APPLICATION OF REMOTE SENSING DATA FOR MAPPING OF DAMAGE ASSESSMENT OF FLOOD TO THE LAND COVER, AN EXPERIMENT IN PHU YEN PROVINCE - VIETNAM

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ABSTRACT

Vietnam is the country which suffers from many storms and flood every year. Mapping flood damage assessments caused by flooding is very necessary. From the damage assessment, these studies could protect the construction and help to make zone of land use management in the area with regular floods. This project focus on using remote sensing data and GIS database for evaluating flooding area and damage assessment with different type of land use. The study area is Phu Yen province where flood was happened in 2009. Two kinds of satellite images were used, these are Alos PalSAR and SPOT5. The Alos PaLSAR images were used for water extraction whereas SPOT5 images were utilized for land cover mapping. Overlaid analysis of two layers from image processing could be resulted flood damage in land cover.

1. INTRODUCTION

Mapping of losses evaluation due to floods on the land cover is very important for the effective investigation and monitoring of resources and environmental protection for the purpose of sustainable development. Satellite image brings rich information captured on many ranges of frequency, with different space resolution, from medium to super-high and repeated periods of from one month to one day. Many advantages were witnessed in satellite image processing and information exploiting technology, especially having specialized equipment and software for analyzing and interpreting satellite image. Satellite images are stored digitally thus using satellite images to extract information and with the support of image processing modules are considered to be very effective to evaluate, classify land cover. Moreover, exploiting remote sensing image by digital technology also serves in the quickest way as input data for geographical information system. With the ability to provide various information of satellite images and combination with information of GIS, the mapping will be more effective, quicker, more accurate, and more reliable.

Optical satellite image, due to its nature as being captured in visible and near infrared wave lengths is suitable with human sense, clear and user-friendly. However, the main disadvantage of optical image capturing system is that it inactively uses solar energy thus depends on weather conditions. Images captured in cloudy weather are affected to their information quality. Besides, optical satellite image only provides information about reflection and absorbed characteristics of objects on surface in visible waves and near infrared thus the image lacks information about structure and roughness of the studied surface.

Compared to optical imagery, radar imagery using microwave sense with longer wavelength provides more information about surface roughness, material content and structure of surface object on Earth. In addition, with the capabilities of penetration through cloud, radar remote sensing could observe in all weather conditions, day and night. This could ensure more successful and active earth observation. However, geometric distortions such as fore-shortening, layover, shadow… and difficulties in processing are drawbacks remaining in radar images. Therefore, geometric processing, noise processing and information extraction from radar images is more challenging than optical images.

Optical data will be able to provide detailed information of land cover, while as, a quick observation of flood area can be provided from radar data. As a result, integration of both data is promising to enhance their advantages in studying flood effects to land-cover. It would be applied in quick report and assessment of damages of important objects for planning and rescue activities.

2. RESEARCH METHOD

All processing and analyzing satellite imagery for mapping of damage assessment due to flood are described in the flowchart (figure 1)

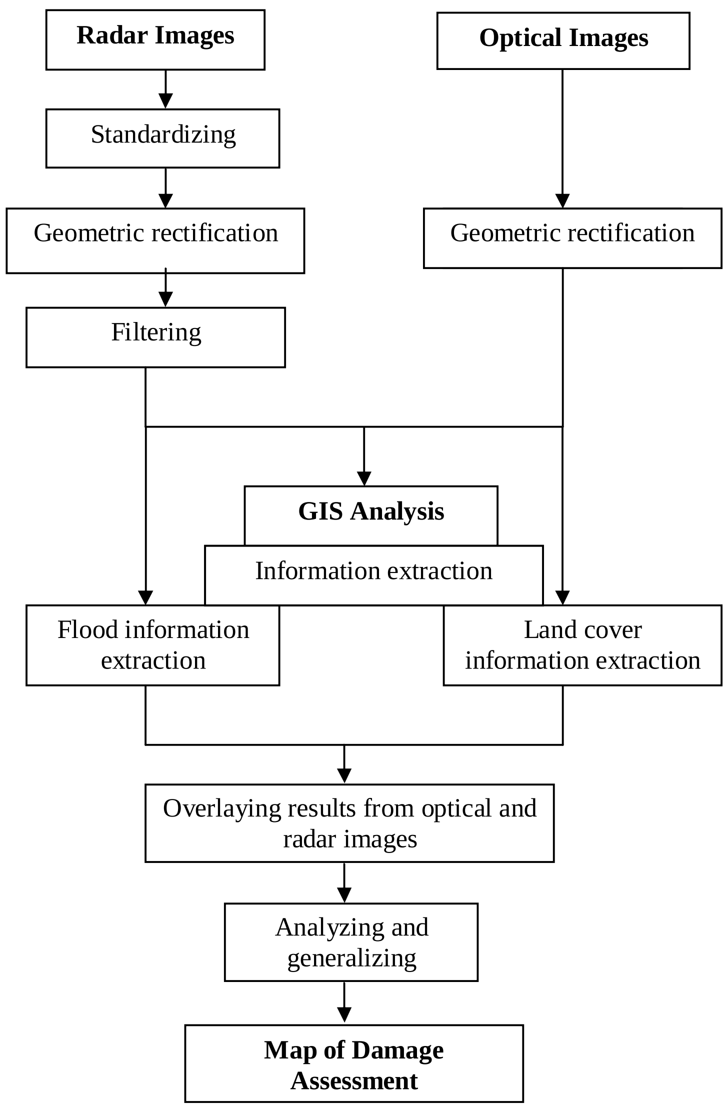


Figure 1: Flowchart of processing and analyzing satellite imagery

The same as other remote sensing data, radar data are also available in digital form. The digital information on the radar data is encoded and represented by 16 bits gray level image. So series of environmental effects and the device effects are averaged. The restoration of the original information in the form of radiation response measured in dB (decibel) from the energy value or the amplitude of the radar image is actually standardization process.

Then the optical satellite images and radar is registered to coordinate system by mapping software PCI (Canada) with required high accuracy that satisfies for image overlaying. Both images were resampled to achieve pixel size equivalent to the native resolution of radar images. Corrected radar images were noise- filtered by such interactive filtering as Lee, Sigma, or Frost.

After geometric correction and noise-filtering on the radar image, the flood information was extracted. This stage was treated in the ENVI software using approach "Density Slice".

Information on land cover is extracted from SPOT5 image by digitizing, mapping land use status of this area, and combining with supervised classification results. This stage is performed on the software ENVI with Maximum likelihood classification algorithms.

Results extracted from the flooded area in radar image and information from the status maps of land cover combined with surface cover information extracted from SPOT5 image, were overlaid to calculate area of flooded object in land cover. This stage is performed on ArcView software.

Analyzing and evaluating the results obtained were based on GIS tools and criteria for evaluating the effects of damage caused by flooding to the land cover.

Damage assessment map is the result of the analysis overlay layers of information and the criteria for damage assessment due to the impact of flood to land cover.

3. EXPERIMENTAL RESULT AND ANALYSIS

3.1 Introduction of study area

Phu Yen is a coastal province in southern Central Vietnam, located in the area of 12042’36” to 13042’28” degrees North and 108040’40” to 109027’47” degrees East, facing Binh Dinh province in the North, Khanh hoa province in the south, Daklak and Gia Lai provinces in the west and the South China Sea in the East. Phu Yen has 70% mountainous areas, the terrain slopes from west to east and divided up. The climate is affected by the hot and humid tropical monsoon, with two seasons: the rainy and the dry, the average temperature is about 27 degrees Celsius. Forests take up two-third of the province’s total area.

3.2 Used materials

Materials used in this study was provided by National Remote Sensing Centre of the Ministry of Natural Resources and Environment. It is demonstrated in the table 1.

Other supporting data and documents:

- Topographical maps
- Statistical annual rainfall
- Total average flow per months.

Table 1: Satellite image data set

No	Type	Date	Status
1	Alos PalSAR	3-3-2009	Before flood
2	Alos PalSAR	3-11-2009	Flood time
3	Alos PalSAR	8-11-2009	5 days after flood
4	Spot5(280-323)	2-12-2008	
5	Spot5(280-324)	20-08-2009	

3.3 Experimental steps

- *Geometric correction of Radar and optical images*

ALOS PALSAR radar and SPOT 5 optical image is processed by PCI software. Coordinates of control points are measured directly in the field by GPS devices. Digital elevation model was established from topographic maps 1:50,000 scale with contours around 20 m which was used to adjust effects of bias caused by the terrain. Optical satellite images are then sampled to 12 m resolution equal to radar images.

- *Filtering and noise removing in radar image*

Some types of interactive filters have been used and the results showed that interactive Lee filters was more effective. After filtering, it removed most noise on the Alos Palsar image, but not losing significant details on the image. Figure 2 shows the Alos PalSAR image before and after Lee filtering after.

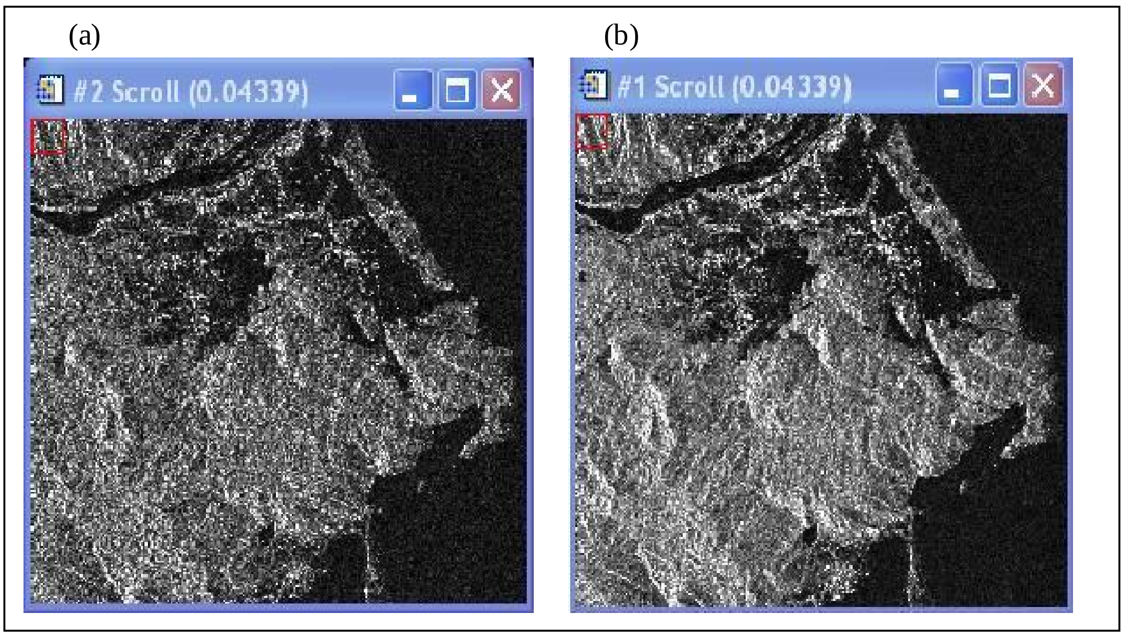


Figure 2: Radar imagery before (a) and after Lee filtering (b)

Extracting flood area was carried out in Envi software. Firstly, flood area was sampled manually and analyzed statistically to calculate minimum, maximum, mean and standard deviation value. From that a range was determined by following equation

Range = mean $\pm$ (n* standard deviation)

Which : n is natural number

Density slicing tool was used to classify min and max range and extract flood area. Checking and adjusting range or samples were repeated until the result showed high accuracy and suitability. Figure 3 shows the statistical table of Alos PalSAR image.

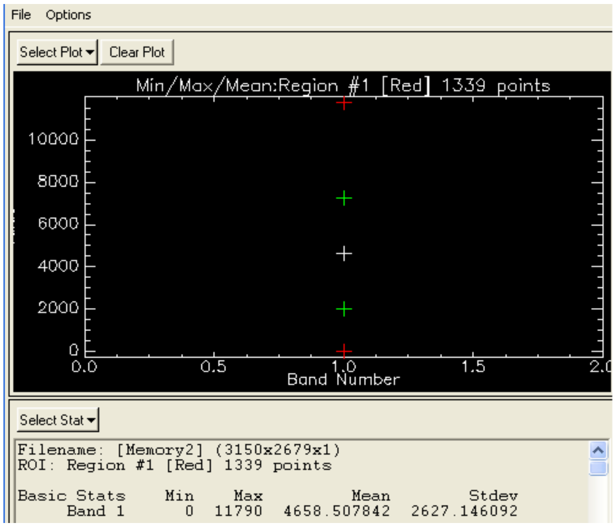


Figure 3: The statistical table of Alos PalSAR image.

After testing, it was found that the range from 0 to 9106.5 was suitable. The result can be shown in the figure 4

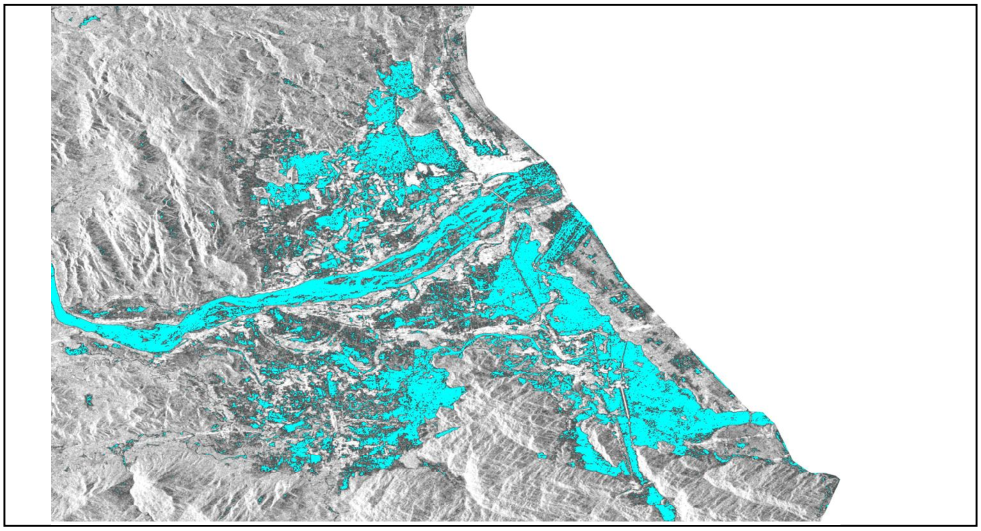


Figure 4: Result of extracted flood areas

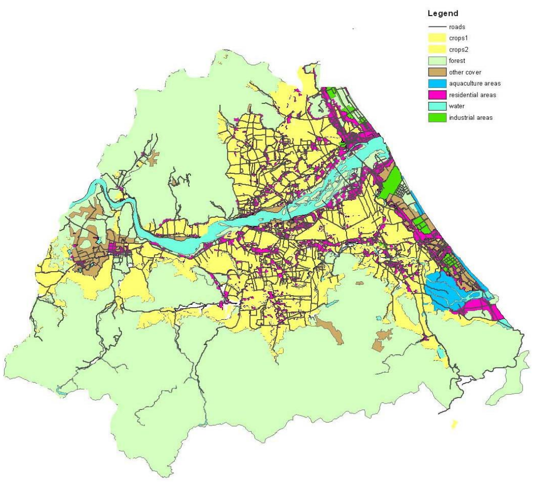
- *Extracting land cover information from optical images*

Considering to characteristics of the study area, classification was carried out with the classes as:

- Natural object: water and forest
- Economic object: crops (rice, vegetables, short - term industrial plant..), aquaculture areas, resident, industrial park, other cover (sand, alluvial area..)
- Traffic objects: highway, road…

Digitizing land cover information before flood base on optical images and available topographic maps, land use maps and using GIS tools to calculate area of severe affected objects.

After overlaying land cover information from optical image with flood area from radar image we got the land cover areas influenced with the water (figure 6).



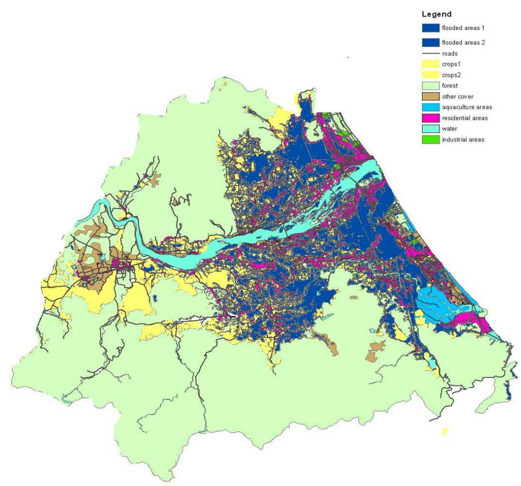


Figure 5: Result of land covers

Figure 6: Result of data overlaying

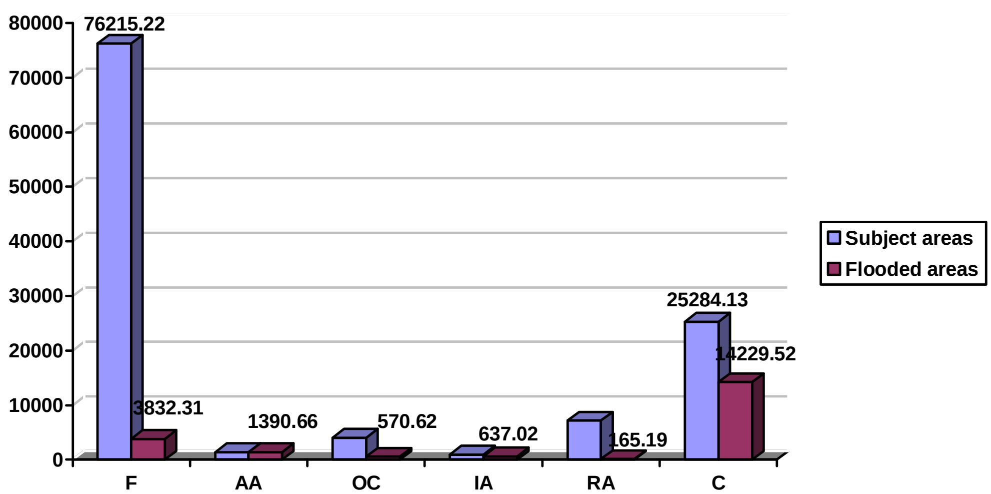


Figure 7: Subject areas and flooded areas (hectare)

3.4. Data analysis

The statistic results were obtained (figure 7):

Which:

F: forest

C: crops (rice and vegetables, industrial crops, etc....)

AA: aquaculture areas

RA: residential areas

IA : industrial areas

OC: other cover

In term of damage level, forest is the object which has the less losses because lying on high mountains and steep slope. On the other hand, flood areas is 3832.31 ha compared to total area of 76215.23 ha that can be said negligible.

According to the chart, it can be seen that the most severely affected areas are aquaculture. With an area of fish, shrimp lake and cage aquaculture is 1390.66 hectares were completely destroyed by sweeping away by the flood waters, while the embankment areas affected by the influx of fresh water as a light source of water.

For residential areas, although the quantity is not much damage, with 165.19 ha of the total 7212.35 ha, but flooded area is located in Tuy Hoa city where dense population centers, causing much damage human life and properties, many people lose their homes. On the other hand with 94.14 km of roads were flooded, separating residential areas, affecting the transport of food salvage.

Damaged arable land consisting of rice and vegetables, industrial crops, etc. was 14229.52 ha of the total area. With damaged cultivated land area is 25284.13 ha, we can say damage in agriculture is extremely great. Not only the area of rice and crops were influenced in the current time but also affected the quality of land for cultivation after the flood.

With the industrial area, the damage is very serious that 637.02 hectares was flooded in total 975.12 hectares. The flood affected industrial production, equipment, facilities, and work of employees.

In addition, for other types of land (mainly sandy and alluvial), the barren land area is 570.62 hectares inundated in total of 4072.73 ha. However, this land is not much influenced to production and daily life of human.

These research results showed that flood damage is extremely serious,

it gives rise to social consequences such as the settlement of accommodation for homeless people, causing damage to agricultural, industrial, stable life, prevent disease outbreaks after floods, improving water and soil environment …Flood devastated infrastructure, depletion of food resources, destroying crops, soil erosion, destabilizing social and economic life, which is the long-term consequences that will take a long time to overcome. Because of this, there should be quick estimation with high accuracy to prevent floods, weather emergency, and for building dykes and embankments for areas which frequently affected by storms and floods to reduce the maximum damage to humans.

4. CONCLUSIONS

Based on this research and experimental results, some conclusions can be exposed as follows:

Using satellite images specifically a combination of radar and optical images is the advantage method to extract the inundation areas.

In order to evaluate the damage of land cover types caused by the flooding, two kind of images these are Alos PalSAR and SPOT5 were used. For SPOT5 image, it was used to classify the land cover whereas Alos PalSAR images were used for extracting information flood areas.

Beside GIS tools were very helpful for supporting the overlaying tool which can be used for computing the damage of land cover types. Having such a process of using remote sensing data and GIS functions, mapping assessment of the damage caused by floods will be done quickly and accurately.

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