International Approach of Glocal Monitoring

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Abstract: In April 2016, Kumamoto, Japan was hit by a series of heavy earthquakes. 145 people were lost including three students of our Kyushu Campus. Since then, Tokai University has been conducting a project call "Constructing glocal monitoring system for safe and secure society". "Glocal" is a cointed word of "global" and "local". The main concept of the project is to connect the global monitoring using satellite observation with the local monitoring using SNS for reducing the damages of disasters and environmental changes. Tokai University is receiving MODIS, VIIRS and AVHRR data at it's ground stations one in Shonan Campus and the other in Kyushu Campus. The data are automatically processed and archived in near real time. On the other hand, the authors have been operating Disaster Information Tweeting System (DITS) for disaster information collection. The authors are operating the Glocal Monitoring System by connecting the satellite data system with DITS. DITS can be used in any country where Twitter is accessible. To enhance the role of Glocal Monitoring, the authors have been cooperating with international partners from China, Philippines, China Taipei, US, Germany etc. The latest status of the Glocal Monitoring framework will be introduced in this paper.

1. INTRODUCTION

In recent years, many countries are suffered by the serious disasters and environmental changes. Especially, In Japan, earthquakes and/or typhoons are giving serious damages to the country almost every year. In April 2016, Kumamoto Prefecture was struck by the magnitude 7.3 earthquake (see Figure 1). Aso Campus and Kumamoto Campus of Tokai University located in Kumamoto Prefecture were seriously damaged. Three students of Aso Campus lost their lives at their apartment. The importance of preparing for disasters was strongly recognized in the university.

Satellite remote sensing is a powerful tool for disaster monitoring. At the time of the Japan Earthquake in 2011, more than 5000 satellite images were taken within two weeks after the

(a) **Crashed houses** **(b) Cracks in a parking place**

Figure 1. Photos of damaged areas at the Kumamoto Earthquake in 2016.

disaster under the international cooperation (Takahashi et al., 2012). Tokai University Research & Information Center (TRIC) has been involved in utilizing remote sensing technology for various application fields including disaster monitoring. In 1986, Tokai University Space Information Center (TSIC) was established as a branch of TRIC in Kumamoto Prefecture, Japan for receiving remote sensing data from space. Since then, TSIC has received and has been receiving data from various kinds of satellites including MOS-1, JERS-1, ERS-1, NOAA, Terra, Aqua, NPP. In order to meet the strong needs of the society for disaster & environmental monitoring, authors have been developing systems for near real time data dissemination (Cho et al., 2012, 2013). However, of cause the details of the disasters which you can get from the satellite images are always limited.

On the other hand, nowadays, SNS such as Twitter are recognized as strong tools for gathering the local information on disaster (Sakaki et al., 2010. Earle et al., 2011, S. Doan et al., 2011). According to the report of an internet service company, about 79% of the people who replied to their questionnaire survey thought that Twitter were useful at the time of the Japan Earthquake. Very local but precise information on disasters can be acquired with SNS. Figure 2 shows a tweet example at a time of flooding.

Figure 2. A tweet example at a time of flooding.

Considering the above situations, in 2016, the authors have initiated a project call “Constructing glocal monitoring system for safe and secure society”. “glocal” is the coined word of “global” and “local”. The main concept of the project is to connect global monitoring from space using satellites with local monitoring using SNS and/or other local sensors for monitoring disasters and environmental changes. Figure 3 shows the conceptual diagram of the Glocal Monitoring. In late 2016, the project was selected and funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan as a Research Branding Project of Private Universities. The objective of the project was to support original and attractive research projects of private universities. Since then, the authors have been proceeding the project under the cooperation with domestic and international organizations. This paper describes about the outcome, current status, and future plan of the project.

Figure 3. Conceptual diagram of Glocal Monitoring

2. CONSTRACTION OF GLOCAL MONITORING SYSTEM

2.1 Global Monitoring with Satellite

(1) Antenna System

Tokai University is operating two 2.4m x-band antennas for receiving data from earth observation satellites, one at TSIC in Kumamoto and the other at Shonan Campus in Kanagawa. Currently, those antennas are sharing the reception of data from Aqua, Terra, NPP, and NOAA-20 satellites. Figure 4 shows the outlook of the antennas and locations of TSIC and Shonan Campus.

Figure 4. The locations of the two x-band antennas of Tokai University.

(2) Near Real Time Monitoring System

Usually, disaster occurs suddenly in unexpected place. Even though the data reception is organized automatically, if you are out of office, you may not able to extract the disaster area from the full scene of a satellite image in timely manner. To solve this kind of problem, the authors have set up the near real time monitoring system Quick Station. Figure 5 show the procedure of the Quick Station. When a disaster occurs in certain place, the operator can remotely specify the location of the disaster area using our mapping system displayed on his/her smart phone or lap top PC connected to internet. Then, our system automatically extracts the area from the satellite images observed before and after the disaster which are archived in our system. In order to identify the damages of the area, images before the disaster is very important.

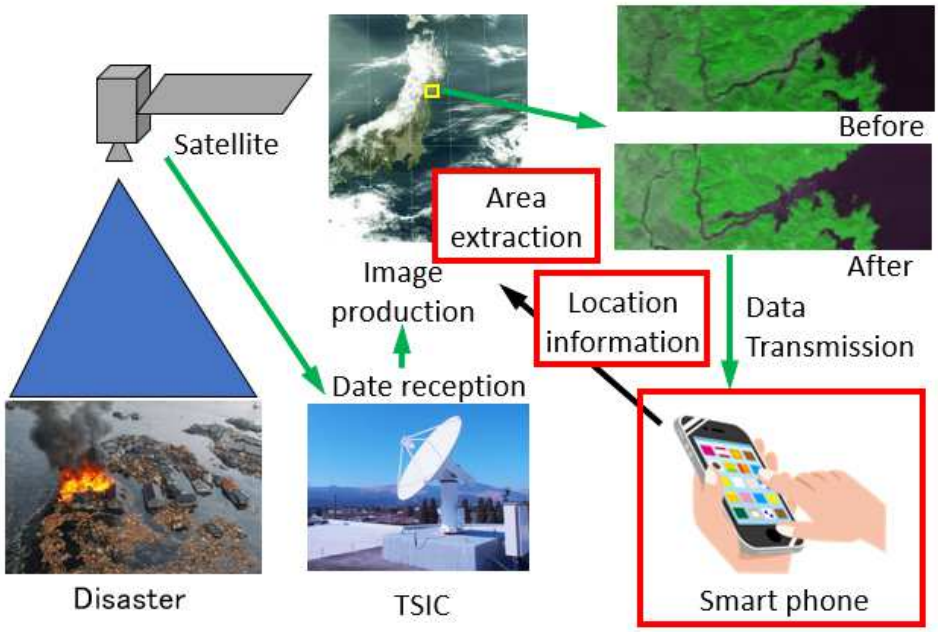


Figure 5. Near real time target area extraction procedures

2.2 Local Monitoring with SNS

Considering the advantage of SNS for correcting personal information on the disaster of the local area in timely manner, authors have developed a Twitter-based disaster-related information sharing system (Uchida et al., 2016). The system is consisted of the following two subsystems;
(1) DITS (Disaster Information Tweeting System)
(2) DIMS (Disaster Information Mapping System).

Figure 6(a) shows the top page of DITS & DIMS displayed on a smart phone. This system is a web application accessible by any web browser.

(1) DITS (Disaster Information Tweeting System)
DITS is a tweeting system focused on disaster information reporting. In case of emergency, it is not easy to tweet the address of your location. In DITS, the user's current geolocation information (street address and UTM Code) and the hashtag "#disaster _(city name)" are automatically added to the tweet. So, even if you just tweet "The river next to my house is flooded. Help!", the person who reads the tweet can recognize your location and the name of the flooded river. Also, the hashtag "#disaster" will push others to understand that you are in danger. In addition to the text comments, user can upload a photo captured by the smart phone. Figure 6(b) shows an example of tweet information appeared on the display of a smart phone. In using tweets, one of the problems which is always specified is fake tweets. At the time of disasters, fake information is often tweeted in the past like "A lion escaped from a zoo. Watch out!". However, in DITS, a user has to register first. Also, the location information of the tweeted place is automatically attached to each tweet. These regulations may reduce the fake tweets in DITS service.

(a) Top page of DITS **(b) Tweet layout produced by DITS**

Figure 6. An example of tweet produced with DITS

(2) DIMS (Disaster Information Mapping System)
DIMS is a visualization tool to plot the location of tweets provided from DITS. Since the location information of each tweet are automatically attached to the tweet in DITS, it is easy to plot the location of tweets on a digital map. The blue and red icons in Figure 7 shows the location of tweets tweeted using DITS and displayed on a digital map of DIMS. By using DIMS, the local government can easily identify the geographical distribution of tweets submitted from various users and may decide where to send the rescue team. This system was highly evaluated by a number of local governments in Japan. For an example, Hiratsuka City of Kanagawa Prefecture is using DITS/DIMS at their disaster prevention practices (See Figure 8).

Figure 7. DITS tweet displayed on DIMS

Figure 8. Disaster prevention practice of Hiratsuka City using DITS&DIMS

(3) Daily use version of DITS/DIMS

The problem of this kind of disaster information system is that users do not use the system daily. As a result, users are likely to forget how to use the system and cannot use it at the time of disaster. To avoid this kind of situation, the authors modified DITS/DIMS to be used also for daily life. We have divided the layout of the top page of DITS/DIMS to two side as shown on Figure 9(a). The left-hand side of the page is for tweeting **daily** Information and the right-hand side is for tweeting **disaster** Information. If you click the button on the left-hand side, the second page appears as sown on Figure 9(b). Then, you can select a topic from shopping, food, sightseeing, and tweet on that topic. In the third page, user can upload a photo related to the topic with some comments. Since the procedure of daily & disaster tweets are the same, users can also use the system smoothly at the time of emergency.

The latest DITS/DIMS is accessible from http://glocal-dits.u-tokai.ac.jp/.

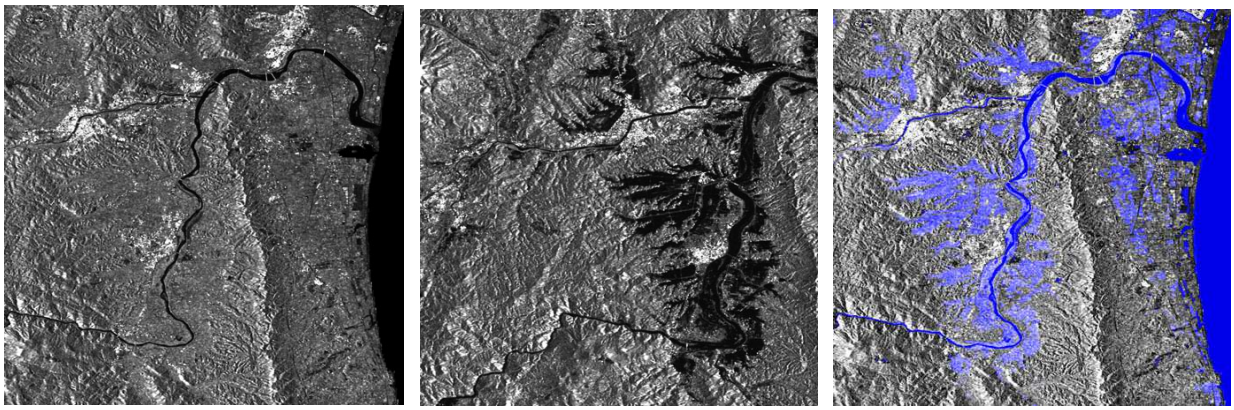
(a)Top page of DITS **(b) Pages for tweeting daily information**

Figure 9. DITS for tweeting daily information

3 SYSTEM INTEGRATION FOR GLOCAL MONITORING

3.1 Use of SAR images

The authors are now integrating the system to use not only the data received our ground stations but also the data acquired through internet such as Sentinel-1 SAR images. Since SAR can penetrate clouds and sensitive to water, SAR images are very useful for extracting flooded areas at the time of heavy rain. Figure 10 shows an example of extracting flooded area using Sentinel SAR images of before and after the flooding of Abukuma River of Fukushima prefecture in Japan.



(a) October 7, 2019 **(b) October 12, 2019** **(c) Extraction of flooded area**

Figure 10. Flooded area extraction using Sentinel-1 SAR images of Abukuma River

3.2 Satellite Image Overlay

Currently, the authors are integrating the near real time satellite image browsing system Quick Station with DIMS (Cho et al., 2017). The system can overlay different satellite images on the base map and display together with DITS tweet. Figure 11 shows MODIS image overlaid on DIMS. Though the special resolution of MODIS is limited, every day observation is an advantage of the sensor at the time of huge disasters.

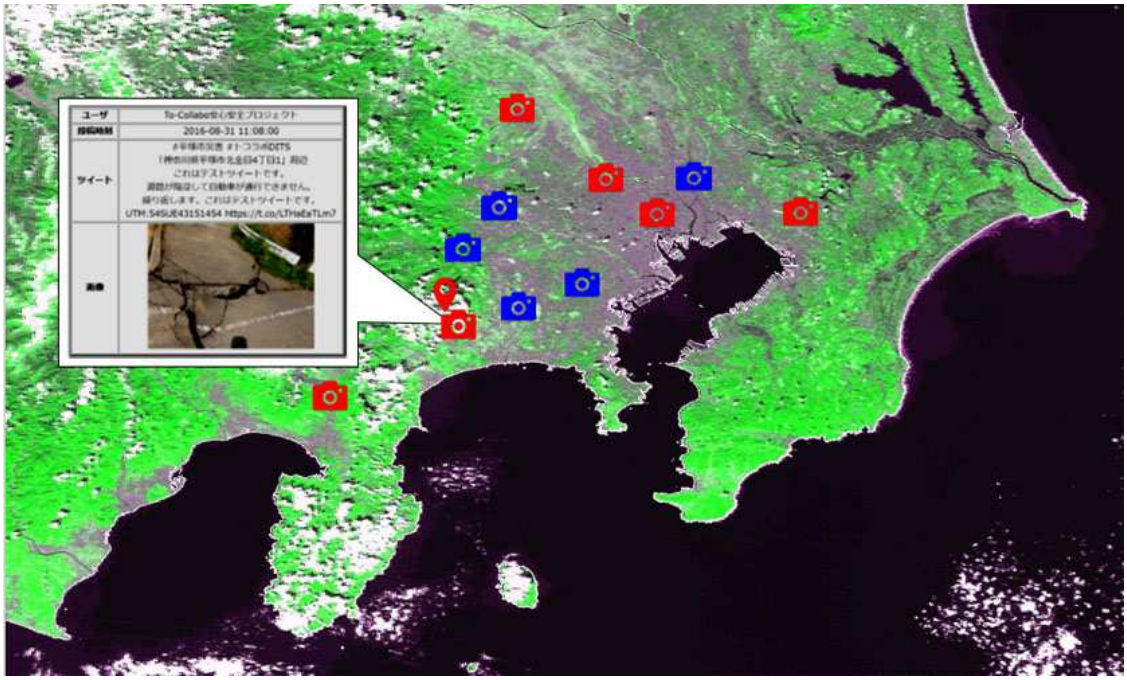
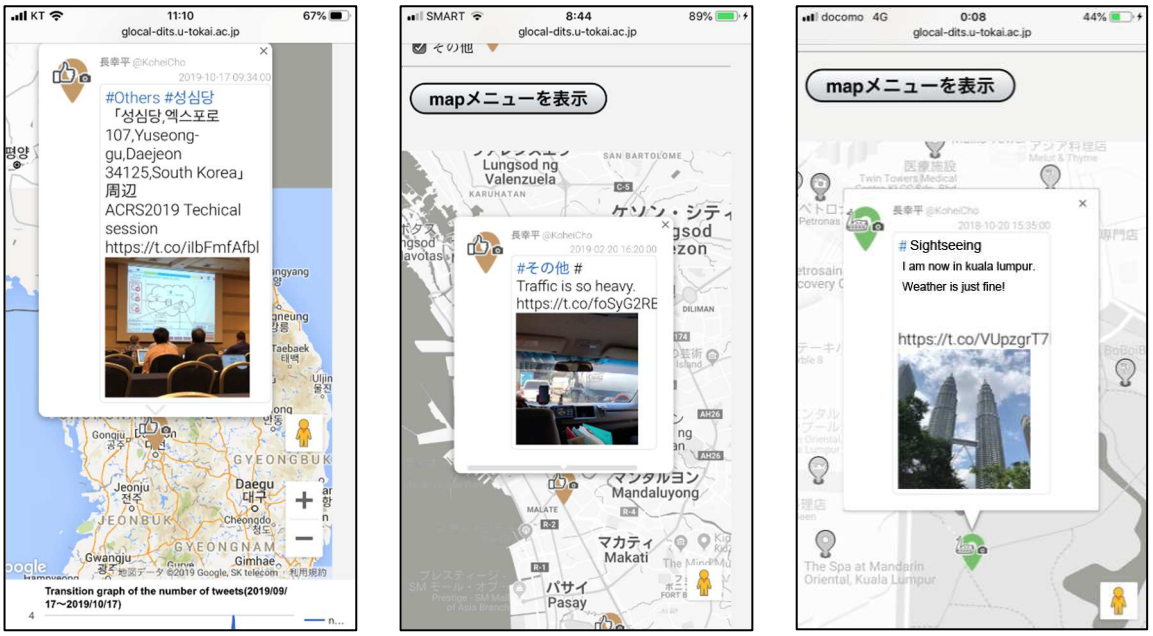


Figure 11. An example of Overlaying a tweet on a MODIS image

3.3 International Version of DITS/DIMS

Originally, Yahoo Japan Map API was used for displaying maps in DIMS. So, the applicable area was limited. However, recently we have started to use Google Maps API for DIMS, as far as Google Maps API is accessible, DITS/DIMS can be used in any country. Figure 12 show DITS/DIMS demonstrated in outside Japan.



(a) Korea **(b) Philippines** **(b) Malaysia**

Figure 12. International version of DITS/DIMS

4. INTERNATIONAL COOPERATION

One of the important objectives of this project is to expand the framework of the Glocal Monitoring under the international cooperation. On February 25, 2017, the First International Workshop on Constructing Glocal Monitoring System was successfully organized in Tokyo with five invited speakers from overseas and around 100 participants. In August 2018, the International Symposium on the Cloud Remote Sensing, Atmosphere Radiation and Renewal Energy Application (CARE-2018) featuring Glocal Monitoring was co-organized by ISPRS and RADI in Beijing with around 80 participants. In February 2019, 2nd International Workshop on Glocal Monitoring was organized at the University of the Philippines with more than 100 participants. The third international workshop on Glocal Monitoring was organize in January 2020 in Tokyo with around 80 participants. Also, Special Session on glocal monitoring is organized every year at ACRS. Thus, the international cooperation on Glocal Monitoring is expanding (See Figure 13).

(a)1st WS in Tokyo(2017) **(b) Symposium in Beijing(2018)** **(c) 2nd WS in Manila(2019)**

Figure 13. International meetings on Glocal Monitoring

5. CONCLUSION

In this paper, the progress of the Glocal Monitoring project was reported. The important objective of the project is construct practical system for Glocal Monitoring and share the concept and the system within both local and international communities and work together for minimizing the damages of disasters. The Disaster Information Tweeting System (DITS) and Disaster Information Mapping System (DIMS) are now available in any countries where Twitter is accessible. The development of the Daily Information Tweeting System (DITS) and Daily Information Mapping System (DIMS) and connection of satellite data with DITS/DIMS may reinforce the usefulness of the Glocal Monitoring framework against serious disasters.

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