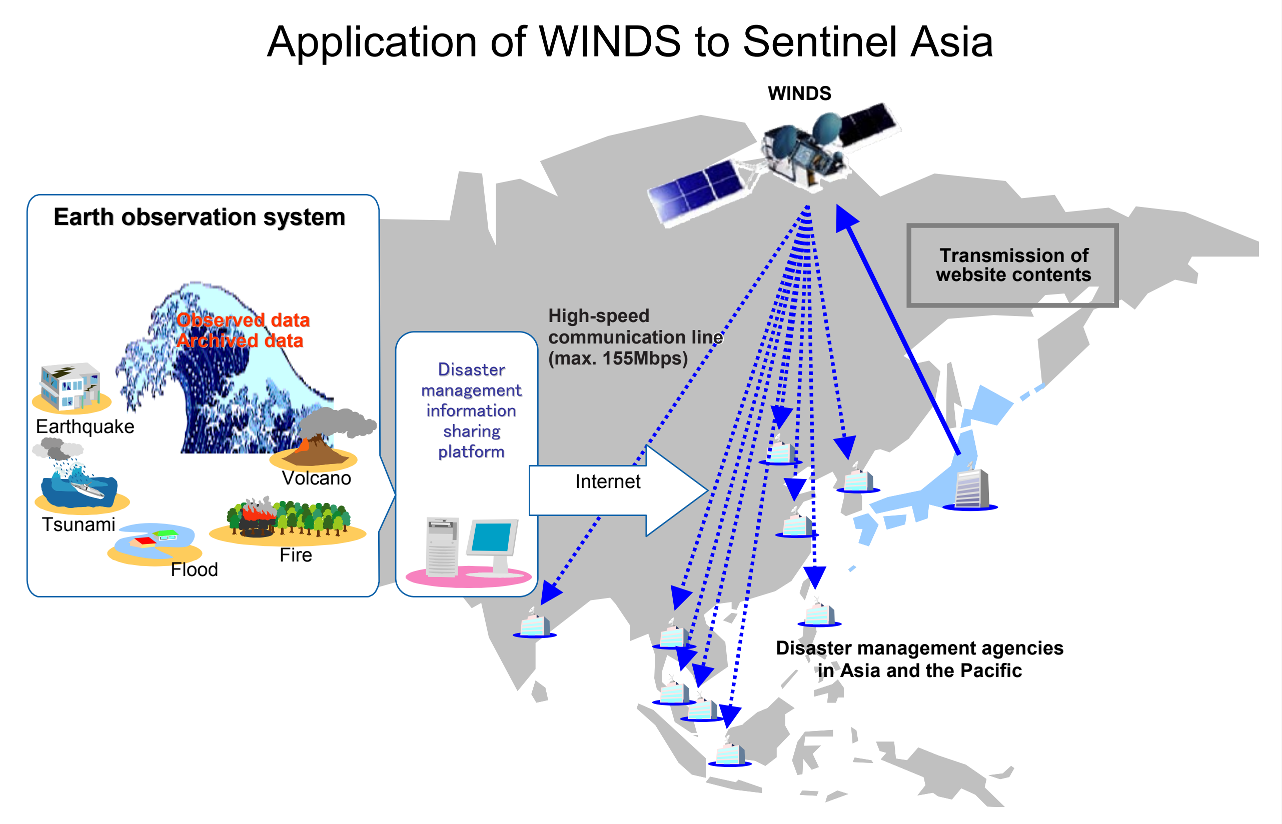

Figure 10 : Application of “KIZUNA (WINDS)” to Sentinel Asia

Source: JAXA

for such regions. The “KIZUNA” super high-speed internet satellite will be able to provide super high-speed internet services to Asian regions as well as to Japan.[14] In the second step of Sentinel Asia, when “KIZUNA” will be available, the problem of such large-volume data transmission in these areas will be overcome.

“KIZUNA” will cover major Asian cities of Seoul, Beijing, Shanghai, Hong Kong, Manila, Bangkok, Bangalore, Kuala Lumpur, Singapore, and Jakarta with 10 beams, enabling high-speed internet communication with Japan. If, taking into account the effect of rain, a ground terminal with an antenna of about 1.2m in diameter is installed and used in these cities, disaster information can be provided with a maximum transmission rate of approximately 155Mbps (Figure 10).

At present, image data on disaster areas are distributed to furnish disaster information quickly. The damage map information provided by the International Charter seems to be an effective means to assess disaster damage conditions. It would further contribute to disaster management activities in Asia if such information were provided through Sentinel Asia.

Asia is also frequently damaged by forest fires and floods. MODIS data from the National Aeronautics and Space Administration (NASA) of the United States are distributed to provide information on hotspots that might indicate forest fire locations. Observation data from the NASA Tropical Rainfall Measuring Mission satellite that carries the precipitation radar developed by Japan are also distributed, assisting the prediction of heavy rains and floods. Since Asia is also frequently damaged by typhoons, data from the Japanese Meteorological Agency’s “HIMAWARI” satellite are also provided.

Data from satellites owned and operated by India, Thailand, and other countries will also be provided. India has been making great progress in the field of space development. In January 2007, it launched an earth observation satellite equipped with a panchromatic optical sensor with a resolution of 1m. Thailand is receiving technical support from Europe to develop a small earth observation satellite. It is of great significance if participating countries other than Japan provide their own earth observation satellites’ data to enhance and strengthen Sentinel Asia.

Applying small satellites to earth observation is thought to be promising because one of their advantages is their relatively low development costs, and some Asian countries are highly interested in such application.[26] Though not directly related to Sentinel Asia, as an example of such small satellite application other than that of Thailand, the Surrey Satellite Technology Ltd. (SSTL), a UK company, manufactured small satellites weighing about 70-130kg for disaster damage monitoring, and delivered them to countries such as Algeria, Turkey, China, and Nigeria.[27]

5-3 Activities of China and the United Nations

China, being frequently damaged by natural disasters such as earthquakes, floods, and typhoons, in its White Paper "China's Space Activities in 2006" [28,29] released in October 2006, officially announced its plan to use earth observation satellites for disaster management. China joined the International Charter in 2007, and furthermore, together with Austria, Germany, and India, China expressed to the United Nations (UN) its commitment of support to establish a UN space technology application project for disaster management. The United Nations General Assembly approved in December 2006 to establish the UN project, whose official name is the United Nations Platform for Disaster Management and Emergency Response (UN SPIDER), to apply space technologies such as earth observation satellites, meteorological satellites, and navigation and positioning satellites to disaster management.[30] Algeria, Argentina, Italy, Morocco, Nigeria, Romania, Russia, Switzerland, and Turkey expressed their support for the project.

The project has started its activities in 2007 with the objectives to cooperate with existing programs such as the International Charter to provide UN member states, especially developing countries, with opportunities to apply space technologies to disaster management as well as to help those countries build human capacities for such application. UN SPIDER is to have an office in Vienna, Austria, one in Beijing, China, and one in Bonn, Germany. As part of its outreach activities, a workshop is scheduled to be held in China in December 2007[NOTE3], following one held in Germany in October 2007.

[NOTE3]
The workshop was held on December 3 to 5, 2007 in Shenzhen, China.

6 Conclusion—Space technology for Japan's diplomacy in Asia

Japan's efforts to promote international cooperation with Asian countries to apply earth observation satellites to disaster management, and to maintain and strengthen friendly relationships with these countries should serve its national interest. Following are recommendations to further utilize Japan's space technologies for Sentinel Asia, which is really becoming Asia's disaster management satellite system, and to carry out Japan's space diplomacy in Asia.

(1) Planning and implementing a strategy for science and technology diplomacy in the field of space activities

Space technology applications to disaster management are carried out through various frameworks such as the Europe-led International Charter, United Nations-led UN SPIDER, and APRSAF-led Sentinel Asia.

In Japan, the Council for Science and Technology Policy at the meeting held on June 7, 2007 established a working group for S&T diplomacy, which is now discussing issues in the field of environment.[31]

Likewise, it is desirable that Japan plan and implement a comprehensive national strategy for S&T diplomacy in the field of space activities.

(2) Establishing a cooperative relationship between the International Charter and Sentinel Asia

The International Charter is a framework where member states that own and operate earth observation satellites exchange observation data among them for disaster damage assessment. Asian countries that do not own such satellites cannot be members of, and request observation data to, the International Charter . At present, such observation data can be acquired only when international organizations such as United Nations agencies activate the Charter.

Although observation data from Indian, Thai and other Asian nations' satellites in addition to those from Japan's "DAICHI" and "HIMAWARI" satellites are to be provided through Sentinel Asia, as in the case of the EU's GMES, to ensure diverse observation data sources is desirable to quickly respond to disasters.

Establishing a new cooperative relationship between the International Charter and Sentinel Asia is desirable to enable mutual data exchange between them.

(3) Continuation of research and development on successor earth observation and super high-speed internet satellites

Sentinel Asia does not require owning an earth observation satellite as a condition to be its member, and can be said to be a friendly framework for Asian counties, which are frequently damaged by natural disasters, to participate. Its members include the National Disaster Reduction Center of China (NDRCC) and Beijing Normal University (BNU), as well as international organizations such as the Secretariat of the Association of Southeast Asian Nations (ASEAN), the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP), and the United Nations Office for Outer Space Affairs (UN OOSA). Although limited to the area of disaster management, Sentinel Asia is an international project where Japan is demonstrating its leadership and is making a visible contribution.

Japan should continue research and development on successors to the "DAICHI" earth observation satellite and the "KIZUNA" super high-speed internet satellite, through which Japan is contributing to Asia, to expand and enhance Sentinel Asia under the leadership of Japan, and to maintain and strengthen friendly relationships with Asian countries.

(4) Promotion of cooperation in small satellite development activities in Asia

As part of its industry-academia-government cooperation activities, JAXA provides Japanese research institutes and private sector with opportunities to launch small satellites weighing 5-50kg onboard the H-IIA launch vehicle.

Japan has succeeded in the development of a very small science satellite called "REIMEI" and in the observation of auroras using the satellite. A common bus for 500kg-class small science satellites is under study. While there are numerous examples of small satellite development in Asian countries in cooperation with European and other countries, Japan has just begun cooperation with Vietnam and other countries for such development. Thus, it can be said that Japan has a low presence in Asia as a partner in the small satellite development.

To enhance Sentinel Asia with diverse satellite data sources, as well as to improve Japan's presence in Asia, Japan should not only provide Asian countries with opportunities to launch small satellites, but also promote cooperation with them in the small satellite development, provided that they cooperate for Sentinel Asia.

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[NOTE4]
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