Development of Sentinel Asia as a Platform to Facilitate Space-Based Technology Application to Disaster Management Operations

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Abstract

Sentinel Asia was conceptualized in 2005 and first began operation in 2007. SA is engaged in activities to share and provide disaster-related information including earth observation satellite images via the internet to contribute to disaster management in the Asia-Pacific region. Between 2006 and 2016, 270 emergency observation requests were made or accepted, providing satellite images and Value Added Map to Sentinel Asia members to support disaster management. These provided data unable to find out specific affected area and shared between space agencies and disaster management organizations in affected country by natural hazard. However it is expected that more swift response is needed for local emergency response activity in case of natural hazard.

1. Introduction about Sentinel Asia

1.1. Background

Natural hazards have been on the rise worldwide, including Asia-Pacific region. A lot of natural hazards hit in the Asia-Pacific region and suffers from different types of natural hazards such as earthquakes, cyclones, typhoons, floods, landslides, droughts, tsunamis, volcanic eruptions and forest fires. Several of them are of large-scale, devastating disasters. Given the high level of population (about 3 billion), and the high frequency and calamity from natural hazards in the region, the integrated use of space technology, such as earth observation satellite data and geographic information systems, can be an effective means to reduce the magnitude of the calamity, or as a means of managing large-scale natural hazards supporting disaster responses. The Sendai Framework for Disaster Risk Reduction indicates an importance about promoting real time access to reliable data making use of space and in situ information, including from geographic information systems under Priority for Action 1, “Understanding disaster risk”.

In light of the increasing frequency of natural hazards and elevated loss of lives and property from these events, Sentinel Asia (SA), a collaborative, regional project, was conceptualized in 2005 and first began operation in 2007. SA is engaged in activities to share and provide disaster-related information including earth observation satellite images via the internet to contribute to disaster management in the Asia-Pacific region. Space agencies of the member countries of the Asia-Pacific Region Space Agency Forum (APRSAF), including the Japan Aerospace Exploration Agency (JAXA), and the disaster risk reduction agencies in the Asia-Pacific region, such as the Asian Disaster Reduction Center (ADRC), cooperate in forming a Joint Project Team (JPT) and promoting SA. SA aims to support for the Asia-Pacific region collaborate with these organizations. As of December 2018, it consists of 108 member organizations, including 92 agencies from 28 countries/regions and 16 international organizations.

1.2. Aims and Framework

The SA aims to (i) improve safety in society with the use of modern Information and Communication Technology (ICT) and space-based technology, (ii) improve speed and accuracy of disaster preparedness and early warning systems, and (iii) minimize the number of victims and social, economic losses. To achieve these goals, various activities have been undertaken.

The following are the main data and products provided by SA to its members (i) satellite imagery (and data permitted by data providers) and value-added images with extraction of stricken areas, etc., (ii) on-site digital camera images (iii) wildfire hotspot information and data (iv) rainfall (short-term and long-term) information and data, and (v) meteorological satellite imagery and data.

SA is promoted under cooperation among the following three communities (i) Space Community (APRSAF), (ii) International Community and, (iii) Disaster Reduction Community (see Figure 1). To promote the activities of SA, the JPT was established, which is open to all the APRSAF member countries, disaster prevention organizations and regional/international organizations who wish to participate in disaster information sharing activities.

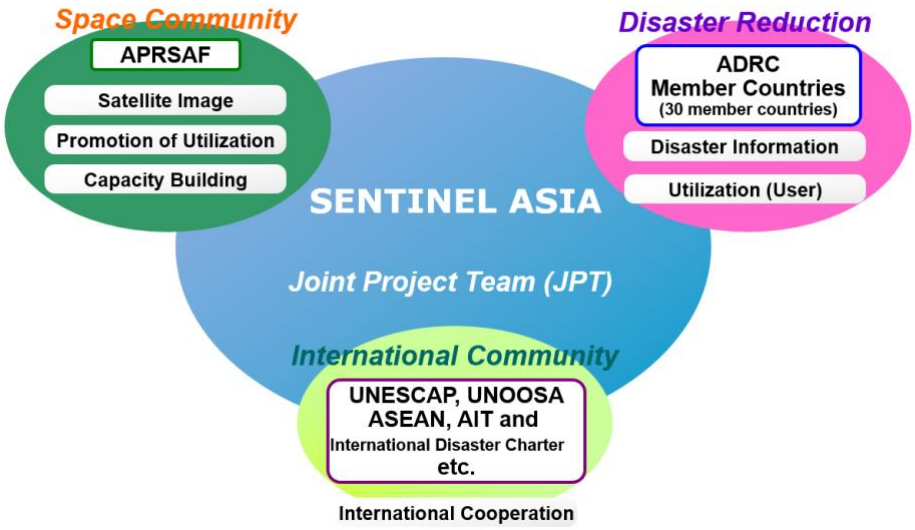

Figure 1. Framework of the Sentinel Asia

And SA is composed of two Nodes (Data Provider, and Data Analysis) and four Working Groups (Wildfire, Flood, Glacial Lake Outburst Flood and Tsunami). The Data Provider Node (DPN) provides own satellite imagery and other relevant data to JPT members upon an Emergency Observation Request (EOR) from a JPT member to the extent permitted by the data policy of each DPN when a disaster occurs, while the Data Analysis Node (DAN) analyzes the satellite data provided by DPN, makes value added products and uploads and shares the result through the Sentinel Asia System. Between 2006 and 2016, about 270 EORs were made or accepted, providing data and products to SA members to support disaster management.

Sentinel Asia is making a challenge to respond to all of disaster management cycle such as Preparation, Response, Recovery and Mitigation. In this study, we set a purpose to confirm all of 270 EORs for supporting

“Emergency Response Phase” and consider trend and improvement. In addition, disaster management organization’s perspective is shown as results of a good practice information.

2. Trend of Emergency Observation Request (EOR)

Table 1 presents the number of EOR, activations and rejections for each disaster. Floods represented the largest number of disasters, with 132 requests (48.9%), followed by earthquakes at 31 (11.5%), landslides at 21 (7.8%), typhoons at 20 (7.4%), forest fires and fires at 17 (6.3%), volcanic eruptions at 14 (5.2%), and cyclones at 10 (3.7%). Generally, activation is made for around 80% to 90% of requests for most disasters, but the activation rate is 41.2% for forest fires and fires only. According to several comments from JPT members, the reason for this is that forest fires affect a much broader region than other disasters, making it difficult to obtain accurate information from the disaster-affected areas.

Table 1. Number of Requests, Activations, and Rejections for Emergency Observations by Disaster (2007-2016)

	Number of Request	Number of Activation	Number of Rejection	Activation percentage (%)
Flood	132	124	8	93.9%
Earthquake	31	27	4	87.1%
Landslide	21	17	4	81.0%
Typhoon	20	18	2	90.0%
Forest Fire	17	7	10	41.2%
Volcano	14	11	3	78.6%
Cyclone	10	9	1	90.0%
Oil Spill	4	2	2	50.0%
Others	21	13	8	61.9%
Total	**270**	**228**	**42**	84.4%

Figure 2 presents the number of requests, activations and rejections involving emergency observations over the past 10 years, from 2007 to 2016. The number of requests and activations peaked in 2010 and 2011, with the number declining subsequently thereafter, but the number increased once again from 2015 to 2016. This correlates to the period from the shutdown of Advanced Land Observing Satellite (ALOS) from April 2011 to the launch of ALOS 2 in May 2014.

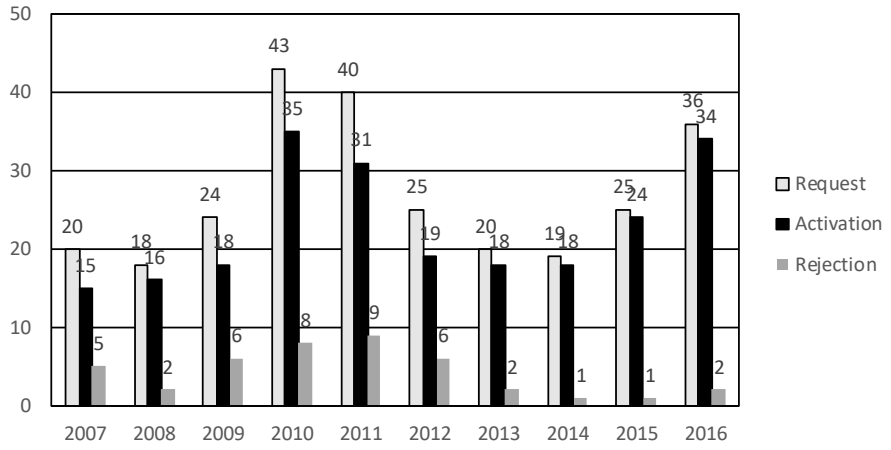

Figure 2. Comparison of the Number of Requests, Activations and Rejections for Emergency

All the number of EOR, activations and rejections in 2016 are listed in Table 2. In total, 36 requests were received in 2016. The following two requests were rejected due to a failure to maintain contact with SA following initial request. On a request basis, floods represented the largest number of disasters, with 12 requests (33.3%), followed by earthquakes at 5 (13.9%), landslides at 3 (8.3%), typhoons at 4 (11.1%), forest fires and fires at 1 (2.8%), volcanic eruptions at 1 (2.8%), cyclones at 4 (11.1%) and oil spill at 1 (2.8%).

Table 2. Number of Requests, Activations, and Rejections for Emergency Observations by Disaster in 2016

	Number of Request	Number of Activation	Number of Rejection
Flood	12	12	0
Earthquake	5	4	1
Landslide	3	3	0
Typhoon	4	4	0
Forest Fire	1	1	0
Volcano	1	1	0
Cyclone	4	4	0
Oil Spill	1	1	0
Others	5	4	1
Total	**36**	**34**	**2**

Figure 3 shows the monthly distribution of activations throughout 2016. During 2016, the monthly average of activations was 2.8 requests. The highest number of activations occurred in April, August, and September corresponding to 47% of the total number. The remaining months of 2016 saw the number of activations vary from 0 to 4. Most of the activations in August and September were caused by water disasters such as floods and typhoons.

Figure 4 presents the number of emergency observations by country. Countries and regions with a large number of requests are mostly located in Southeast Asia, including Indonesia, Taiwan, the Philippines and Myanmar.

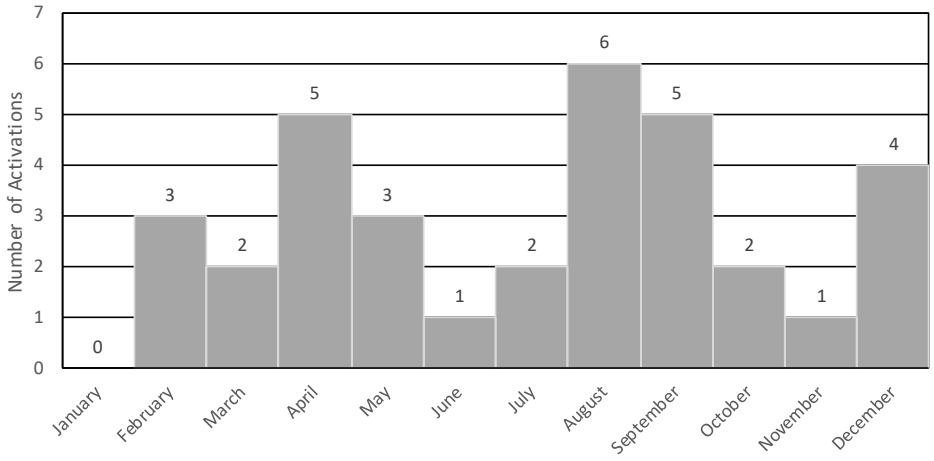

Figure 3. Number of monthly activations in 2016

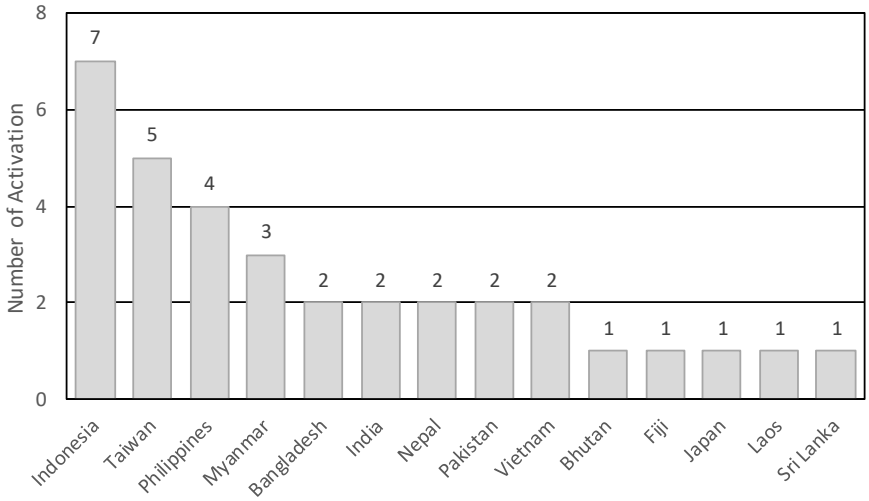

Figure 4. Number of activations by country in 2016

3. Good Practices

3.1. Flood in 2016 (Sri Lanka)

Following the devastating floods and landslides in May 2016, SA received EOR from the International Water Management Institute (IWMI), Colombo. Below is a brief description of the event and a good example of our EOR activity (data and information sharing) to support the Sri Lankan Government's efforts for disaster management.

On 15 May 2016, Sri Lanka was hit hard by a powerful tropical storm that caused widespread floods and landslides in 22 of the 25 districts in the country, destroying hundreds of homes and submerging entire villages. At least 104 people are known to have died and 99 people remain missing, the majority due to a landslide in Aranayake, Kegalle District, which destroyed three villages. An estimated 301,602 people were affected by the disaster, including at least 21,484 people who were displaced from their homes. In response, SA provided a large number of satellite images and map products: at least three pre-disaster and 122 post-disaster images, and 40 analyzed products. Figure 6 shows such an example of Value Added Map (VAP).

Figure 5. Flooding in May 2016

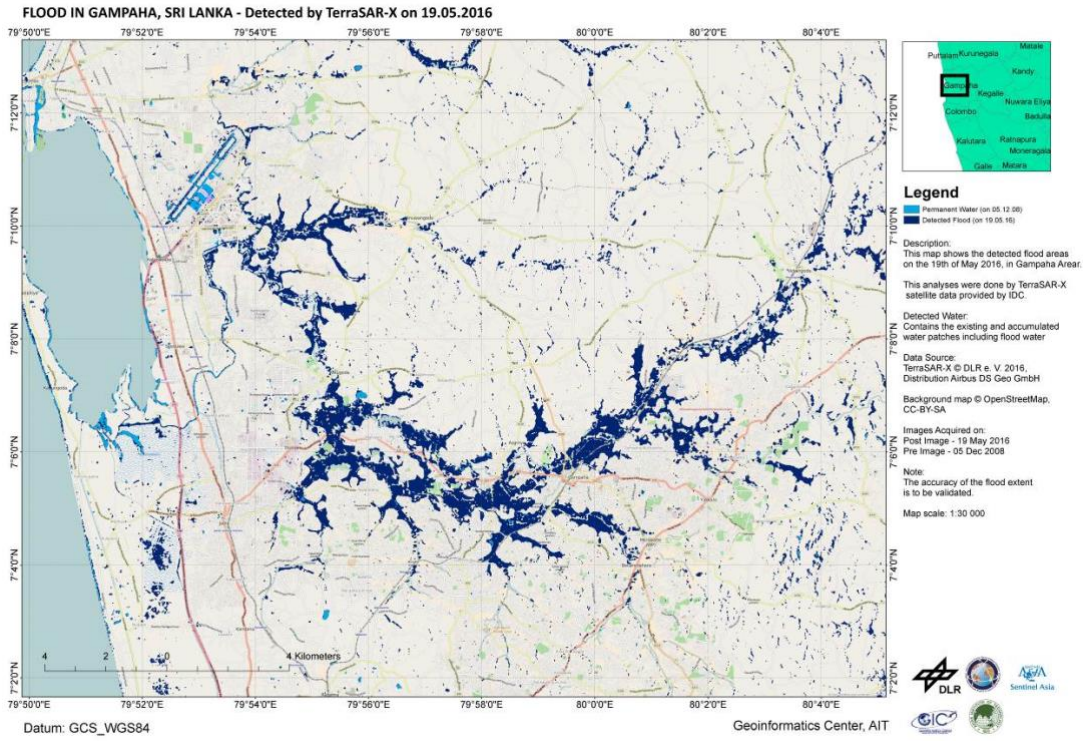

Figure 6. VAP of flooding area in Colombo

SA tried to collect latest disaster information and updated flood area information from the Disaster Management Center (DMC) in Sri Lanka and IWMI. And SA shared these information with DPN and DAN to provide appropriate satellite images and VAP. The DMC and IWMI officers said that provided satellite images and VAPs had been very useful for/during rescue and recovery operations, assessing the damaged areas, and advocacy to donors for assistance.

3.2. Heavy rain and floods in 2015 (Myanmar)

Torrential, heavy rainfall occurred across Myanmar since June to August 2015 (on 19 July it was particularly severe) that triggered floods and landslides in several parts of the country. According to the Situation Report 4 of National Natural Disaster Management Committee (NNDMC), 12 out of 15 states/regions were affected by the disaster. A total of 122 persons were killed, 1,616,761 were affected or displaced, 476,242 houses and 224 health facilities were damaged, and 841,620 acres of farmland was destroyed. A major concern remained on water contamination, as most villagers use water ponds for drinking water and many ponds were flooded and contaminated. Affected areas have suffered US$ 149 million direct economic losses, with heavy concentrations of

the losses in Rakhine and Chin States.

SA also provided appropriate satellite images and VAPs based on request from disaster management organization in Myanmar. Officers said that these data were disseminated to or shared with concerned government ministries/departments as well as UN and other partner agencies for their response activities. Although the provided data were useful both for recovery and emergency response, those products were highly technical and difficult to understand for our resource persons, operation staffs and local people. In some cases, space agencies does not have detail natural hazard information in affected area. Also experts in space technology field is limited in disaster management organizations. Mutual collaboration and support between these organizations is important via SA.

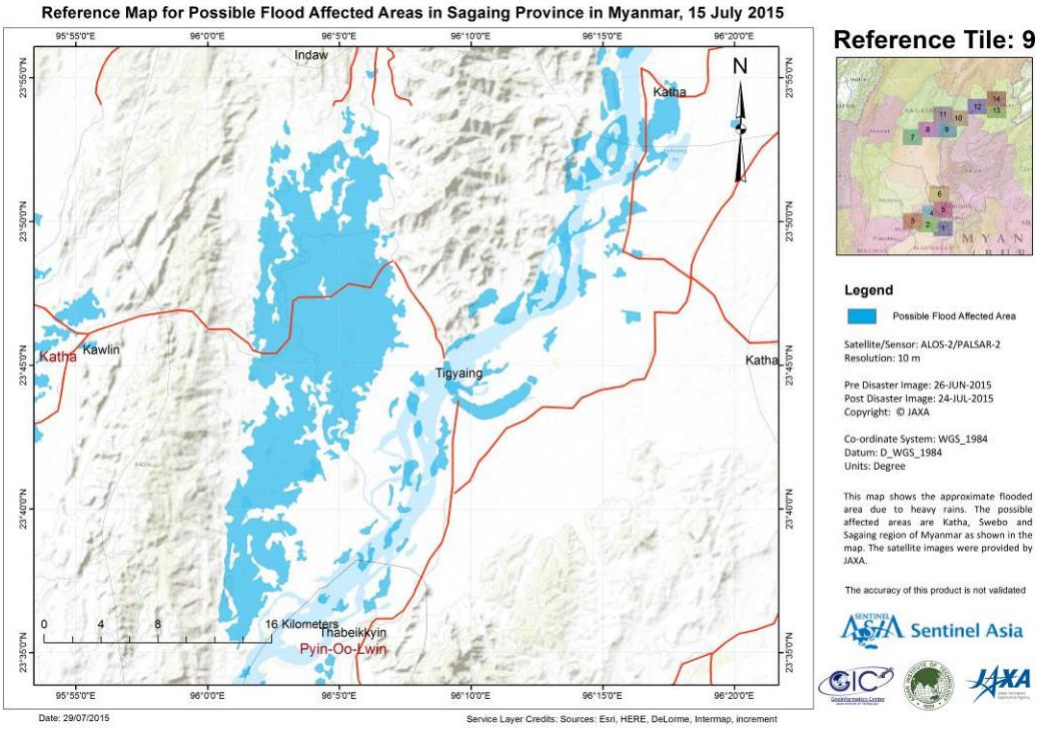

Figure 7. VAP of Flooding areas in Myanmar

4. Operational Performance about past EOR

Figure 8 summarizes the number of days from disaster occurrence to request for each disaster and year. Overall, this shows it took a couple of days from disaster occurrence to request for the period between 2011 and 2016. And the number of days required from the date the request is received to activation. Overall, it took an average of 0.8 days from request to activation for the period between 2011 and 2016.

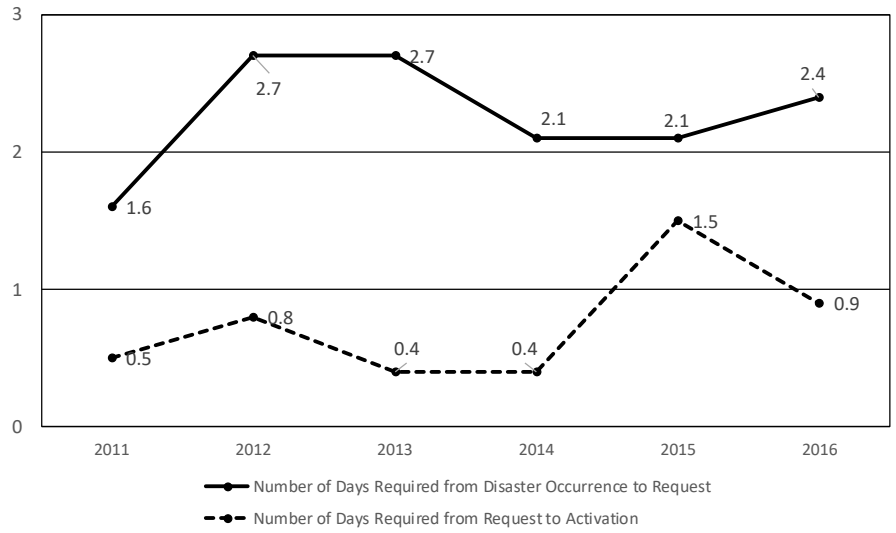

Figure 8. Number of Days Required from Disaster Occurrence to Request and Request to Activation

Figure 9 to Figure 11 present the average number of days required to provide each data for each year and the percentage of completed data provisions. Figure 11's Archive Satellite Data indicated the percentage of provisions declined from 2015, totaling 61.8% in 2016, while the average number of days required for provision was 5.3 days. Figure 12's Satellite Data after Disaster showed the percentage of provisions increased sharply from 2014 onward, while the number of days required for data provision has declined in recent years. Figure 13's products were only provided in 73.5% of the cases in 2016.

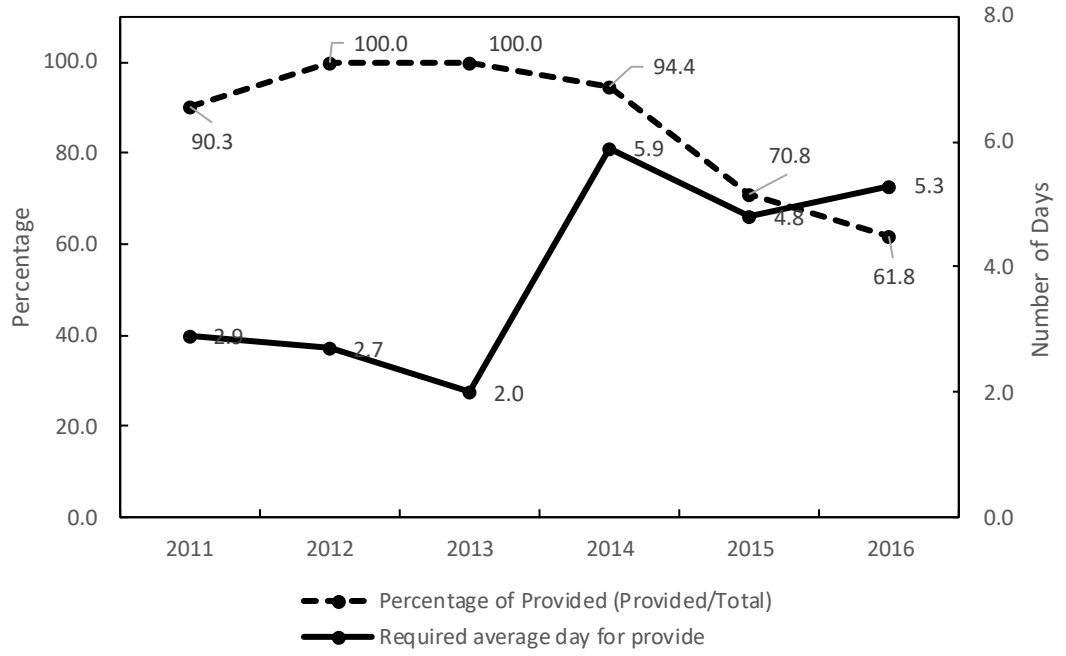

Figure 9. Average Number of Days Required to Provide Archive Satellite Data and Response Rate for Each Year

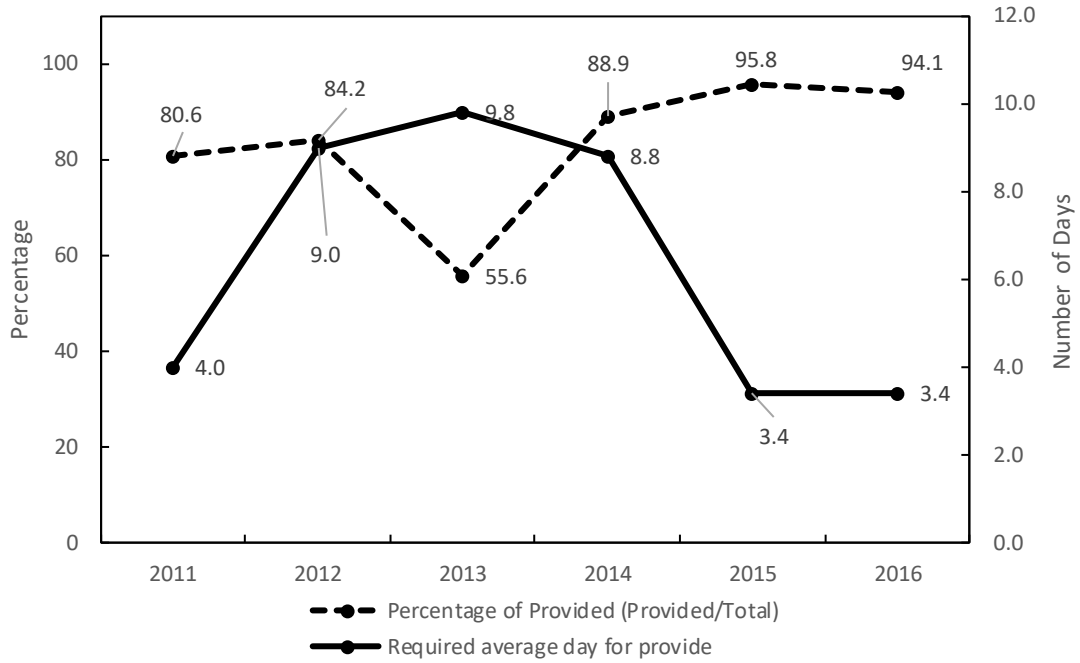

Figure 10. Average Number of Days Required to Provide Satellite Data after Disaster and Activation Rate for Each Year

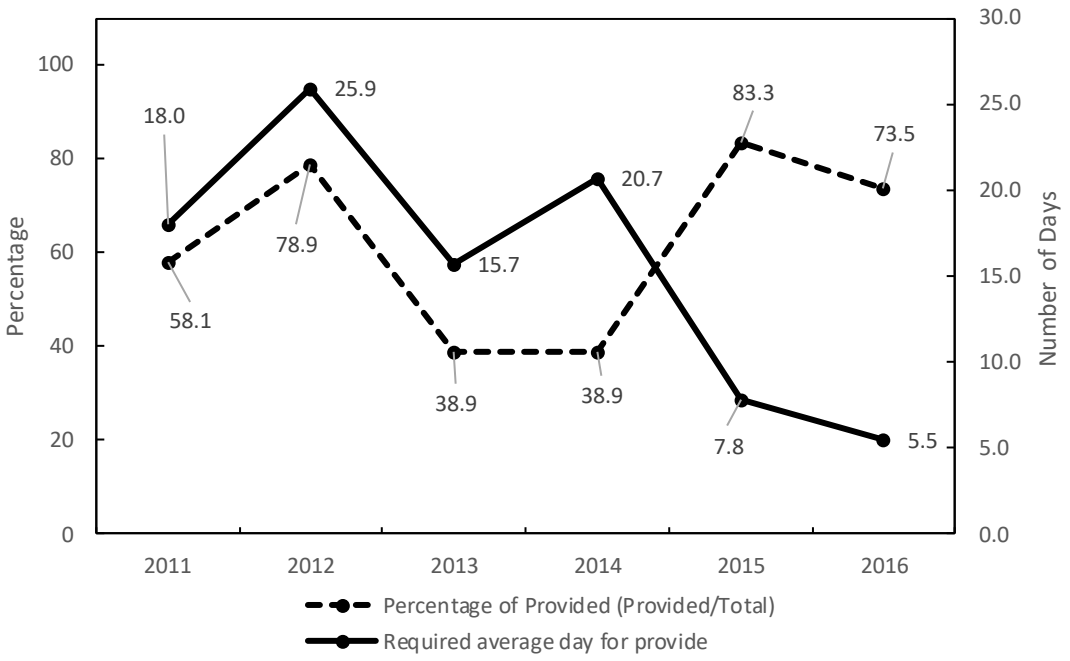

Figure 11. Average Number of Days Required to Provide Products and Activation Rate for Each Year

For the swift emergency response activity, time for providing satellite images and VAPS should be shorten. However it still takes 5.5 days for providing VAPs in 2016 (see Figure 11). Especially it is expected that action for life saving should be taken within 72 hours after natural hazard. It is needed that SA improve about this matter cooperate with DPN, DAN and JPT members.

5. Conclusion

In 2016 SA celebrated its 10th anniversary. Since the start of 2007, we have conducted emergency observation activities of 270 natural hazards. Number of Days required to satellite data and VAP are improved in recent year. However it is necessary to steadily advance the recommendation toward the future development of SA. One recommendation is to encourage the establishment of a system for rapid observation and sharing of analyzed information. Because shortening time is important for an emergency response activity. Other one is to promote capacity development of disaster management using space technology. SA has been providing lots of satellite data and VAPs for “Emergency Response Phase” in disaster management cycle. On the other hand, exclusive understanding is needed to confirm these provided data. Experts in some small countries is not enough yet. For the one of solution, SA started to develop a Standard Operation Procedure (SOP) for SA in Thailand, Myanmar and Vietnam since 2017. This SOP enables to understand a procedure for EOR before disaster. This activities is applicable

for “Mitigation Phase” in disaster management cycle and correspond to concept of the Sendai Framework for Disaster Risk Reduction.

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