

Combination of Microwave and Optical Remote Sensing in Land Cover Mapping

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Key words: microwave and optical remote sensing; land cover; mapping.

SUMMARY

Land cover map mapping of various types use conventional remote sensing methods as a very important part of the methodology. Use of optical remote sensing data is limited due to the high cloud cover in tropical area such as Viet Nam, accordingly, the microwave remote sensing may be considered as a solution. This study aims to develop a method to create a land cover map using microwave remote sensing in combination with optical data.

The TerraSAR-X and Spot 5 image of Binh Thuan area in Vietnam were chosen to be processed for this study. Some filters such as Lee, Forst, Gama and local Sigma has been applied to the radar image in order to reduce the noise. The radar and optical data were geo-rectified to VN-2000 coordinate system. Then, data fusion techniques such as NDVI, PCA and Color Composite (HIS and Brovey) has been applied to the radar and Spot 5 images. A supervised classification was applied to fusioned images to identify different types of land cover such as water, forest, residential area, etc. The fusioned images were also unsupervised classified. Finally, the classified result of data fusion was compared to the SPOT5 classification and manually edited to establish land cover map. During the processing and mapping steps, the role of TerraSAR-X data in land cover mapping was estimated.

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1. PROBLEM STATEMENT

Remote Sensing is a very useful method in application of establishing land cover map. It has very important signification which serve efficiently in monitoring natural resources and protecting the environment, especially in the developing countries like Vietnam. In conventional method, the data of optical remote sensing satellites such as Spot is used due to its advantage resolution, both radiometric and spatial. The disadvantage of the optical data is cloud effected. It is become considerable in establishing land cover map in cloudy covered areas. Microwave remote sensing data is not effected by cloud but effected by the relief, so that the combination of radar and optical remote sensing data in land cover mapping is necessary to be studied. The method used in this paper is fusion the information before classification and information from fusioned data is used to add the absent information of the cloudy areas on the optical image. The main objective of the study is to develop a fusion technique that can be used to create land cover map from microwave and optical remote sensing. In order to reach the objective, tasks have been done are: Filters applied; Data fusion methods; Classification of optical data and fusioned data; Establish the land cover map scale 1:10.000. From the study, we found that the information from radar image may be used to add the absent information under cloud on the optical image. However, this method need to be considered only in case the optical one cannot be used for establishing land cover map, because the method required more data and more work.

2. METHODOLOGY

Binh Thuan area in Vietnam was chosen to be processed for this study, satellite images and thematic maps. Land cover mapping from microwave and optical remote sensing data, the study used a SPOT multi-spectral image, (Scene 5 278-329, dated 07 October 2005, resolution 10 m) and a TerraSAR-X image (QL_HH_SRA_strip_009, dated 9 December 2007; Resolution 1,25 m), Envi 4.3 and Microstation softwares. Beside the satellite data, a topographic map is used for geometric correction and a land use map of the study area is also used for field checking and estimate the result. The main step of combination of TerraSAR-X and SPOT5 image for land cover mapping and accuracy estimation are shown on figure 1.

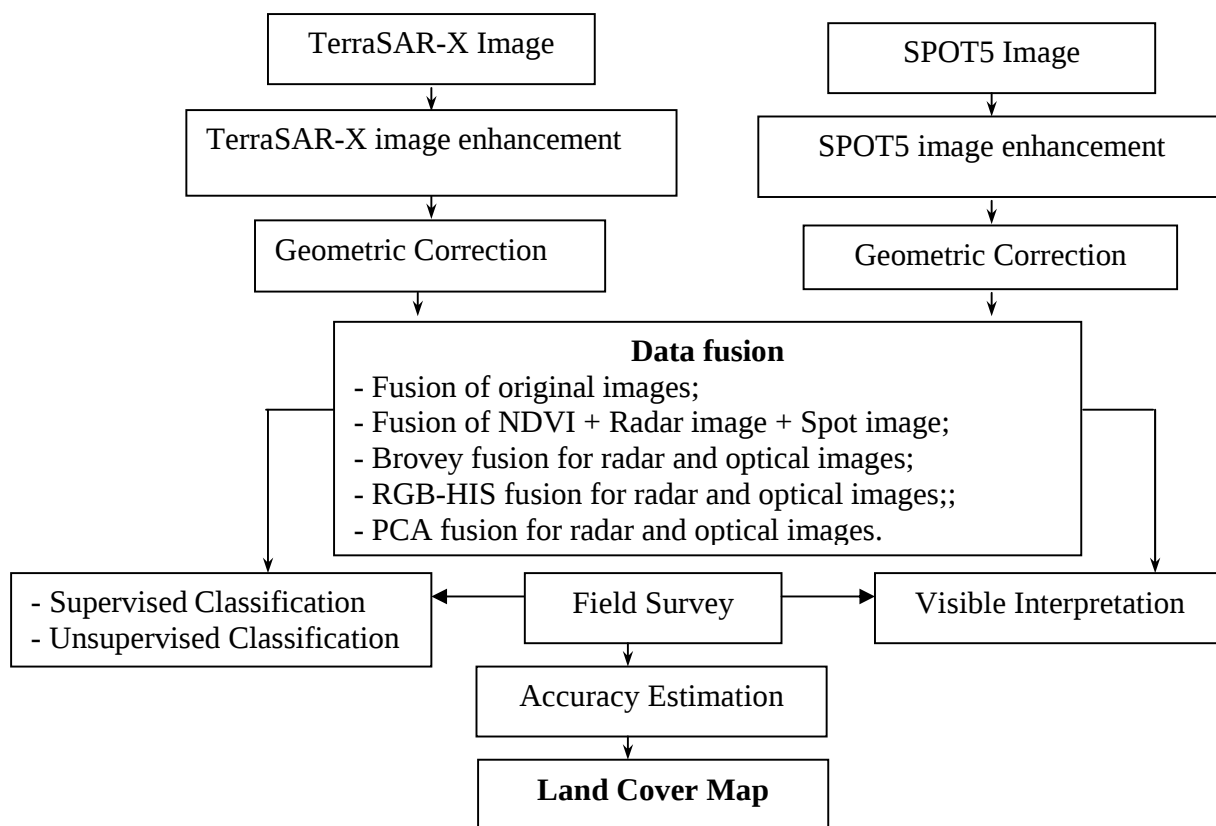


Figure 1. Combination of TerraSAR-X and SPOT5 image for land cover mapping

Image fusion may be considered as an effective method when it may used to extract the needed information from both radar and optical image. Fusion techniques can bring the advantages in some case. Naturally, the radar image has only one important advantage which is the ability to penetrate the cloud, then, the information from radar is used to add the absent information under cloud on the optical image.

Digital image processing steps in the figure 1 are described more detail bellows.

TerraSAR-X image enhancement: Radar image enhancement is very important step in the progress of digital image processing for land cover mapping. Radar image reflects clearly the structure of relief because of its oblique perspective (side-looking) imaging geometry. Radar image in digital form, like the others, has the most important character is numeric value of each pixel, that can be understood as gray level. This value and its difference in spatial reflect the back-scattering characters of radar from objects and through that, objects can be determined. In term of statistic, the numeric value (absolute value) of pixels can be estimated by mean and the changing (relative value) by standard deviation. For radar image enhancement, those two statistical characters were used. Filters, such as Lee, Frost, Gamma, Local Sigma were applied to

reduce the noise and enhance the image quality in this study. Lee filter, as well as Gamma filter, has been developed as standard filter for radar image processing. Figure 2 showing the effectiveness of Lee filter size 7x7 pixels, the noise has been much reduced in this study.

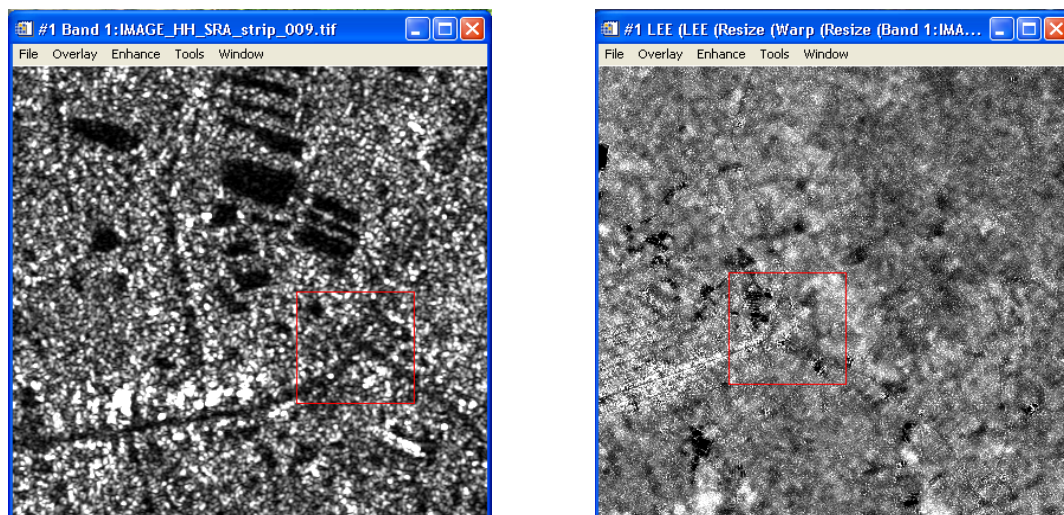


Figure 2. Lee filter size 7x7 pixels of radar image enhancement method in this study

Geometric Correction: A topographic map is used for geometric correction of the optical image. The geometric correction has been done first for Spot image then for RadarSat image (based on geo-referenced Spot image) with the allowed accuracy (<1 pixel).

Data Fusion: Data fusion technique was applied to integrate information between two images (SPOT5 - optical image - and TerraSAR-X - radar image -). This technique allows to create one or many new channels contain information from input channels. Recently, there are many types of fusion between radar and optical satellite image. In the studying progress, many types of data fusion were applied: Fusion of original images; Fusion of NDVI + Radar image + Spot image; Brovey fusion for radar and optical images; RGB-HIS fusion for radar and optical images; PCA fusion for radar and optical images. In the fusion images, land cover objects can be separated quite easily.

Unsupervised Classification of Data Fusion: Unsupervised classification can be seen as traditional method of digital image processing. Digital image can be classified to specified number of classes by user but the natural character of the classes is unknown. In the study, fused images were used for classification. Clustering is a grouping of data with similar characteristics. The result is shown on map in figure 3.

Supervised Classification of Spot Image and Data Fusion: The fused images were also supervised classification like Spot image. In supervised classification, considering the differences of spectral features between different objects in each Spot band and each Data fusion,

the maximum likelihood method was applied in order to separate different types of land cover. The difference of spectral features of land cover is strong. For separating the different types of land cover, besides using spectral characters, the information from field survey and land use map are also needed to refer. The result are shown on map in figure 3.

3. RESULT AND DISCUSSION

The information from field survey and land use map are also needed to refer. Through it, the fusion classification can be estimated and also accuracy of the method. Some of the study area was covered by cloud so the result of Spot classification can not be used. The result of classification of the fusion and also radar image were used for adding lack information. Data fusion progress includes fusion steps, unsupervised classification and supervised classification of fusion image. At the same time, the optical progress includes unsupervised classification and supervised classification. All progresses aim to combine information between radar and optical imagery. The combination can bring the best information about studied objects. Optical imagery with wide spectral range can bring plenty information about land cover while radar imagery can give the adding information that lacked by effect of cloud on optical imagery. The method can be modified detail in order to apply to other field studies. The disadvantage of method is requiring remote sensing datas of the same area and fee to buy optical and also radar images. The final result is a land cover map from multi-satellite data, scale 1:10.000. The result shown on figure 3 is application of the method for Binh Thuan area. On the final map, types of land cover (shown on table 1) were separated almost based on the difference of their spectral response on Spot image and thematic maps.

Table 1. Types of land cover classification

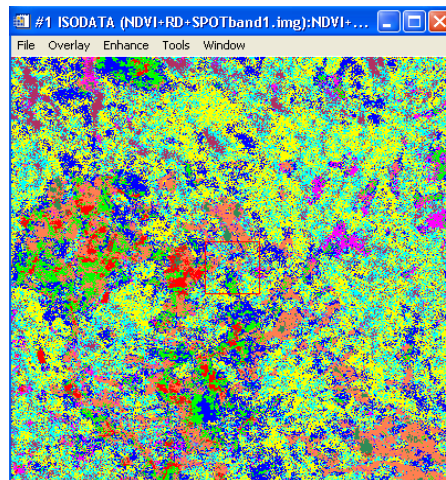
Types	Note
Water bodies	(1)
Forest	(2)
Seasoned cultivated land	(3)
Short cultivated land	(4)
Dry Agriculture	(5)
Rice – growing land	(6)
Bareland	(7)
Land of traffic	(8)
Residential area	(9)

- Accuracy Estimation: Using Ground Truth ROIs.

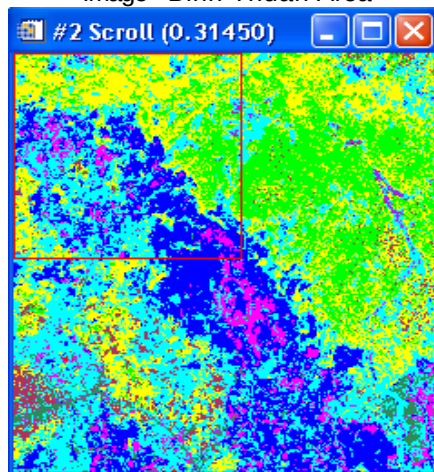
Table 2. Overall accuracy of classification results

Types	Commission (%)	Prod. Acc		Omission (%)	User.Acc	
		pixel	%		pixel	%
(1)	7.46	62/64	96.88	3.13	62/67	92.54
(2)	3.45	868/913	96.07	4.93	868/899	96.55
(3)	0.71	556/562	98.93	1.07	556/560	99.29
(4)	16.54	212/259	81.85	18.15	212/254	83.46
(5)	11.56	153/175	87.43	12.57	153/173	88.44
(6)	19.18	59/65	90.77	9.23	59/73	80.82
(7)	0.03	68/69	98.55	1.45	68/69	99.97
(8)	5.00	38/39	97.44	2.56	38/40	95.00
(9)	23.76	77/89	86.52	13.48	77/101	76.24
Overall Accuracy				93.65%		
Kappa Coeficient	0.91					

Land Cover Unsupervised Classification from Fusion Image - Binh Thuan Area



Land Cover Supervised Classification from Spot Image - Binh Thuan Area



Land Cover Supervised Classification from Fusion Image - Binh Thuan Area

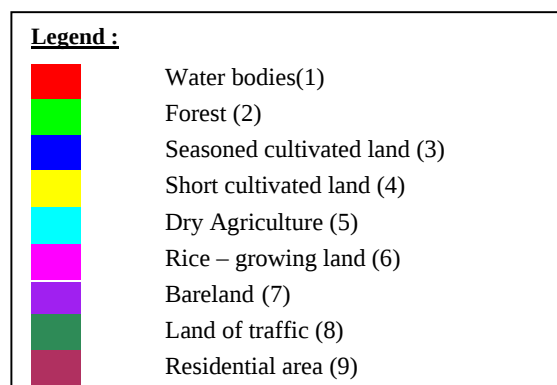
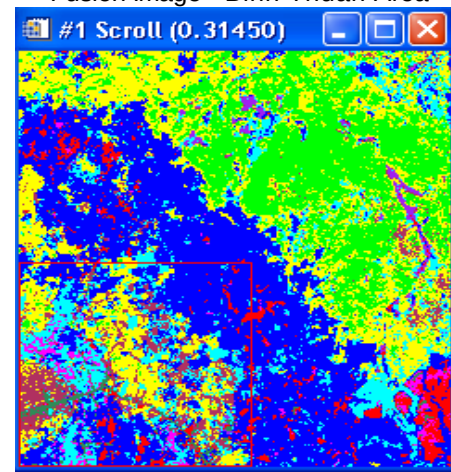


Figure 3. Land cover unsupervised and supervised classification from Spot and fusion image

- Using Microstation software to manually edit to establish land cover map:

Land cover map scale 1: 10.000 from Combination of Classification Results - Binh Thuan Area

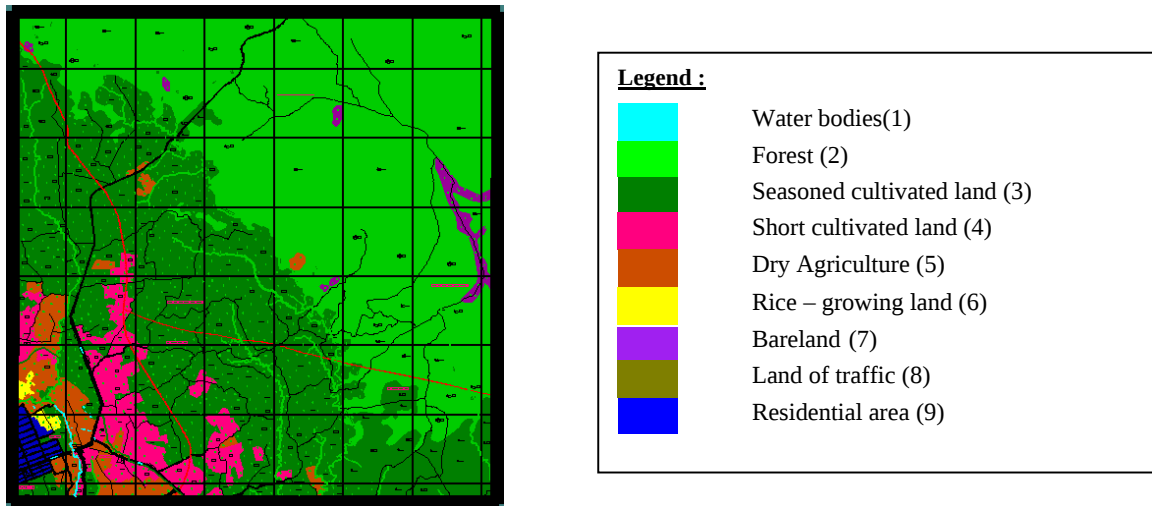


Figure 4. Land cover map from combination TerraSAR-X and Spot classification

4. CONCLUSIONS

- Microwave remote sensing data is not effected by cloud but effected by the relief, so that the combination of radar and optical remote sensing data in land cover mapping is necessary to be studied, especially in the high cloud cover area such as Viet Nam.
- Radar and optical imageries can be combined successfully in application studies, land cover map in this case. The information given by radar image is useful for monitoring natural resources and protecting the environment, especially in the tropical and cloudy country like Vietnam, and can be used effectively in the integration information model.
- For land cover application, method of enhancement for radar image is very important. In this case, the most effectiveness methods Lee filter size 7x7 pixels after many filters were applied.
- Data fusion is very useful technique in term of imagery combination. Data fusions have much useful information, increased the accuracy of the interpretation in rooms, to save time and expense for field survey.

5. ACKNOWLEDGEMENT

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6. REFERENCES

- [1]. James B. Campbell. Introduction to Remote Sensing, 1996.
- [2]. Ho Dinh Duan. Methods of Image Processing, Workshop of Satellite Remote Sensing for Southeast Asian Scientists, Taiwan 11/2008.
- [3]. ITC Educational Textbooks Series2. Principle of Remote Sensing, 2001.

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