CAPACITY BUILDING IN APPLICATIONS OF REMOTE SENSING AND GIS FOR DISASTER MANAGEMENT

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ABSTRACT

The Asia-Pacific region is one of the worst disaster affected region in the world and in terms of disaster-related deaths, six of the top ten countries are from Asia. Longer-term statistics on disaster occurrence and casualties shows continuous increase over the last three decades in the region and it is expected to get worse due to climate change which has a negative impact on hydro-meteorological disasters. There is an urgent need for effective disaster management in the region and satellite remote sensing offers an opportunity to address this issue to a great extent. With the advances in space science and technology, more and more good quality satellite data are getting available both in terms of resolution and variety (optical and microwave), which can be used effectively for disaster management. However, not enough capacity exists in many of the developing countries of the Asian-Pacific region to make use of satellite data effectively in disaster management. This is particularly true for the satellite data available through the Sentinel Asia Project initiated by the Japan Aerospace Exploration Agency (JAXA). Sentinel Asia is consortium of a few space agencies from the region to provide satellite data to a country immediately after a disaster event. As a part of the capacity building effort, JAXA has initiated a program called Mini-Project in 2005 through the Asian Institute of Technology (AIT) in Bangkok. This capacity building project targets most prevalent disasters in the south and south-east Asian countries by selecting relevant agencies, providing need-based technical support, imparting training for handling satellite data, conducting field verifications and guiding them to achieve tangible results. Several projects have been taken up in areas like flood, landslide, drought, earthquake, forest fire, tsunami, volcano monitoring etc. in 14 countries of the region involving national mapping agencies as well as disaster related or development agencies. The results of the Mini-Projects are further disseminated for greater benefits of the society in respective countries.

1. INTRODUCTION

The Asia-Pacific region is prone to a wide variety of natural disasters. According to the EM-DAT database, between 1975 and 2006, while the region experienced 37% of number of world's disasters and 44% of economic losses, it suffered more than 57% of total number of global mortality and 88% of the affected populations. Unfortunately, this trend has continued in subsequent years. In 2007, 37% of natural disasters recorded by the EM-DAT database occurred in Asia alone accounting for 90% of all the reported victims and 46% of economic damage. In 2008, out of the 10 worst disasters in terms of total human losses nine occurred in the Asia-Pacific region and consequently 98% of people killed by natural disasters worldwide were from Asia. The same year witnessed two disasters of historical dimension, Cyclone Nargis in Myanmar and the Wenchuan earthquake in China, both in Asia, causing large-scale death and destruction. No mega-disasters occurred in 2009, the event ranking highest in death toll was the earthquake in Indonesia on September 30 which killed over 1,100 people, followed by a series of typhoons and floods that caused many deaths, making Asia once again the most affected continent. Asia-Pacific region accounts for 42% of the world's natural disasters and 65% of their victims and therefore, unsurprisingly, the region occupies the top spot in the list of world's regions for most of the disaster related indicators.

With the growing occurrences and impacts of disasters in the Asia-Pacific region, there is an urgent need for effective disaster management in the region. With the advances in space science and technology, more and more good quality satellite data are getting available both in terms of resolution and variety (optical and microwave), which can be used effectively for disaster management. This has also brought tremendous opportunities to the user community for using such a wide range of datasets in areas such as disaster management and environmental monitoring. There is a regional initiative called 'Sentinel Asia' under the leadership of Japan Aerospace Exploration Agency (JAXA) in which several space agencies from the region are members and it aims to carry out emergency observations during a disaster and provide satellite images to the affected countries. Unfortunately, there is not enough capacity in many of the developing countries of the Asia-Pacific region for making use of these datasets at the time of disasters. Therefore, JAXA has taken a capacity building program called 'Mini-Project' which is being implemented through the Geoinformatics Center (GIC) of the Asian Institute of Technology (AIT).

GIC has nearly 15 years of experience in capacity building in Asia-Pacific region in applications of remote sensing and GIS. Since its inception in 1995, the Center has carried out a larger number of training programs, drawing participants from more than 25 countries and, till date, more than 1,000 persons have been trained. Although at the initial years of its operation, the training courses were limited to basic remote sensing and GIS applications, but over the years this has been expanded to other areas such as disaster management, environment management,

natural resources management, poverty mapping etc. Modelling and integration of remote sensing and GIS data to models for developing applications in various disasters such as flood, landslide, drought, earthquake, forest fire, tsunami, volcano monitoring etc. is also a major focus of the Center.

2. PROJECT IMPLEMENTATION METHOD

JAXA sponsored Mini-Projects are being conducted by GIC since 2005-06 in 14 countries of Asia as shown in Table 1, covering a wide range of disasters such as flood, cyclone, tsunami, earthquake, volcano monitoring, forest fire etc.

Table 1. List of Mini-Projects implemented since 2005

Country	Year	Areas
Bangladesh	2005-06	Flood
	2006-07	Flood
	2007-08	Flood
	2008-09	Flood
	2009-10	Cyclone
Bhutan	2007-06	Disaster Info. System
	2008-09	Landslide
Cambodia	2005-06	Flood and LU Change
	2006-07	Flood
	2008-08	Flood
China	2006-07	Flood
Indonesia	2007-08	Tsunami
	2009-10	Landslide
Kyrgyzstan	2009-10	Earthquake
Laos	2006-07	Flood
	2007-08	Flood
	2008-09	Flood
	2009-10	Flood
Mongolia	2008-09	Drought
	2009-10	Drought
Myanmar	2007-08	Flood
Nepal	2004-05	Earthquake
	2005-06	Flood
	2006-07	Flood
	2007-08	Flood
	2009-10	Landslide
	2009-10	Flood
Philippines	2005-06	Landslide
	2006-07	Landslide
	2007-08	Volcano Monitoring
	2008-09	Drought
Sri Lanka	2005-06	Landslide
	2006-07	Landslide
	2007-08	Flood
	2008-09	Sea Level Rise
	2009-10	Flood
Thailand	2008-09	Flood
Vietnam	2005-06	Flood
	2006-07	Landslide
	2007-08	Forest Fire
	2008-09	Flood

The Mini-projects were conducted in three phases:
Phase-I: Training and project formulation workshop
Phase-II: Field visits and
Phase-III: Data analysis and report writing workshop

Training and project formulation is the aim of the Phase-I of 4-weeks duration, which is conducted at AIT in the month of September or October. At the beginning of the phase-I, presentations are made by the each project participants about their respective project objectives, data requirements, methodologies and expected outcomes. At the beginning of this phase, participants undergo a week-long training on remote sensing and GIS. The training consists of introduction to optical remote sensing and GIS with adequate hands-on exercises. These includes training on a remote sensing software, image handling, geometric correction, image analysis and classification, while introduction to a GIS software is also given with GIS database management, raster modelling, vector analysis and map composition. ALOS data are mainly used for the training so that participants get enough experience in handling this data. A brief introduction to GPS is also given to the participants. JAXA's ALOS satellite has both the optical and microwave sensors and most of the emergency data acquisition on disaster events are normally made by using the microwave sensors due to its all-weather and day and night observation capability. Therefore, capacity building in microwave remote sensing is very important and a week-long training exclusively on microwave remote sensing is done in the Phase-I. Microwave remote sensing is an excellent technology for environment monitoring as well as emergency observation of disasters, especially south and south-east Asian countries, where cloud coverage is high and a major problem for timely data acquisition. Lessons on SAR basics, backscatter characteristics, calibrations, noise/speckle reduction and data fusion are given in the training. Lessons on rainfall downscaling is also given in this phase, which can be used for rainfall forecasting. Rainfall downscaling is very important for Mini-Projects particularly those related to hydro-meteorological disasters as well as environment problems. Most of the Mini-Projects require Digital Elevation Model (DEM) as a basic input data and a training on creation of DEM from ALOS data is also given.

After the training, participants are regrouped according to their project themes and relevant models are introduced to them. For example, all the participants working in floods will be separated to undergo training on flood modelling and so on. Each group will then work on project formulation and methodology development specific to their respective study areas. To review the progress of each project, presentation sessions are organized at the end of third and fourth week and detail discussions are held for each project.

Figure 1. Workshop at AIT during 2009-2010

Immediately after the Phase-I, field visits are conducted jointly with the participating agencies for field verifications and using

ALOS data, if available. Field visits are mainly focused in collection of land use and land cover information which are later used as training samples for image classifications. Participants also get first-hand experiences in collecting data in the field, which would eventually be helpful for them to implement any other projects with applications of remote sensing data in future. In some of the projects, household sample surveys are carried out by interviewing local communities for collecting the socio-economic data. Such data are usually integrated in the analysis using suitable methodologies to reflect the socio-economic aspects.

Figure 2. Field visit in Lao PRD during 2009-2010

During the Phase-III, a data analysis and report writing workshop is organized at AIT during the month of January or February of the following year. Individual discussions with participants from each project are first conducted for reviewing the progress after Phase-I. At the mid of first week, a progress review presentation is held in which participants report about the progress they had made after the Phase-I.

Mini-Projects are unique not only in terms of objectives and data requirement but also in terms of knowledge, background and capacity of the participants. Individual consultations are made according to the need of the participants and sincere efforts are made to meet their requirements. Participants are supervised and guided by GIC staff throughout the project period and from time to time inputs are given by the external resource persons. Since the Mini-Projects covers a wide range of topics, GIC brings expert hands from time to time form various fields to implement the project effectively.

Presentations are held from time to time during the Phase-III. Participants and GIC staff participate in the discussions and various suggestions are made to improve the project outputs. This is always a good opportunity for the participants to share their experiences among themselves as well as with the GIC Staff.

3. RESULTS

Mini-Projects have helped in individual and institutional capacity building in applications of remote sensing and GIS in disaster management among the participating agencies from various countries from the Asia-Pacific region. On completion of the Mini-Projects, participants can handle satellite data independently and use them effectively in various applications. Now-a-days emergency data acquisition are often made by satellites immediately after disaster events and those data need to be processed urgently and handed over to concerned authorities for rescues and relief work. In the Mini-Projects methodologies for such emergency data processing techniques are given to the participants, especially projects related to floods. Further, most of the Mini-Projects are aimed at hazard, vulnerability and risk assessment and project participants get practical knowledge on these topics for real-world applications. Hazard, vulnerability and risk assessment are getting increasingly important due to increasing trends of disasters and capacity building in these areas will certainly help in mainstreaming disaster risk reduction in their respective countries.

4. CONCLUSIONS

We recognize the needs for the capacity building in the Asia-Pacific region in applications of remote sensing and GIS for disaster management and the Mini-Projects could be an ideal approach to address such needs. With the increasing availability of satellite data acquired through emergency observations, the capacity building activities in most of the developing countries of the region is indispensable so that countries can process the data quickly by themselves for immediate response activities after a disaster event. With the step by step expansion of JAXA initiated ‘Sentinel Asia’ project in the region, more capacity building activities will be necessary and Mini-Projects framework could contribute to a great extent.