Glocal Monitoring for Disaster Information Sharing

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ABSTRACT: In 2016, the authors have initiated a project call "Constructing glocal monitoring system for safe and secure society" at Tokai University, Japan. "Glocal" is the cointed word of "global" and "local". The main concept of the project is to connect the global monitoring system using satellite remote sensing with the local monitoring system using SNS such as twitters for monitoring and exchanging information on disasters and environmental changes. Tokai University owns two ground stations, one in Shonan Campus in Kanagawa Prefecture and the other in Kyushu Campus in Kumamoto Prefecture, which are receiving MODIS data from Terra & Aqua satellites, VIRRS data from NPP satellite, and AVHRR data from NOAA satellites. Sentinel-1 SAR data provided from ESA via Internet are also used in this study. In case of disasters, the data are analyzed and archived in near real time. On the other hand, the authors have been operating Disaster Information Tweeting System (DITS) and Disaster Information Mapping System (DIMS) for disaster information collection and sharing. The authors have constructed the Glocal Monitoring System by connecting the satellite data system with DITS & DIMS. The latest status and practical examples of applying the Glocal Monitoring System for flooding etc. are presented in this paper.

1. INTRODUCTION

In recent years, serious disasters are occurring all over the world. WMO says that the number of disasters has increased by a factor of five over the 50-year period [1]. Remote Sensing from satellites is a powerful tool for monitoring large scale disasters. 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 and were provided to Japan [2]. Figure 1 show the ALOS/AVNIR-2 images of Kitakami River, Miyagi Prefecture, Japan before and after the Tsunami associated with the Japan Earthquake. The images clearly show the destroyed coastline and flooded area caused by the Tsunami.

In 2020, the total number of earth observation satellites operating in space has become 971 [3]. The possibility of monitoring disasters from space is dramatically increasing. However, the details of the damages which we can identify 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 [4], [5], [6], [7]. Very local but precise information on disasters can be acquired with SNS. SNS is sometimes called "social sensor". Because so many people are now carrying mobile phones and disseminating various information with them on daily basis, we can consider SNS as a big sensor monitoring the society. Figure 2 shows a tweet example at a time of flooding. The people who are isolated in a building under

(a) February, 27, 2011（JAXA）

(b)March 19, 2011（JAXA）

Figure 1. ALOS/AVNIR-2 images of Kitakami River observed before and after the Japan Earthquake.

the flooded situation are asking for help. This kind of very local information on a disaster cannot be acquired with remote sensing.

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

2. CONCEPT OF GLOCAL MONITORING

In April 2016, Kumamoto Prefecture of Japan was struck by the magnitude 7.3 earthquake. Aso Campus and Kumamoto Campus of Tokai University located in Kumamoto Prefecture were seriously damaged. The importance of preparing for disasters was strongly recognized in the university. Considering the above situations, in 2016, the authors have
initiated a project call "Constructing glocal monitoring system for safe and secure society" at Tokai University. "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. The project was selected as one of the Research Branding Project of Private Universities by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. Since then, the authors have been proceeding the project under the cooperation with domestic and international organizations [9]. The funding by MEXT started in 2016 and continued for four years.

Figure 3. Conceptual diagram of Glocal Monitoring

3. CONSTRACTION OF THE GLOCAL MONITORING SYSTEM

3.1 Global Monitoring from Satellites

Tokai University Research & Information Center (TRIC) is operating two receiving antennas, one in Shonan Campus located in Kanagawa Prefecture and one in Tokai University Space Information Center (TSIC) located in Kumamoto Prefecture (see Figure 4) for receiving data from Terra, Aqua, NPP and NOAA satellites [9],[10]. In addition, the authors are collecting Sentinel-1, 2, 3 and Landsat-8 data occasionally via internet to utilize the data for disaster monitoring. The data received at the antennas are automatically process and archived. In disaster monitoring, comparison of the images taken before and after the disaster is essential. Once a disaster occurs, by specifying the location of the disaster, the system automatically search the data archive and extract the satellite images of the area observed before the disaster.

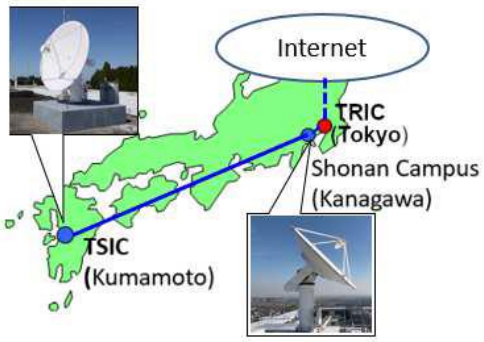


Figure 4. Satellite data acquisition diagram of the Golocal Monitoring System

3.2 Local Monitoring with SNS

To utilize SNS for disaster monitoring, the authors have developed Twitter-based disaster-related information sharing system in 2016 [11]. The system is consisted of the following two subsystems; (1) DITS (Disaster Information Tweeting System) and (2) DIMS (Disaster Information Mapping System). Figure 5 show the relationship of the two systems.

(1) DITS (Disaster Information Tweeting System)
DITS is a tweeting system developed for disaster information reporting. If you have a Tweet account, you do not have to install any software. By accessing to the DITS address from your mobile phone, you can use DITS. Figure 5(a) shows the top page of DITS. By simply answering to three questions, you may tweet your message for an example "The road in front of my house collapsed". When you tweet, current geolocation information (street address and UTM Code) and the hashtag of the form "#disaster (city name)" are added to the tweet automatically. So, you do not have to input address of your location by yourself at the emergency. You can also send a photo if you want.
In using tweet information, one of the problems which always specified is retweet of fake news. However, in DITS, since the user's location information is automatically attached to the tweet, the fake information dissemination may be constrained.

(2) DIMS (Disaster Information Mapping System)
DIMS is a system that plots the location of tweets posted via DITS on a digital map. Immediately after you tweet with DITS, the location of your tweet appears as an icon on the map of DIMS as shown on Figure 5(b). IF you click the icon, then your tweet including your photo will appear on the map. With this system, user can easily identify not only the disaster information of each location, but also geographical distribution of tweets submitted from various places. This system is well accepted by not a few local governments in Japan, and some of them are using DITS/DIMS at their disaster drill.

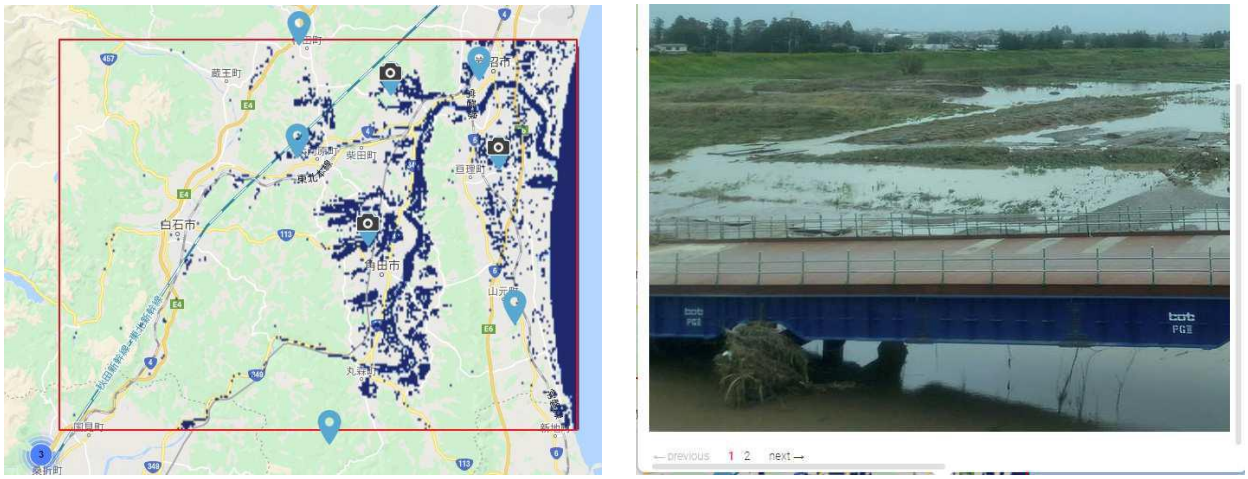
(a) DITS (b) DIMS

Figure 5. The relationship between DITS and DIMS

3.3 Integration of Glocal Monitoring System

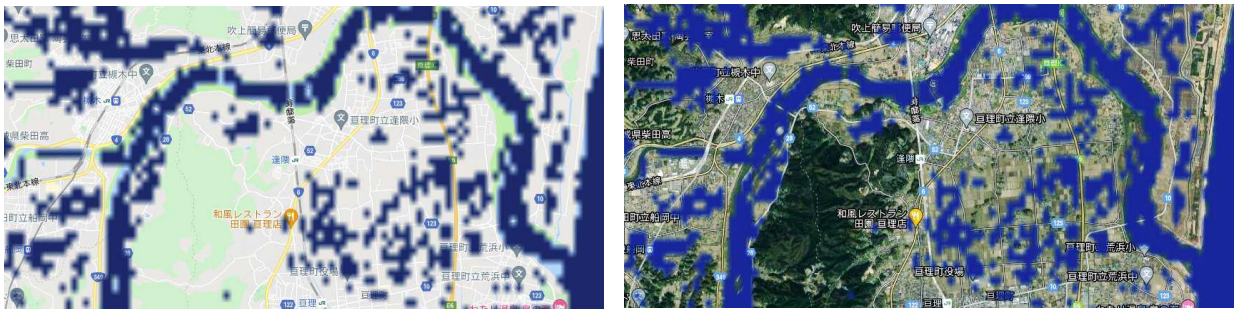
Finally, the authors have upgraded the system to integrate satellite images with SNS information. Figure 6 show the latest outlook of our Glocal Monitoring System. Figure 6(a) shows a map of Abukuma River in Miyagi Prefecture. In October 2019, the area was struck by the typhoon No.19 and the Abukuma River flooded. The dark blue areas on the map are the estimated flooded areas extracted from the Sentinel-1 SAR image of October 12, 2019. The icons on the map show the locations of tweets. If we click the camera icon in the red circle, the local photo uploaded from the point will be pop up on the screen as shown on Figure 6(b). This allows users to understand the real situation of the

disaster. Moreover, this function is also useful for the remote sensing scientists to validate the accuracy of flooded area extraction. Since the extracted flooded areas are overlaid on the Google map in our system, the local people may look into details and comment whether the area were really flooded or not.
The Figure 8 show the comparison of folded area extracted from Sentinel-1 SAR image and the estimated flooded area produced by the Geospatial Information Authority of Japan (GSI) using DEM and the other data. The pattern of the flooded area matches quite well between both images.



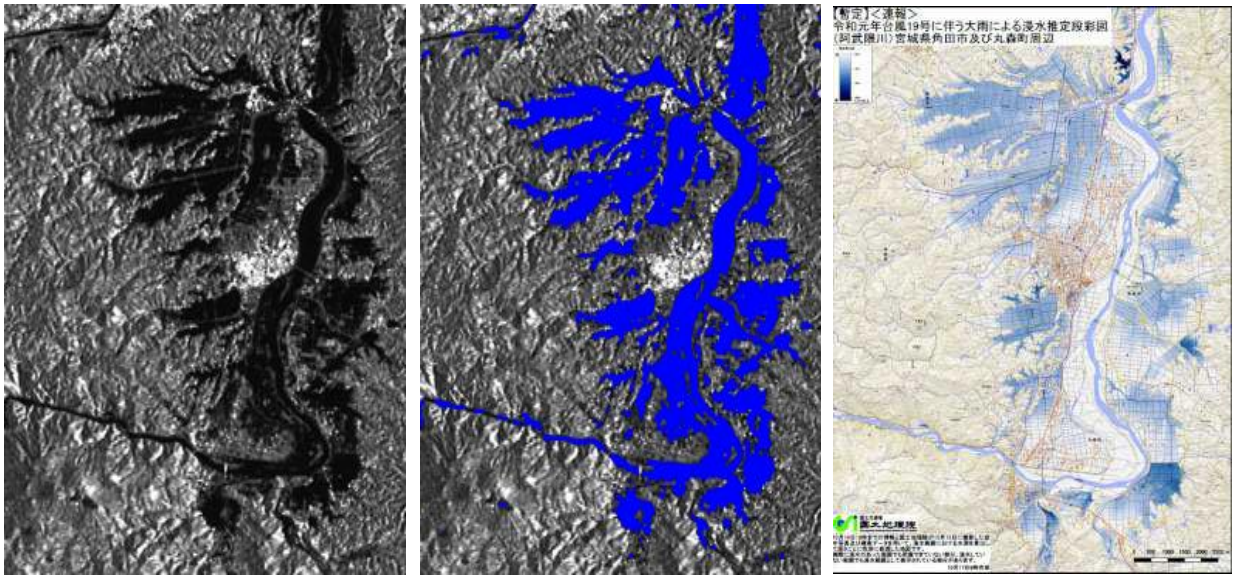
(a) Estimated flooded area overlaid on a map **(b) A photo of the flooded area attached on a Tweet**

Figure 6. The outlook of the display of the Glocal Monitoring System



(a) Overlaid on a map **(b) Overlaid on a satellite/aerial image**

Figure 7. Zoom up image of estimated flooded areas over laid on the Google Map (Abukuma River)



(a) Sentinel-1/SAR VH image observed on Oct. 12, 2019. **(b) Flooded areas extraction from the SAR image** **(c) Estimated flooded area using DEM etc. produced by GSI. (Oct.19, 2019)**

Figure 8. Evaluation of the flooded areas around Abukuma River estimated from Sentinel-1/SAR data

4. PROMOTION OF GLOCAL MONITORING SYSTEM

For the past few years, the authors have been promoting the Glocal Monitoring System, not only in Japan but also in overseas [8]. Many people expressed their interest to the concept of Glocal Monitoring System. Some of them even tries to use DITS/DIMS. However, since it is a disaster information system, most of them do not use DITS/DIMS on their daily life. As a result, they likely to forget how to use DITS/DIMS when they are in emergency. 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" to original DITS/DIMS. The new DITS/DIMS stand for "**Daily** Information Tweet System" and "**Daily** Information Mapping System". With this new DITS/DIMS, the user can tweet daily information like shops, food, and sightseeing. Figure 9 shows the top page of the 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. Since the procedure of operating the system is same in both systems, the users may not forget how to use disaster DITS/DIMS at the emergency. Since Google Maps API is used in DIMS, as far as Tweet service and Google Maps API are accessible, DITS/DIMS can be used in any country. Please join our Glocal Monitoring Project! The latest DITS/DIMS is accessible from http://glocal-dits.u-tokai.ac.jp/.

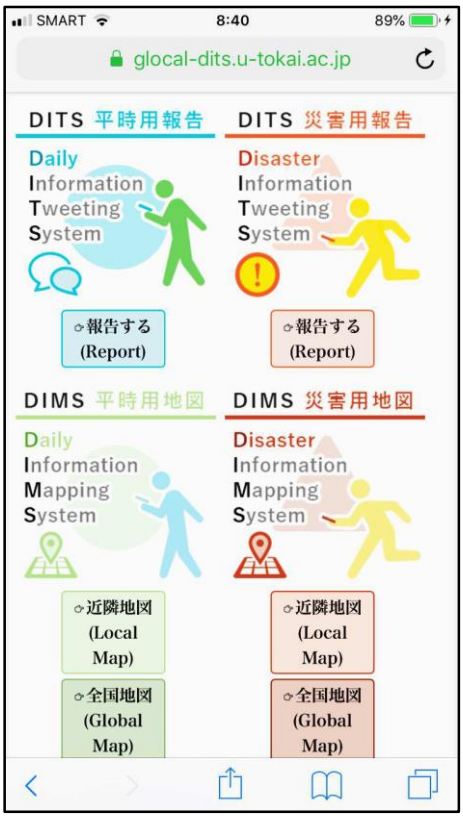


Figure 9. Top page of DITS/DIMS

5. CONCLUTION

Disaster suddenly occurs at unexpected place. We can not stop disasters. However, by utilizing the latest information technologies including remote sensing, we may reduce the damages of disaster. As described in this paper, the authors have been working for years on the Glocal Monitoring Project. 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. DITS/DIMS is a disaster information sharing tool for anyone. DITS/DIMS is now available in any countries where Twitter and Google Maps API are accessible. The authors would like to share the concept of Glocal Monitoring within the international community and work together for minimizing the damages of disasters. Looking forward to your kind cooperation and contribution.

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