INTRODUCTION OF SAFE TAIWAN INFORMATION SYSTEM (SATIS) - AN EMERGENCY REMOTELY SENSED GROUP FOR DISASTER SURVEILLANCE

Tzu-Yin Chang[*1], Chia-Cheng Yeh[2], Shang-Yu Wu[3], Wen-Ray Su[4], Hsueh-Cheng Chou[5]

[1] National Science and Technology Center for Disaster Reduction
9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 231, Taiwan; TEL: +886-2-81958668
E-mail: geoct@ncdr.nat.gov.tw

[2] National Science and Technology Center for Disaster Reduction
9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 231, Taiwan; TEL: +886-2-81958665
E-mail: andrew@ncdr.nat.gov.tw

[3] National Science and Technology Center for Disaster Reduction
9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 231, Taiwan; TEL: +886-2-81958667
E-mail: cat@ncdr.nat.gov.tw

[4] National Science and Technology Center for Disaster Reduction
9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 231, Taiwan; TEL: +886-2-81958672
E-mail: wrsu@ncdr.nat.gov.tw

[5] Department of Geography, National Taiwan Normal University
No. 162, East Hoping Road, Section 1, Taipei 10610, Taiwan; TEL: +886-2-77341645
E-mail: hchou@cc.ntnu.edu.tw

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ABSTRACT: The top five major nature disasters of Taiwan are Earthquake, Typhoon, Flood, Landslide, and Debris Flow, which have caused huge losses of properties and casualties in the past five decades. The managements of these five disasters from monitoring potential disaster areas to disaster warning announcement are divided by the specific authorities. For example, the Ministry of the Interior (MOI) is responsible for earthquake and typhoon hazards; the Water Resources Agency (WRA) is responsible for flood inundations; the Soil and Water Conservation Bureau (SWCB) is for landslides and debris flows. However, when Typhoon Morakot attacked Taiwan in August 2009, it brought nearly 3,000mm of rainfall to Taiwan in August 2009. Even the 24-hour rainfall and 48-hour rainfall achieved respectively 89% and 96% in the world rainfall record. The multi-disaster conditions happened here and there at the same time. Warnings for typhoon, landslides, debris flow, and flooding announced by different authorities had made the public and the rescue teams confused during this severe disaster. After this event, it was found that if a disaster exceeded what a single authority was able to respond, an information integration system based on consolidating various forecasts from the related authorities would be urgently needed. Therefore, Safe Taiwan information system (SATIS), a decision support system for National Emergency Operation Center (NEOC), was established by the National Science and Technology Center for Disaster Reduction (NCDR) in July 2010. An Emergency Remotely Sensed Group, one of the schemes of SATIS, aims to collect the real time disaster intelligence through a multi-platforms mechanism. This multi-spatial and multi-temporal disaster collection mechanism is useful and helps a great deal for disaster assessment.

1. INTRODUCATION

Over two thirds of the land surface of Taiwan is hills and mountains. The average annual rainfall in the mountainous areas can reach between 3,000 and 5,000mm. As the slopes around the mountains are often extremely steep, plus the weakened geological structure after the 921 Earthquake, the torrential rain brought by one single typhoon could easily trigger compound disasters such as flood inundations, landslides, and debris flows. Statistics for the past four decades had shown that the average damages from typhoons each year stand at NTD17.4 billion, approximately 0.33% of the Gross National Product (GNP) of Taiwan.

In August 2009, Taiwan was under the attack by Typhoon Morakot with the near 3,000mm heavy rainfall. The 24-hour and 48-hour rainfall achieved respectively 89% and 96% of the world-record rainfall were achieved respectively during the 24-hour and 48-hour. The typhoon catastrophes-caused by Morakot was the worst during the past five decades for central and southern Taiwan. The multi-disaster conditions happened everywhere at the same time. The large scale landslides occurred at the upstream areas and the inundation were at the downstream areas.

Among the several affected areas, Siaolin Village in Kaohsiung County was given no warning thus was buried under an enormous amount of mud and debris. Hundreds of villagers were either dead or missing. Mid- and downstream plains were also hit hard by the large amount of rocks and trees flushed down by the heavy rains. Once again, the government's ability to cope with the compound disasters proved inadequate. On top of it, there were also other unresolved issues, such as integrated management of the upstream and downstream of rivers, information consolidation mechanism, communication and coordination between the central and local governments during an emergency, disaster prevention preparedness, and transparency of the early warning system. In particular, the impact of a compound disaster that Typhoon Morakot brought exceeded what a single government agency was able to handle. To achieve this, a disaster management decision support system capable of integrating scientific forecasting, acquiring real-time information and distributing resources was urgently needed for the central government for disaster assessments and response.

Since providing positive support for decision-making, the National Emergency Operations Center (NEOC) needs to analyze the information from different stages of the disaster-fighting task under the varied and complicated issues. Therefore, in order to make the information for the decision maker more easily to understand, SAfe Taiwan Information System (SATIS) consolidates and converts the text information from various units into simple charts and diagrams. The satellite and/or airborne images are as well.

2. FRAMEWORK OF SATIS

The SATIS, a decision support system, was designed to integrate the real-time monitoring data on the WEB-GIS platform for preparedness and response of typhoon hazards. The geospatial database of this platform includes the complete basic national geographic data from the National Geographic Information System (NGIS), and hazard maps indicating areas of potential landslide, debris flow and inundation made by the National Science and Technology Center for Disaster Reduction (NCDR) herself. Moreover, the real-time information including accumulated precipitation provided by the Central Weather Bureau (CWB), rivers and reservoirs status provided by the Water Resources Agency (WRA), dynamic images of potential debris flow rivers provided by the Soil and Water Conservation Bureau (SWCB), and traffic information and bridges and roads safety surveillance provided by Directorate General of Highways (DGH) and forecast information including the prediction of typhoon tracks, rainfall forecast, and radar estimate precipitation provided by the Central Weather Bureau (CWB) are all consolidation on this platform. The early warnings in accordance with hazard risk reports analyzed from the integrated information on the SATIS are delivered to the NEOC and help the decision-maker to make the right decisions in disaster preparedness. Figure 1 demonstrates the operating system of SATIS while a typhoon attracted Taiwan.

Figure 1. The operating system of SATIS

Moreover, disaster reports collected by the remote sensing are also overlapped on the SATIS to evaluate damage scales for disaster response and relief. The SATIS has proven the effective function for the flood inundation on Jul. 26, 2010. The achievement was affirmed and valued by related officials and supervisors. The establishment of disaster prevention and relief database in combination with various disaster analysis models is another expansion scheme of SATIS. Therefore, the regular maintenance and system stability are a big issue for the current designated platform in the future.

3. FRAMEWORK OF ERSG

The Emergency Remotely Sensed Group (ERSG), a scheme of SATIS, aims to collect the real time disaster intelligence across large areas without the need of entering into these areas. It is useful for the NEOC disaster management through mitigation, response and recovery in time.

Four intelligence surveillance squads, the basic map squad, the satellite photogrammetry squad, the aerial photogrammetry squad and the image processing squad, are included in this group (Figure 2). The duty of basic map squad is to provide the national basic map, digital terrain model, land cover/ land use map and detail facilities information. The satellite photogrammetry is requested to offer the optical and/or radar satellite imagery from domestics or overseas, such as Formosat-2, SPOT and PALSAR. The aerial photo and unmanned aircrafts (UAV) images are provided by the aerial photogrammetry squad. The interpretation and classification will be undertaken for the all raw images in the affected area by the image processing squad. Finally, the integrated intelligence delivers to NCDR and then present to NEOC for hazard mitigation.

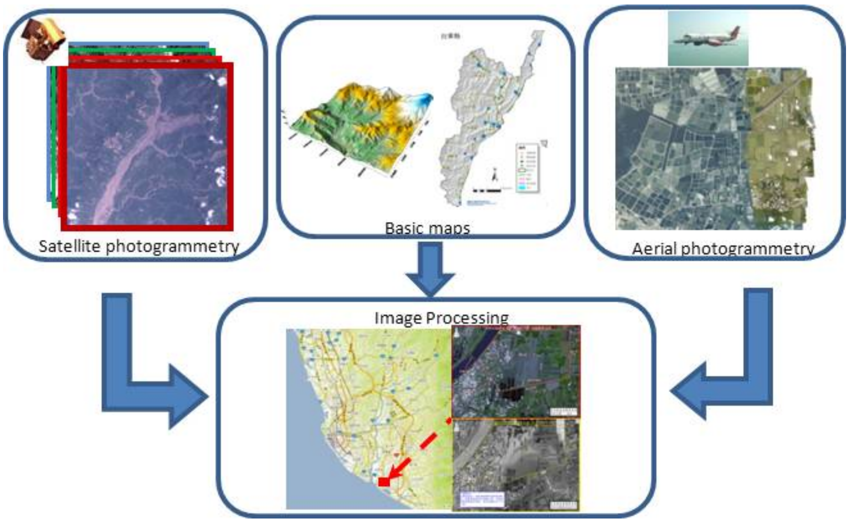

Figure 2. Four squads of an emergency remotely sensed group

4. CASE STUDY: OPERATIONS IN TYPHOON MEGI

In October 21, 2010, Typhoon Megi brought 114 centimeters of rain in Ilan county over 48 hours. Rain record from Megi typhoon caused massive mud and rock slides along the eastern coast of Taiwan caused a Buddhist temple is berried where three people killed, and many vehicles were trapped on the SuHwa Highway, one bus of them carrying 19 Chinese tourists was missing. After the weather conditions turned better, relevant investigations such as Formosat-2 and aerial photos were immediately provided by National Space Organization (NSPO), Agricultural and Forestry Aerial Survey Institute (AFASI) and SWCB to assess the size and status of the affected areas.

Figure 3 shows the integrated disaster intelligence acquired from ALOS/PALSAR, Formosat-2 and aerial photo images. All information was delivered to NCDR for image processing and disaster classification. The reports of landslides on the SuHwa Highway were not only posted on SATIS but also presented in the NECO meeting for disaster assessment and disaster relief. Finally, more than 200 rescue workers were asked to look for the missing people across the rock trail among mountainside and coastal area on foot.

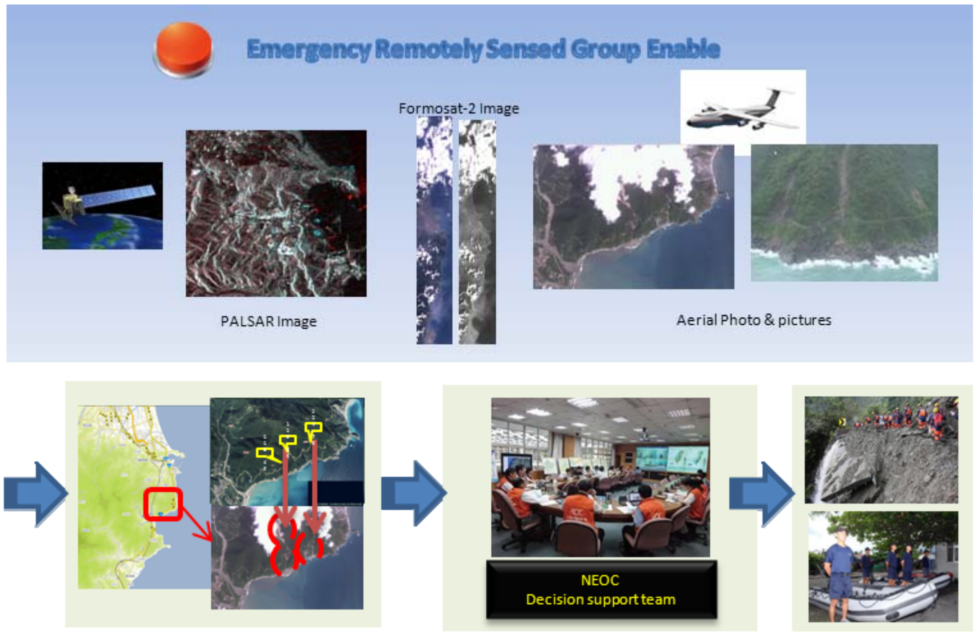

Figure 3. The disaster surveillance from ERSG for hazard mitigation

5. CONCLUSIONS

This study demonstrates the contribution to Taiwan from the SATIS provides a decision support platform to coordinate the various surveillance information and real-time remote sensing data for disaster assessment and management. ERSG, a multi-sensors mechanism for disaster surveillance, did help a great deal when the Typhoon attacked in 2010. However, disaster preparedness should be the priority in disaster prevention and relief. Remote sensing technology applied in environmental and disaster prevention can effectively minimize losses in natural catastrophes. Until now there has been no way to undertake such a comprehensive and integrated system anywhere in Taiwan.

The history of major natural disasters in Taiwan shows that heavy rainfalls are inevitable natural factors. Although remote sensing is not as accurate as the results of direct land surveying, its satellite images provide an overall understanding of large areas and its interpretation can also serve as reference for follow-up field investigation.
Moreover, large quantities of data and images can also be used in combination with different models of disaster progress assessment; and such analyzed results can help the decision-maker to achieve the multiplied effect of obtaining a quick picture of the emergency and prompt evaluation of likely damages. It is expected that this system will further improve our competitiveness in cutting-edge disaster investigation, which will lead to disaster prevention and mitigation.

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