Development of the Glocal Monitoring System

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Abstract: In 2016, Tokai University initiated a project call "Constructing glocal monitoring system for safe and secure society". "Glocal" is the cointed word of "global" and "local". The main concept of the project is to connect the global monitoring system using satellite observation with the local monitoring system using SNS for monitoring disasters and environmental changes. The project was approved by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. Tokai University is receiving MODIS, VIIRS and AVHRR data at it's ground stations one in Shonan Campus and another 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 constructing the Glocal Monitoring System by connecting the satellite data system with DITS. The concept of Glocal Monitoring is expanding. The authors have organized a number of international symposiums and workshops with international partners from China, Philippines, China Taipei, US and some other countries. The latest status of the Glocal Monitoring System will be introduced in this paper.

1. INTRODUCTION

In 1974, Tokai University Research & Information Center (TRIC) was established as a research center mainly focused on image processing Since then, TRIC has been involved in various kinds of research works including remote sensing. 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 for disaster & environmental monitoring, authors have been developing systems for near real time data dissemination (Cho et al., 2007, 2012, 2013).
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 including TSIC. Three students lost their lives at their apartment. The importance of preparing for disasters and emergencies was strongly recognized in the university.

(a) Crashed house **(b) Crack in a parking area** **(c) Rock fall on a road**

Figure 1. Areas damaged by the Kumamoto Earthquake in 2016

Considering the above experiences at Tokai University, the authors have initiated a project call "Constructing glocal monitoring system for safe and secure society" in 2016. "glocal" is the coined word of "global" and "local". The main concept of the project is to connect global monitoring system using satellite observation with local monitoring system using SNS and/or other sensors for monitoring disasters and environmental changes. These days, 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. Considering the advantage of SNS for correcting personal information on the disaster of the local area in timely manner, The authors have been developing Disaster Information Tweeting System(DITS) for disaster information collection (Uchida et al,.2016). Figure 2 shows the conceptual diagram of the Glocal Monitoring Project.

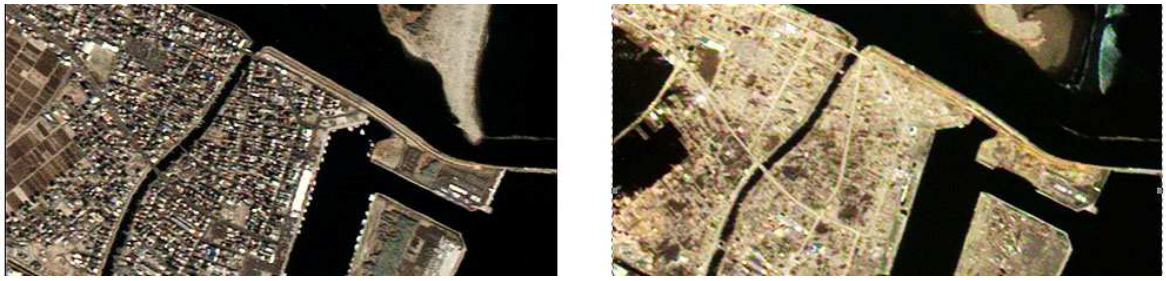
Figure 2. Conceptual diagram of Glocal Monitoring

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. Since then, the authors have been proceeding the project under the cooperation with local and international organizations. This paper describes about the outcome, current status, and future plan of the project.

2. COMPARISON OF DATA EXTRACTION WITH SATELLITES AND SNS

2.1 Global Monitoring with Satellite

Satellite monitoring 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 disaster under the international cooperation (Takahashi et al., 2012). The comparison of the images taken before and after the disaster enhanced the serious damages of a large area. Figure 3 show a pair of satellite images of Yuriage Area, Natori City, Miyagi Prefecture, Japan taken before and after the Japan Earthquake. The images were taken by the optical sensor RSI onboard FORMOSAT-2 satellite. The images clearly show how the area was seriously damaged by the huge Tsunami associated with the earthquake. However, of cause the spatial resolution of satellite images are always limited.



(a) March 11, 2011 **(b) March 19, 2011**

Figure 3. FORMOSAT-2 / RSI pan-sharpen true color composite images of Yuriage Area

2.2 Local Monitoring with SNS

Nowadays, most people are walking with mobile phones, and exchanging personal information through SNS. Many news photos are taken by the ordinally people with their smart phones and disseminated to the world through internet. This means that huge amounts of "personal sensors" are monitoring the society. This is why sometimes SNS is called "social sensor". What you can get from one sensor is limited. However, compared with satellite observation, very local and precise information can be provided from SNS. For an example. if you tweet "The river in front of my house is flooded.", it will be a very important information not only for neighbors but also for the local government. Figure 4 shows an example of tweeting disaster information with a photo recommended by Twitter Japan (2018). However, on the other hand, false information disseminated through SNS is a negative side of SNS which should be treated carefully.

Figure 4. An example of tweeting disaster information recommended by Twitter Japan

3. CONSTRACTION OF GLOCAL MONITORING SYSTEM

3.1 Global Monitoring with Satellite

(1) Antenna System

Tokai University Space Information Center (TSIC) located in Kumamoto Prefecture is a ground station for receiving data from earth observation satellites. With the fully automated system, the multiple satellite date reception is operated with only one engineer. TSIC used to operate four x-band antennas. However, TSIC was seriously damages by the Kumamoto Earthquake in April 2016. Most of the antennas were seriously damaged by the earthquake. After the earthquake, Tokai University has constructed new 2.4m x-band antenna on the top of a 10 story building in Shonan Campus located in Kanagawa Prefecture, Japan in February 2017. Another new 2.4m x-band antenna was constructed at TSIC in August 2018. Currently, those antennas are sharing the reception of data from Aqua, Terra, NPP, and NOAA-20 satellites. Figure 5 shows the outlook of the antennas and locations of TSIC and Shonan Campus.

Figure 5. Location of the two 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 6 show the procedure of the Quick Station. The system was originally developed for Landsat-8 data processing. The images in the figure show the case study results of a land slide occurred in Hiroshima in 2014. 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.

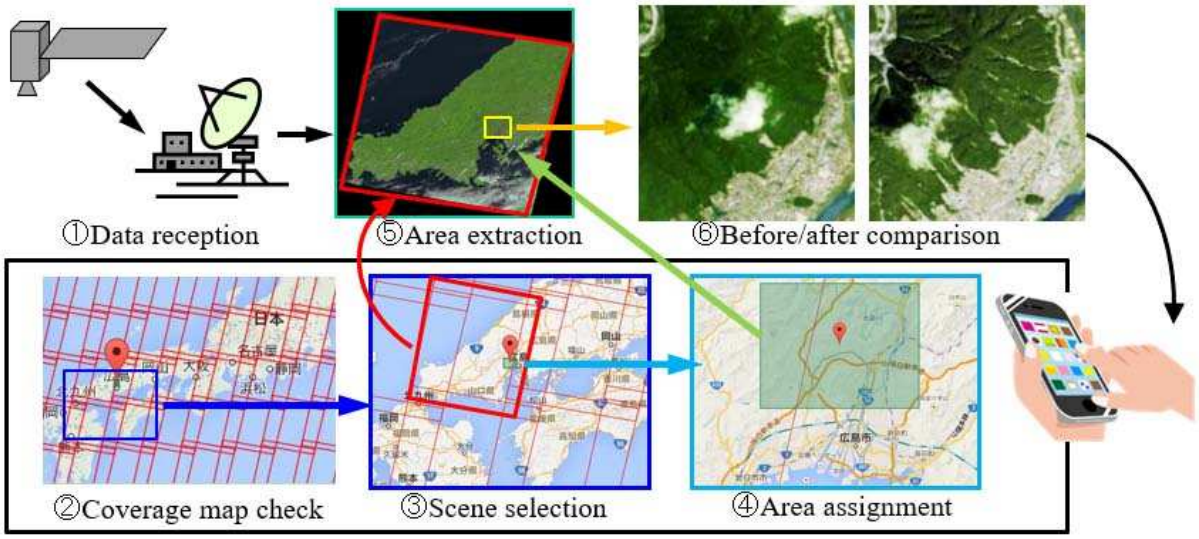


Figure 6. Near real time target area extraction procedures (In case of Landsat8)

3.2 Local Monitoring with SNS

For the past few years, the authors have been developing 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) (2)DIMS (Disaster Information Mapping System).

Figure 7 shows the top page of DITS/DIMS. This system is a web application accessible by any web browser.

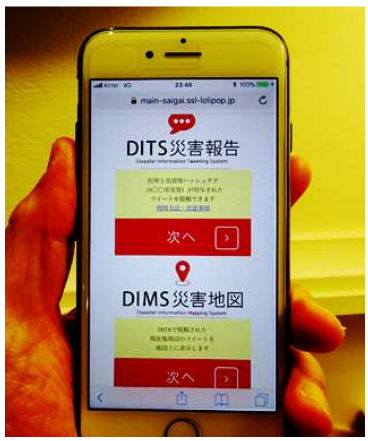


Figure 7. Top page of DITS

(1) DITS (Disaster Information Tweeting System)

DITS is a tweeting system focused on disaster information reporting. When a user tweets, both the user's current geolocation information (street address and UTM Code) and the hashtag of the form "#disaster _(city name)", address and UTM (MGRS) are added to the tweet automatically. So, if the user tweet "The road in front of my house is flooded", the person who read the tweet can recognize the location of the road. Also, the hashtag "#disaster" will help others to understand that the person who tweeted the message is in serious situation. In addition to the text comments, user can upload a photo captured by the smart phone. Figure 8 shows an example of Tweet information to be displayed in the DIMS system. In using tweet information, one of the problems which is specified

all the time is fake tweets. At the time of disasters, many fake information are tweeted like “A lion escaped from a zoo. Watch out!”. However, in DITS, since the user has to register first and the location information of the tweeted place is automatically attached to each tweet, we may expect the reduction of fake information in DITS/DIMS service.

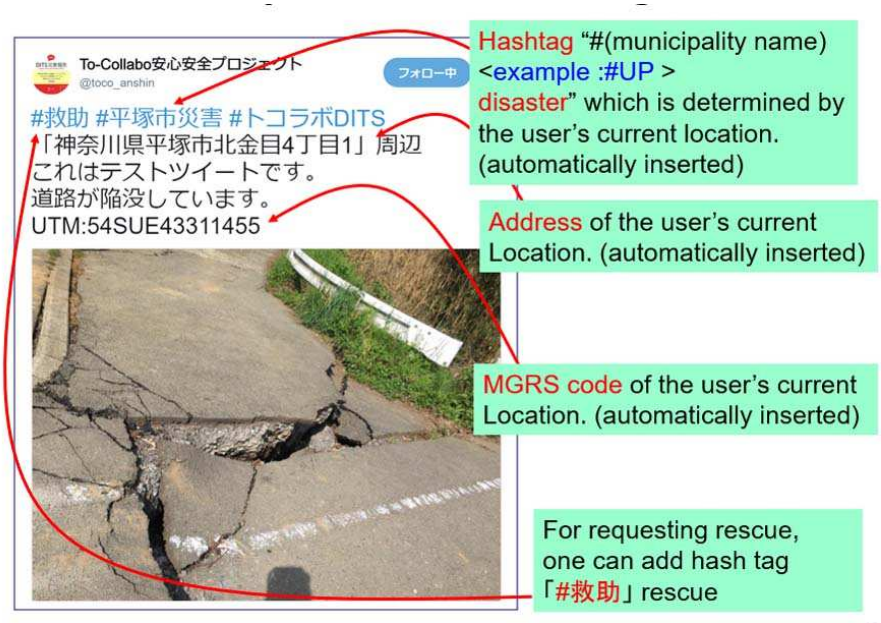


Figure 8. An example of tweet produced with DITS

(2) DIMS (Disaster Information Mapping System)

DIMS is a system that plots the location of tweets posted via DITS on a digital map. Figure 8 shows how the information tweeted using DITS are displayed on a digital map of DIMS. With this system user can easily identify not only the disaster related information of each location but also geographical distribution of tweets submitted from various users. This system was highly evaluated by not a few local governments in Japan. For an example, Hiratsuka City of Kanagawa Prefecture is using DITS/DIMS at their disaster prevention practices.

Figure 9. An example of DITS information displayed on DIMS

3.3 System Integration for Glocal Monitoring

(1) Satellite Image Overlay

Currently, the authors are integrating the near real time satellite image browsing system Quick Station with DIMS (Cho et al., 2017). Figure 9 shows an example of overlaying tweet information on a SPOT-7 satellite image of Aso area of Kumamoto Prefecture taken on April 20, 2016 four days after the magnitude 7.3 earthquake. This figure was produced as a case study. The satellite image clearly shows the huge scale of the the land slide. At the same time, the onsite photo in the tweet helps us understand the real situation of the area damaged by the disaster.

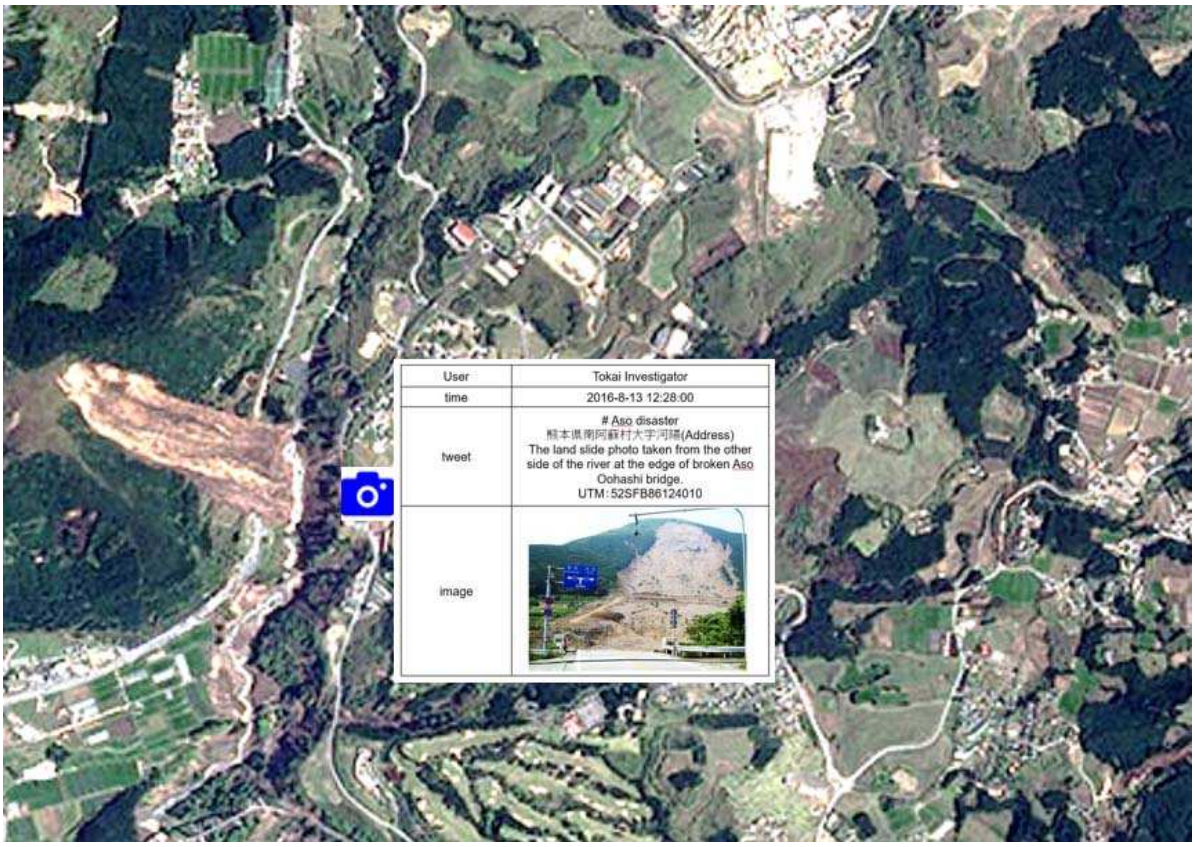


Figure 10. An example of Overlaying a tweet on a SPOT-7 image. Aso Area, Kumamoto Prefecture, (April 20, 2016, ©PASCO)

(2) Daily Information Tweeting System

Through the dissemination activity of DITS/DIMS, the authors have realized the difficulty of users in operating DITS/DIMS. Since DITS/DIMS are system for emergency use, the users don't use DITS/DIMS on their daily lives. As a result, users are likely to forget how to use DITS /DIMS, and become difficult use DITS/DISM at the time of disasters. To solve this problem, the authors have modified the system to be used not only for disasters but also for user's daily lives. The authors have added another "DITS/DIMS" next to original DITS/DIMS. The new DITS/ DIMS stand for "Daily" Information Tweet System and "Daily" Information Mapping System. Figure 11(a) shows the top page of revised DITS/DIMS. The left hand of the page is for reporting daily information and the right hand of the page is for reporting disaster information. Figure 11(b) shows the page for inputting daily information and Figure 11(c) shows the page for inputting disaster information. Since the procedure of operating the system is same, the users may not forget how to use disaster DITS/DIMS at the emergency. The latest DITS/DIMS is accessible from http://glocal-dits.u-tokai.ac.jp/. Since Google Maps API is used in DIMS, as far as Google Maps API is accessible, DITS/DIMS can be used in any country.

(a) Top page **(b) Daily DITS page** **(c) Disaster DITS page**

Figure 11. Daily & Disaster DITS/DIMS

4. INTERNATIONAL COOPERATION

One of the important objectives of this project is to expand the framework of the Glocal Monitoring System under the international cooperation. In December 2016, TRIC exchanged Memorandum of Agreement with the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Science to proceed the mutual cooperation including the Glocal Monitoring. On Febrauary 25, 2017, the international workshop on Constructing Glocal Monitoring System for safe and secure society 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 is planned to be organize in January 2020. Thus, the international cooperation on Glocal Monitoring is steadily advancing.

5. CONCLUSION

In this paper, the concept and progress of the Glocal Monitoring project were reported. The main objective of the project is to connect global monitoring system using satellite observation with local monitoring system using SNS for monitoring disasters and environmental changes to realize safe and secure society. With the use of the satellite data reception system at Tokai University, the near real time satellite data dissemination system for disaster monitoring is approaching the operational phase. The Disaster Information Tweeting System (DITS) and Disaster Information Mapping System (DIMS) are entering the next phase by developing he Daily Information Tweeting System (DITS) and Daily Information Mapping System (DIMS). Based on these experiences, construction of the Glocal Monitoring System by connecting the satellite data system with DITS/DIMS is underway.

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