# AQUACULTURE FACILITIES DETECTION FROM SAR AND OPTIC IMAGES

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ABSTRACT This study attempts to establish a system extracting and monitoring cultural grounds of seaweeds (lavers, brown seaweeds and seaweed fulvescens) and abalone on the basis of both KOMPSAT-2 and Terrasar-X data. The study areas are located in the northwest and southwest coast of South Korea, famous for coastal cultural grounds. The northwest site is in a high tidal range area (on the average, 6.1 m in Asan Bay) and has laver cultural grounds for the most. An semi-automatic detection system of laver facilities is described and assessed for spaceborne optic images. On the other hand, the southwest cost is most famous for seaweeds. Aquaculture facilities, which cover extensive portions of this area, can be subdivided into three major groups: brown seaweeds, capsosiphon fulvescens and abalone farms. The study is based on interpretation of optic and SAR satellite data and a detailed image analysis procedure is described here. On May 25 and June 2, 2008 the TerraSAR-X radar satellite took some images of the area. SAR data are unique for mapping those farms. In case of abalone farms, the backscatters from surrounding dykes allows for recognition and separation of abalone ponds from all other water-covered surfaces. But identification of seaweeds such as laver, brown seaweeds and seaweed fulvescens depends on the dampening effect due to the presence of the facilities and is a complex task because objects that resemble seaweeds frequently occur, particularly in low wind or tidal conditions. Lastly, fusion of SAR and optic spatial images is tested to enhance the detection of aquaculture facilities by using the panchromatic image with spatial resolution 1 meter and the corresponding multi-spectral, with spatial resolution 4 meters and 4 spectrum bands, from KOMPSAT-2. The mapping accuracy achieved for farms will be estimated and discussed after field verification of preliminary results.

**KEY WORDS:** Seaweed, Detection, Laver, SAR, KOMPSAT-2

## 1. INTRODUCTION

As farm facilities continue to increase, a policy is needed to maintain a proper level of production through control of unlicensed laver farms and stabilization of supply and demand. To put such a policy into effect, it seems that continuous monitoring of laver farms is necessary.

To manage inshore laver farms efficiently, we need to make investigations into actual sizes of farming facilities; probably, the most efficient method is by use of satellite. However, because laver farms have different types and sizes of facilities by region, investigations should be made on the basis of field data. (Yang & Park, 2006)

As shown in Fig. 1, the kinds of laver farm facilities are diverse. Floating type A is used in Hwaseong, Ansan, and so forth, floating type B in Jindo, Haenam, Wando, Goheung, Jangheung, and so forth; these types are found in most coastal areas, with about 1.8 to 2.4m wide and 40 to 200m long. Floating type C is seen mainly in Gunsan, Seocheon, and Gangseogu in Busan. Strut types are set up in tidelands of Sinan and Mokpo sea areas, as shown in pictures. (Yang & Park, 2006)

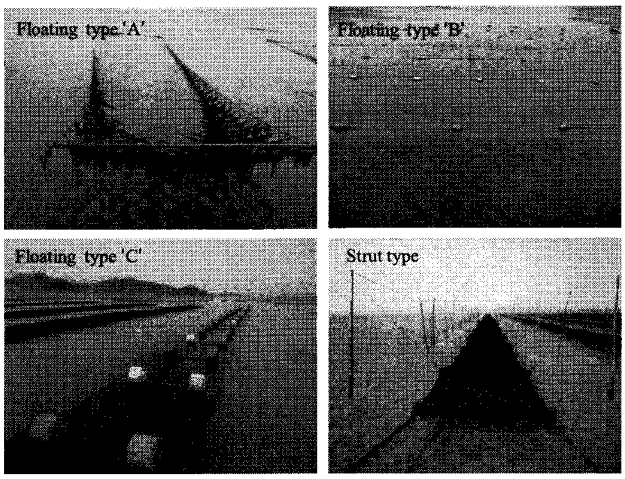


Figure 1. Types of laver farm facilities.

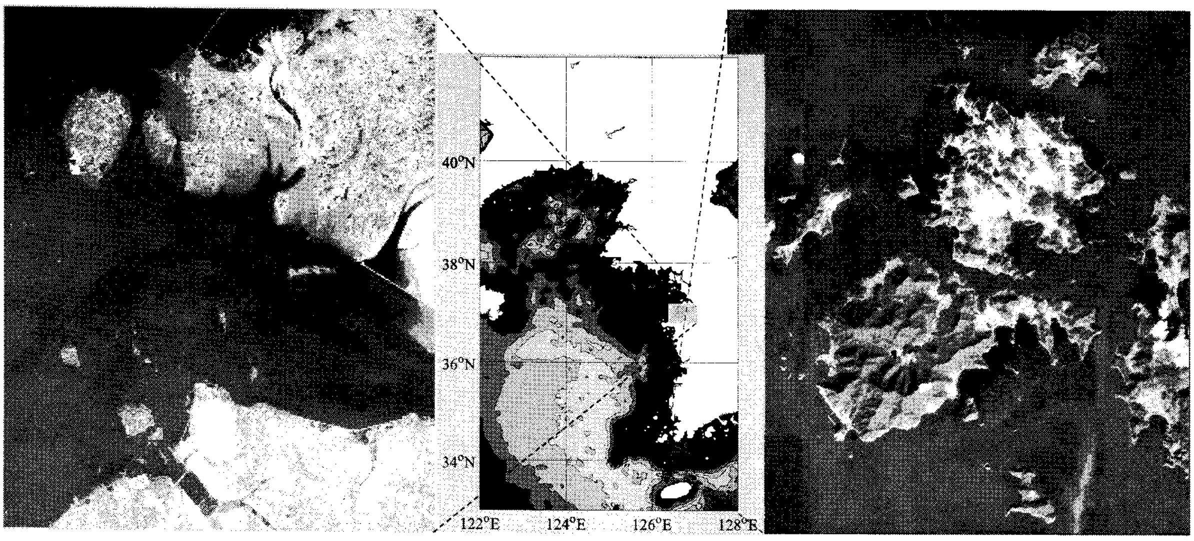


Figure 2. Research area for culturing farms, Korea. Asan Bay (Left), Dadohae Marine National Park (Right).

Systematic studies have rarely done for analyzing and abstracting satellite imagery data of strut and floating type laver farms in inshore areas. This study attempts to establish a system extracting and monitoring cultural grounds of seaweeds (lavers, brown seaweeds and seaweed fulvescens) and abalone on the basis of both KOMPSAT-2 and Terrasar-X data. The study areas are located in the northwest and southwest coast of South Korea, famous for coastal cultural grounds.

## 2. STUDY AREAS AND DATA

There are two research areas. One is located in and around Asan Bay (Fig.2-left). The northwest site is in a high tidal range area (on the average, 6.1 m) and has laver cultural grounds for the most. Two images of KOMPSAT-2 are used to extract laver facilities and compare their difference between 2007 and 2008.

The other is the west part of Dadohae (Sea of many islands), the largest marine park where is most famous for seaweeds. Aquaculture facilities, which cover extensive portions of this area, can be subdivided into three major groups: brown seaweeds, lavers and abalone farms. Both KOMPSAT-2 and Terrasar-X data are here used. The TerraSAR-X images were obtained on May 25 and June 2, 2008 with spotlight of HH.

## 3. LAVER DETECTION SYSTEM

An semi-automatic detection system of laver facilities is described and assessed for spaceborne optic images. In Fig. 3 the main module of the Coastal Farming-Facilties Monitoring System (CoFaMS) is shown. The sub-modules of pre-processing and farming-facilities detector are also presented in Figs. 4 and 5.

In extracting laver farms, spectral characteristics as well as visual inspection were employed. The farm boundary is extracted in the detector module and the detected objects can be displayed in the module of CoFaMS Viewer (Fig. 6).

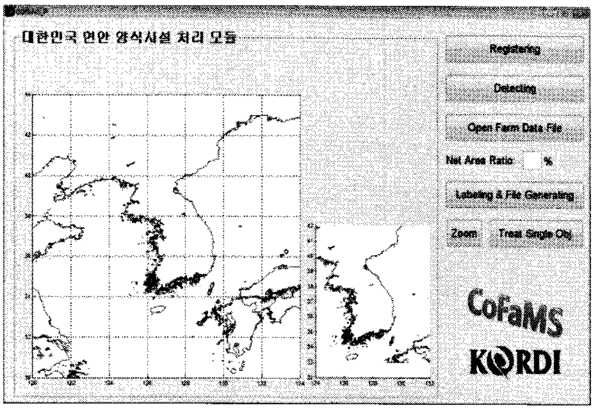


Figure 3. Main Module of CoFaMS.

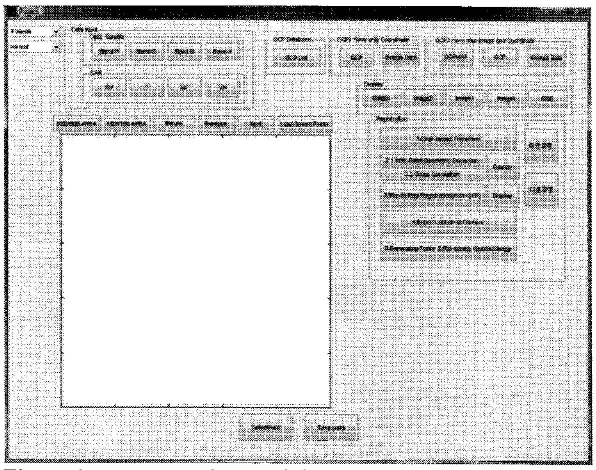

Figure 4. Pre-processing module of CoFaMS.

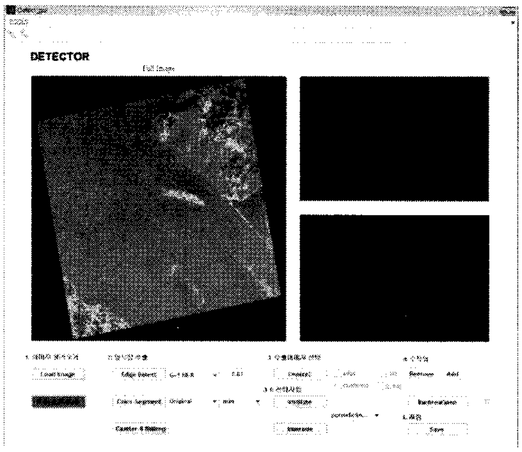


Figure 5. Farming-facilities detector.

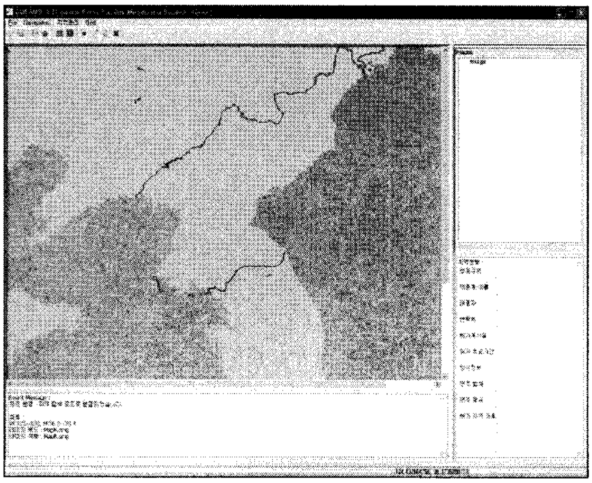

Figure 6. CoFaMS Viewer.

## 4. RESULTS

Figure 7 shows annual changes of laver cultivation areas from 2005 to to 2008 in Hwaseong calculated from SPOT-5 and KOMPSAT-2. While the laver facilities from 2005 to 2007 indicates a great change, the next period indicates an immaterial increase in the facility structure.

This study applies farm detection techniques to spectral images, whose detection levels depend on the spectral characteristics of farm facilities. However, it is very difficult to obtain data without being affected by clouds; also, there is a limitation to extracting farm facilities submerged below the surface. So, it is expected that the Synthetic Aperture Radar (SAR), which is not affected by climatic conditions, will assist in detecting the net and strut of a laver farm shown in Fig. 1.

To test SAR application on aquaculture, ENVISAT ASAR was used to investigate SAR signature on laver cultivation areas in Hwaseong (Fig. 8). SAR signatures were overlaid with a red square which indicates the laver boundaries calculated from KOMPSAT-2. It is shown that C-band low resolution SAR has a difficulty to detect a laver facility under sea surface. In the next, a high resolution X-band image was tested.

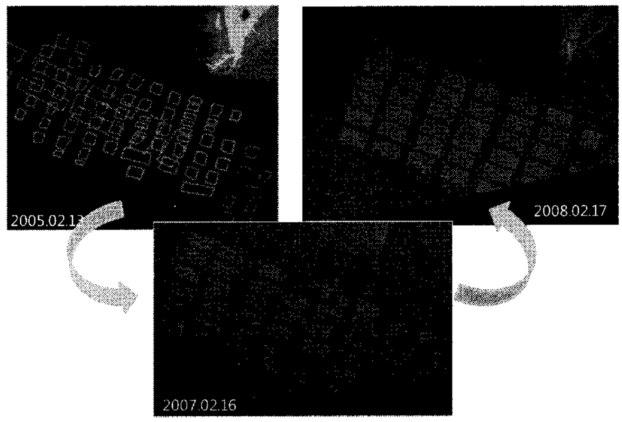


Figure 7. Annual changes of laver cultivation area from 2005 to 2008 based on optical satellite images.

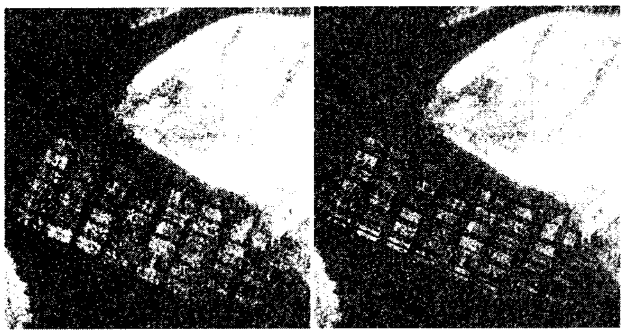

Figure 8. Laver facilities obtained from ENVISAT ASAR (Feb. 18, 2007). SAR signatures are overlaid with a red square which means the laver boundaries from KOMPSAT-2.

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The study in Dadohae Marine National Park is based on interpretation of optic and SAR satellite data. On May 25 and June 2, 2008, the TerraSAR-X radar satellite took some images of the area. SAR data are unique for mapping those farms. In case of abalone farms, the backscatters from surrounding dykes allows for recognition and separation of abalone ponds from all other water-covered surfaces. But identification of seaweeds such as laver, brown seaweeds and seaweed fulvescens depends on the dampening effect due to the presence of the facilities and is a complex task because objects that resemble seaweeds frequently occur, particularly in low wind or tidal conditions. Lastly, fusion of SAR and optic spatial images is tested to enhance the detection of aquaculture facilities by using the panchromatic image with spatial resolution 1 meter and the corresponding multi-spectral, with spatial resolution 4 meters and 4 spectrum bands, from KOMPSAT-2. The mapping accuracy achieved for farms will be estimated and discussed after field verification of preliminary results. (not shown here)

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