Application of Envisat ASAR Image in Near Real Time Flood monitoring and Assessment in China

Huang, Shifeng
Prof., Remote Sensing Technology Application Center, China Institute of Water Resources and Hydropower Research, Beijing, China

ABSTRACT: China is one of the countries in which flood occurs most frequently in the world and with the current economic growth; flood disaster causes more and more economic losses. Chinese government pays more attention to flood monitoring and assessment by space technology. Since 1983, NOAA(AVHRR), Landsat-TM, LANDSAT-ETM+, JERS-1, SPOT, ERS-2, Radarsat-1, CBERS-1, Envisat have been used for flood monitoring and assessment. Due to the bad weather conditions during flood, microwave remote sensing is the major tools for flood monitoring. Envisat is one of the best satellite with powerful SAR. Its application for flood monitoring has been studied and its near real time(NRT) application can be realized on the basis of real-time delivery of image. During the 2005, 2006 and 2007 flood seasons, over the 31 NRT flood monitoring based on Envisat, had been carried out in Yangtze, Songua, Huaie, pearl river basin. The result shows that Envisat SAR is very useful data source for flood disaster monitoring and assessment.

1. INTRODUCTION
China is one of the countries in which flood occurs most frequently in the world and with the current economic growth; flood disaster causes more and more economic losses. Remote sensing ( RS ) technology has its special superiority and potentiality for disaster monitoring and assessment , so it has been applied for this purpose for a long time in the whole world, especially for the disaster resulting from floods and waterlogging. A lot of scientific and practical achievements have been obtained in this field.

Chinese government pays more attention to flood monitoring and assessment by space technology. Early in 1983, the Remote Sensing Technology Application Center of the Ministry of Water Resources of China ( RSTAC/MWR ) investigated the flood occurred in the Raoli River Basin located in the Sanjiang Plain by means of TM image of Landsat. The information on inundated area and the variation of river channel was successfully obtained. In 1984 and 1985, by using the polar-orbit meteorological satellites, the floods occurred in the Huaie and Liaohe River Basins were investigated separately.

During this period, the airborne SAR image was used for monitoring the flood in the Panjing District of the Liaohe River Basin. After scanning, image processing was done by computer. At the same time, airborne infrared remote sensing was applied for the investigation of distribution of obstacles in the channel of New Yongding River and the location of breaching dike in Sanjiangkou of the East Liao River. Especially from 1987 to 1989, through the cooperation among RSTAC/MWR, Chinese Academy of Science, National Bureau of Surveying & Mapping and Chinese Airforce, the application experiment of RS on flood protection was early or later carried out in the Yongding River, the Yellow River, the Jingjiang District, the Dongting Lake and the Huaie River. A system for quasi-real-time and all-weather monitoring flood and waterlogging was established. It played an important role to the
monitor of the heavy floods in the Huaihe River Basin as well as the middle and downstream basins of the Changjiang River in the year of 1991. After 1991, a lot of experts recognized the importance of real time transmission of image data for reducing the loss to the minimum and suggested to set up the real-time transmission system of airborne remote sensing for disaster monitoring. Through five years’ efforts, this system has been established and applied in 1994, 1995, 1996, 1998 and 1999 respectively. With the development of technology, more and more satellites with SAR have been launched. At present Envisat and Radarsat are the major data source for flood and waterlogging disaster monitoring and evaluation.

2. ADVANTAGES OF ENVISAT ASAR IMAGE IN FLOOD MONITORING

Many kinds of satellite image can be used for flood monitoring. The different image source may be chosen according to different requirement and different conditions, including flood range, time limited, precision, acquirability of data. In general, the following six kinds of remote sensing platform are most widely used in flood monitoring: meteorological satellite, land optical satellite, spaceborne SAR, airborne SAR, mid-resolution EOS/MODIS, and helicopter. Meteorological satellite image and MODIS have characteristics of wide cover range and low spatial resolution, which are fit for macroscopical, widely and dynamic flood monitoring. Both these two kinds and land optical satellite acquire image passively, data quality are importantly depend on weather condition. In this situation, radar, with capability of “all weather” monitoring and capability of penetration, become the best choice. Such as JERS SAR, Radarsat SAR, ESA’s ERS and Envisat are commonly used to monitor flood. In last several years, ESA’s ERS and Canada’s Radarsat-1 were the most ordinary used spaceborne SAR image source in summer flood monitoring in China. Radarsat image mainly used for flood monitoring widely happened on basin scale, ERS image mainly used for flood investigation of local regions. Flood Dragon project brings us much convenience to obtain appropriate radar image as Envisat. In this instance, we have more chance to monitor flood which occur possibly everywhere at any moment, especially in south China. The largest single instrument in Envisat satellite is the Advanced Synthetic Aperture Radar (ASAR), operating at C-band, it features enhanced capability in terms of coverage, range of incidence angles, polarisation, and modes of operation. The improvements allow radar beam elevation steerage and the selection of different swaths, 100 or 400m wide. Through the Dragon project titled ‘Flood Plain Disaster Rapid Mapping and Monitoring’, Envisat ASAR image will be used freely for flood monitoring. In this summer, we used ASAR image in flood monitoring several times. Its capability of acquiring near real-time(NRT) image and “day and night”, “all weather” monitoring, are justly appropriate to flood monitoring.

3. METHOD DESCRIPTION OF FLOOD MONITORING AND ASSESSMENT

2.1. Data Preparation

Data preparation before flooding is the first step of flood monitoring. It includes real-time image ordering, background data collection and processing. Situation of rainfall and runoff are basic information for flood forecasting. Rainfall forecasting information in future days that mainly comes from weather forecast, together with real-time situation of hydrological engineering and water level of every river, lake and reservoir, help researchers making a primary estimation on where flood would occur and when it will happen. Based on the primary analysis, SAR image of the interested region can
be ordered in advance more purposefully. Background data of monitoring area is important. Water body distribution at stage of normal water level will be used for making contrast with image of flood period so as to identify the area flooded or waterlogged, the social data such as population, build and economic data will be used for making damage assessment brought by flood.

2.2. Flood Rapid Mapping

Because flood is so emergent that the ordered image should and must be delivered to the researchers as soon as possible. The Chinese partners can order ASAR image from China Remote Sensing Satellite Ground Station (China RSGS) or ESA EOHelp Desk. If success, the processed images are available to download from ESA servers within several hours after acquisition.

After receiving ASAR raw image, first, we use EnviView software, which is one of software developed by ESA, to read the data and export to Geotiff format image, which can be read by ERDAS IMAGINE software; then we use ERDAS IMAGINE to project image to UTM or other kind of geographic coordination system for matching with background data; third, we compare ASAR image with remote sensing image which is received before flooding, the difference of water body distribution can be quickly identified, the flooded and waterlogged region will be mapped rapidly.

In ordinarily, the method of automatic extraction for water area is more effective than digitalization manually. However, sometimes, it’s difficult to distinguish water body with other body. For example, in mountainous area, mountain shadow is very familiar with water body in SAR image. The digital elevation model (DEM) is useful for judging which regions is flooded and waterlogged. Traditional visual interpretation can take the full advantage of human’s transcendent knowledge and experience, the result is rather credible, however it is also time-consumed and strenuous. Automatic or semi automatic extracting water body is more efficient, but sometime the result is not very good. So it’s better to integrate both of them.

On the thematic map of flood monitoring, the flooded area and waterlogged are respectively marked with red and orange or other color according to relative regulation, and the name of river, lake, reservoir, road, railway and important place, the important hydro-station and the water level should be mapped on as assistant information for identifying the flood situation.

Flood monitoring map is mainly used for peoples to know where flood occur and how about it, and very helpful for decision-maker to make decision for flood control and disaster mitigation.

2.3. DAMAGE ASSESSMENT

Flood mapping is the foundation for flood monitoring and assessment, but not all. It’s more important to know how much loss caused by flood. That is damage assessment. The most important assessed items include casualties, flooded farmland and building area, crucial project and so on. It can be carried out under the function of spatial analysis in geographic information system (GIS). Coupled with land use map, building map, population density and economy gross, probable damage due to flood will be evaluated on the basis of distribution of flooded and waterlogged area.


During 2005,2006 and 2007 flood season, severe floods occurred in the Pearl River, Yangtze river, the Minjiang River in Fujian, main stream of the Huai River and so on. In 2005, with the support of ESA, 16 flood rapid mapping actions in NRT have been carried out by China Institute of Water Resources
and Hydropower Research(IWHR), in 2006, 8 actions have been carried out and in 2007, 7 actions have been carried out.

Fig.1 is the enhanced Envisat ASAR image and flood map of Wuzhou on June 25, 2005, which shows that almost all the riverway were widen because of full of water and no beach was visible. Many regions along Xijiang River were flooded. The probable flooded area is about 97km².

![Fig.1. Flood Monitoring to Wuzhou on June 25, 2005](image)

**Fig.1. Flood Monitoring to Wuzhou on June 25, 2005**

Fig.2 is Envisat ASAR image city and flood thematic map around Wuzhou a few days later. The green color means the flood there had disappeared and the red color means that still in flood, and the pink color means that flooded lastly after June 25. It shows that until July 4, the water level of Xijiang River had fall down on the whole, the flood had become weaken but not disappeared completely. The probable area of flooded is about 18km², it include the old and new flood area.

![Fig.2. Flood Monitoring thematic map of Wuzhou city on July 3](image)

**Fig.2. Flood Monitoring thematic map of Wuzhou city on July 3**

5. DISCUSSION AND CONCLUSION

Dynamic NRT flood monitoring can provide direct basis for people to realize the flood happened and know probable damage, and which is helpful for leader to make proper decision to mitigate possible
loss. However, Many problems or difficulties exit still. It mainly involved two aspects, one is limitative to data source, and the other is impercipient to flood. Because of wide range, it is possible especially in summer flood period that flood maybe happened to several province synchronously, but it’s very difficult to get image of several flood risk regions at the nearly same time, in other words, the cover range of image is not wide enough to satisfied the request to monitor flood at the river scale. Another problem about image is that the special resolution is not high enough to monitor some local but pivotal damage such as to railway and dike and other important engineering. The geologic disaster caused by strong rainfall such as coast, collapse and debris flow and so on happen so frequently and are becoming the main factor that lead to calamity, but many of these scene can’t been recognized expressly depending on image only. Of course the cover range and resolution are inconsistent for a long time. On the side, social and economic data of flood regions is too rough to make exact damage assessment. The other problem is the method for flood monitor and control isn’t perfect because of impercipient to flood itself. If flood monitoring depend on accurate flood forecast and integrate itself into flood forecast gradually then its significance will be more and more great, the first step for us to realize is that more and more flood disaster can be caught real-timely by image and more and more correct flood damage assessment be concluded.

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6. REFERENCES


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