

FORMOSAT-2'S EFFECTIVENESS TO TAIWAN'S PUBLIC EDUCATION

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ABSTRACT: Public education is undoubtedly a very important aspect for a country to develop space program. People have the rights to understand how the tax they paid is being used. This paper addresses the effectiveness of FORMOSAT-2 on public education in Taiwan. As the first remote sensing satellite of the National Space Organization (NSPO) of Taiwan, FORMOSAT-2 is a small satellite of 746 kg mass for two remote sensing missions: Earth and upward lightning observations. The mission orbit is sun-synchronous of 888 km altitude for exactly 14 revolutions per day. For earth observation, the payload is an advanced high resolution remote sensing instrument (RSI) with ground sampling distance (GSD) 2 m in panchromatic (PAN) band and 8 m in four multi-spectral (MS) bands. For upward lightning observation, the payload is an imager of sprites and upper atmospheric lightning (ISUAL). After more than two years of Earth observation started in June 2004, the effectiveness of FORMOSAT-2 images on public education in Taiwan is very promised. Five domestic universities and one private company in Taiwan have signed contracts respectively with NSPO to take the roles of satellite image investigator and distributor. A private company has signed contract with NSPO to generate and provide URMMap (= your map) in its website for general public applications by using FORMOSAT-2 images. The Newtonkids Book Company used FORMOSAT-2 images to publish a kind of calendar for children education purpose. Besides, a science team in National Cheng Kung University (NCKU) is doing the research work on the 3820 (up to 30 June 2006) transient luminous events (TLEs) observed by FORMOSAT-2.

1 INTRODUCTION

FORMOSAT-2, the first remote sensing satellite (RSS) owned by the National Space Organization (NSPO) of Taiwan for the observations of earth and upward lightning, was called ROCSAT-2 formerly. It was launched from Vandenberg, California on 20 May 2004. There are two payloads onboard FORMOSAT-2: the remote sensing instrument (RSI) as the primary and the imager of sprites and upper atmospheric lightning (ISUAL) as the secondary. On 4 June 2004 RSI took its first image, and on 4 July 2004, ISUAL captured a red sprite event for the first time. Since then we have used FORMOSAT-2 to observe the disastrous areas caused by typhoons, South Asia seaquake and tsunami, Hurricane Katrina, etc. [1-5]

After the launch of FORMOSAT-2, five domestic universities and one private company signed contracts with NSPO to take the responsibilities of domestic satellite image investigation and distribution in Taiwan. It is very particular that each university

takes different role in compatible with its own unique capability. Three of them are briefly introduced in this paper: National Taiwan Normal University (NTNU), National Cheng Kung University (NCKU), and National Central University (NCU). Then three other activities and events are presented. All are related to the popularization and public education of FORMOSAT-2 images in Taiwan. These activities and events are: (1) generation and provision of URMMap (that is, your map) by OleMap Incorporation, (2) publication of children calendar by Newtonkids book company, and (3) research in the transient luminous events (TLEs). [6-7]

2 IMAGE INVESTIGATION AND DISTRIBUTION CENTERS IN UNIVERSITIES

2.1 NTNU

Public education is no doubt a very important aspect for a nation to promote space technology development. Among the many ways of public education, one is to educate young students in the high schools. In Taiwan, NTNU is the oldest university dedicated to the growth

of high school teachers. Therefore it is very valuable and efficient to seed these to-be-teachers, and hope them to spread the seeds to their students in the future. Under this thinking, NTNU established the FORMOSAT-2 Image Application and Distribution Center (IADC), and have IADC to sign a cooperation contract with NSPO on 21 December 2004.

Upon receiving Level 1 image data from NSPO, IADC uses the position and attitude information of FORMOSAT-2 to do systematic correction and geometric mapping to get Level 2 product. The next step is to make precise geometric correction for Level 3 image by using the local ground control point (GCP) information. Finally with the aid of a 40 m grid digital terrain model (DTM), the Level 4 image can be obtained. The 2 m ground sampling distance (GSD) panchromatic (PAN) and 8 m GSD multi-spectral (MS) images are then used to generate the 2 m GSD color image through the process called image fusion. In 2005, NTNU cooperated with NSPO to generate the image of Taiwan Island as shown in Figure 1. In the area of value-added image, IADC is capable of generating the three-dimensional (3D) image from two-dimensional (2D) FORMOSAT-2 stereo pair. The website of IADC is iadc.geo.ntnu.edu.tw



Figure 1 FORMOSAT-2 image of Taiwan Island

2.2 NCKU

There are two research centers in NCKU working on the roles of earth observation and using FORMOSAT-2 images: the Satellite Geo-Informatics Research Center (SGRC) and the Disaster Prevention Research Center (DPRC). On 8 April 2004, DPRC signed a contract with NSPO to promote the applications of FORMOSAT-2 images in disaster prevention and monitoring. DPRC is obliged to take the advantages of high resolution, daily revisit, near real-time and low price image data provided by NSPO to perform analysis for national specific needs. The specific needs include disaster prevention, rescue, seriousness discretion of disastrous area, build up of historical database, environment monitoring, etc. The website of DPRC is rs.dprc.ncku.edu.tw

2.3 NCU

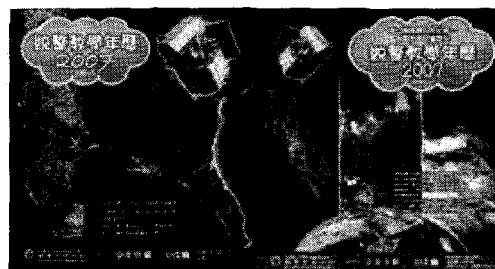
The Center for Space and Remote Sensing Research

(CSRSR) of NCU was established on 1 July 1984, and has been developed to become one of the major institutes in the world. Its missions include the research and teaching of space and remote sensing related sciences, the development of new remote sensing technologies, the study of new applications of remote sensing, etc. There are about 100 personnel working at the center consist of full time staffs and part-time professors and students. Many of them are jointly appointed with other departments where they offer courses and supervise graduate students related to their relevant expertise.

The theme of CSRSR is “Conducting of Earth and Space Observations”. Under this theme, the center focuses principally on remote sensing. The research applications encompass many diverse areas, such as resources remote sensing, atmospheric remote sensing, microwave remote sensing, hydrology remote sensing, geology remote sensing, pattern computing, artificial intelligence & pattern recognition, satellite surveying & navigation, GIS, digital photogrammetry, geo-computation, etc. There are three research groups in CSRSR: Remote Sensing Group, Spatial Information Group, and Space Sciences Group. The website of CSRSR is www.csrnr.ncu.edu.tw

3 CALENDAR FOR CHILDREN EDUCATION

Under the authorization of NSPO, the Newtonkids Book Company has published a year 2007 calendar for children education purpose. A small cute robot is used to represent the FORMOSAT-2. Role of the cute robot is to be a space investigator. Figure 2(a) is the cover page of the calendar for junior students of elementary schools while 2(b) is the cover page of the calendar for senior students. Both calendars use the image taken by FORMOSAT-2 in 2006. As the space investigator, the cute robot asks a very interesting question each month to test the students. The correct answer is provided inside the page.



(a) For junior students (b) For senior students

Figure 2 Cover pages of calendars for the education of elementary school students published by Newtonkids

4 URMAR

The OleMap Incorporation started to develop the URMMap system at about one year ago. It is already a very mature system and handy for application by the general public of Taiwan or the foreign travelers in Taiwan. There are three kinds of map, satellite image map, regular map and electronic map. Many messages and information have been implemented in the maps. For the details please visit the website www.urmap.com.tw

5 PROMOTIONS DONE BY NSPO

5.1 In Urban Land Utilization

FORMOSAT-2 images have been used as reference for large scale urban planning, as well as for monitoring periodically the urban environment and development currently. The purpose is to understand the degree of city expansion and to restrict and prohibit land abuse or over-development. Figure 3 shows the Taichung metropolitan area. Changes in urban view and environmental surveillance can be monitored and used as reference for future city planning.



Figure 3 FORMOSAT-2 image of Taichung metropolitan area

5.2 In Agriculture and Forest Monitoring

Taking advantage of the plants' light reflection property at near infrared frequency, the currently status of farm crops and forest can be identified and monitored. The yellow parts in the Figures 4(a) and 4(b) are areas currently not being cultivated.

5.3 In Disaster Evaluation

The FORMOSAT-2 images of disaster areas can be enlarged and observed in order to obtain more detailed information. In Figure 5, the disaster evaluation of the Wufong Township of Hsinchu County had been made from the image captured by FORMOSAT-2 after Typhoon Aere occurred on 24 to 25 August 2004. The disaster areas of mud flow and soil collapsing were identified clearly and explained accordingly.



(a) Near infrared image (b) Fusion image

Figure 4 FORMOSAT-2 images show areas (in yellow) not cultivated, Hsinchu

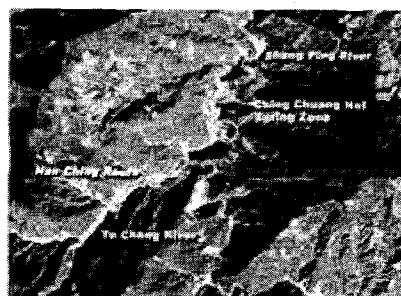


Figure 5 Collapsed soil, landslide and mudflow disasters, Wufeng, Hsinchu, 11 July 2004

5.4 In Environment Monitoring

Periodically monitor the storage and pollution in water sources, reservoirs, and rivers in order to control the status of water supply; monitor the changes in national park and ecological environment protection zone; and monitor the trash disposal, industrial wastes and spoils. Figure 6 shows the mouth of Daan River which can be used to monitor the water pollution.

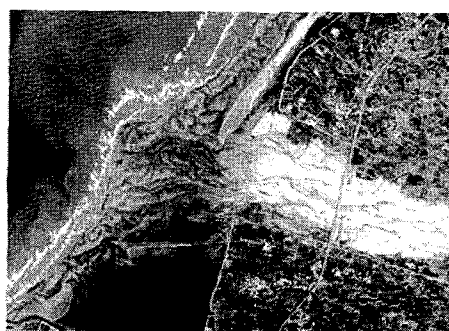


Figure 6 FORMOSAT-2 image of Daan River

5.5 In Ecological Environment and Resources Research

Provide images of the ecological environment for the research and analysis of the ecological resources, and for the participation and promotion of the global ecological preservation and research activities. Figure 7 shows the Dongsha Islands. Its complete coral reef and abundant ecological environment have made Dongsha Atoll a fascinating place for researchers

worldwide.

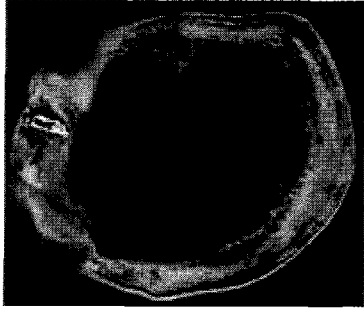


Figure 7 FORMOSAT-2 image of Dongsha Atoll

5.6 In Tourism and Traveling

As shown in Figure 8, by adding remarks, descriptions and travel routes to the FORMOSAT-2 image, it can be used as the guide map for tourists and tour planning.

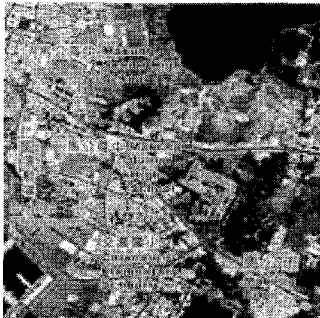


Figure 8 Makung City with remarks and descriptions

6 TLEs OBSERVATION RESULTS

Up to 30 June 2006, 3820 TLEs have been captured by ISUAL, including 3073 emissions of light and VLF perturbation due to EMP sources (ELVES), 380 red sprites, 358 halos and 9 gigantic jets (GJ) (VLF = very low frequency, EMP = electromagnetic pulse). The worldwide distribution is shown in Figure 9.

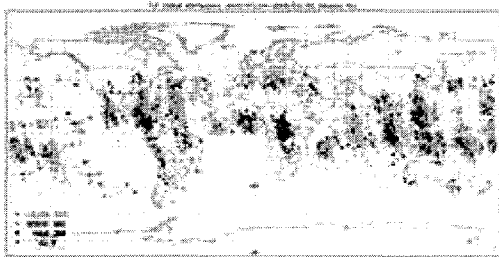


Figure 9 Global distribution of TLEs captured from 4 July 2004 to 30 June 2006

The website of NSPO is www.nspo.org.tw

7 CONCLUSIONS

FORMOSAT-2, the first Earth observation satellite of

ROC, has been working on its mission orbit of 888 km for more than two years. Within the past two years, the effectiveness of FORMOSAT-2 images in the public education in Taiwan has been evidenced by many facts. Five research centers of different universities and one private company have become investigators and distributors of FORMOSAT-2 images. Newtonkids Book Company has published calendars for 2006 and 2007 dedicated to kids education. OleMap Incorporation has developed the URMMap (your map) system for general public use. NSPO has promoted the applications of FORMOSAT-2 images in various aspects include urban land utilization, agriculture and forest monitoring, disaster evaluation, environment monitoring, ecological environment and resources research, etc. A total of 3820 transient luminous events have been captured up to 30 June 2006. All these facts indicate that the effectiveness of FORMOSAT-2 in public education is very promising.

8 REFERENCES

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