Salt pond analysis using ALOS PALSAR case study Sampang, Madura-Indonesia

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Abstract. Indonesia is a country that has a large sea area of about 96,079.15 km2. With this condition we can utilize the natural resources that are infested in the sea, such as fish, and salt. Indonesia has exceptional salt pond commodities from various areas such as Cirebon, Sampang, Indramayu Madura, and Rembang. These resources need to be monitor and inventory in proper way. The development of science and technology, there is an effective and efficient way to identify, monitoring and inventory of salt ponds using remote sensing technology. In this last period the saltwater pond infiltration is still inclined to utilize optical sensor system to monitor and infuse. The method used is visual interpretation through multipolarization composite radar image by using interpretation key. The weakness of passive sensors is affected by the presence of cloud cover. The location of salt ponds in Indonesia is mostly located on the coastal regions that is visually affected cloud cover. In addition the use of active sensor is become a challenging for this aspect. This study was conducted to analysis of hues, patterns, and textures in order to recognize the salt pond object using Alos PALSAR Image (Active Sensor). The salt pond object in multi-polarized composite HH-HH / HV composite radar images is recognizable in dark blue with regular pattern plots with characterized by brighter / clear / bright pink ridges.

1. Introduction

Indonesia has a long coastline, potentially for salt pond. Salt pond is one of superior products in marine field. In recent years salt has become one of the national strategic commodities. Salt Pond is an artificial shallow pond designed to produce salt from sea water or salt water. People's salt production is almost spread throughout Indonesia. Based on the distribution map of people's salt production site In 2015 the land area reaches 25,830.34 Ha [1]. With the area of salt ponds that are so widespread and scattered throughout Indonesia, so monitoring activities is necessary. The most effective and efficient for monitoring is by using remote sensing technology. Remote sensing in the broader sense, measurement or information acquisition of some nature of the object or phenomenon, using a recorder that is physically not in direct contact or intersection with the object or phenomenon studied [2]. Remote sensing system consists of several components [3]. The series of components includes: 1) power source, 2) atmosphere, 3) objects, 4) sensors, and 5) data acquisition and data usage.

Remote sensing technology is divided into two sensor systems, passive sensors and active sensors. Passive sensor is an optical sensor that utilizes sunlight as energy to record an object on the surface of the earth. Active sensor is a radar sensor with its own lighting system to be able to record objects on the surface of the earth. In the case of monitoring and calculation of salt ponds in coastal areas, optical sensors have a weakness that is cloud cover and foggy compared to active / radar sensors. Remote sensing images with active / radar sensors are helpful in monitoring activities of salt ponds because they have the ability to penetrate clouds and fog.

This research uses ALOS PALSAR radar image to perform the identification of salt pond object. The Phased Array L-Band type Synthetic Aperture Radar (PALSAR) is an active microwave sensor that uses L-Band frequencies to achieve groundless observations on a day and night basis. Frequency L-Band Alos PALSAR 1.3 GHz with 10m spatial resolution.

Sampang Madura is selected as a study area because the area has 3,064,55 Ha with production of 398,983.61 ton. Based on data of salt people productivity Year 2015, Sampang is the second highest production in Indonesia after Cirebon. The purpose of this research is to identify and analyze the object of salt pond based on color, hue, and texture using ALOS PALSAR image for Sampang region, Madura, East Java Province.

2. Material and Method

2.1 Time and Research Location

This research was conducted in February 2017 located in Sampang, Madura, East Java, map of research location:

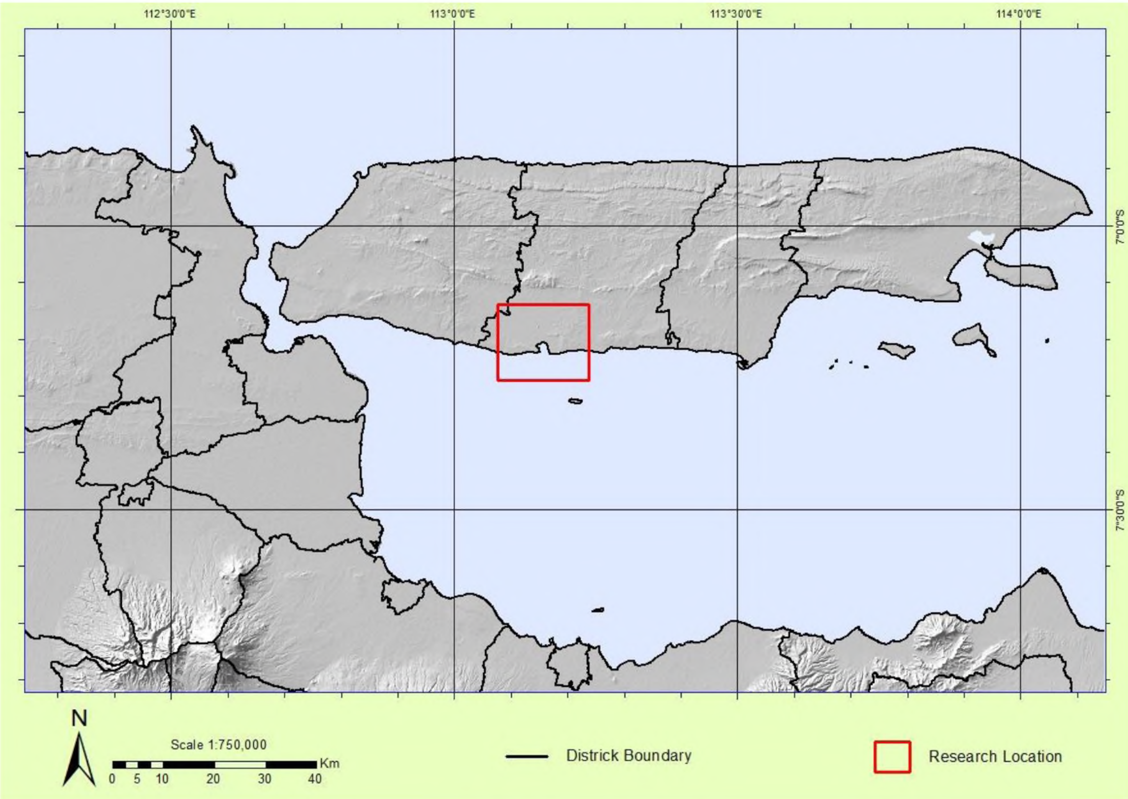

Figure 1. Map Location

2.2 Data Collection

There are of material in this research, namely:

a) Primary data

Raster data : ALOS PALSAR FBD level RT1, Frame 7040, Path 426
Resolution Data : 12,5 meter
Time data : June 20, 2009
Data Location : Sampang, Madura, East Java

2.3 Software and Hardware

There are two software in this research, namely :

a) ENVI 4.5
b) ArcGIS 10.3

There are hardware in this research :

a) Laptop Dell Latitude E7440
   - RAM 8 GB
   - Storage SSD 256 GB

2.4 Analisis Data

ALOS PALSAR RT1 level is remote sensing data that has been corrected terrain level that has been calibrated gamma naught so that satellite image of study area is not affected by topography effect such as layouver (inward fall effect), foreshortening (shortening of the front slope), and shadow (shadow effect).

Radar image processing takes into account the conversion of the slant range to ground range. Varying qualities will be obtained from an independent looks great with a different azimuth. Image taken have variations in pixel size and data processing can be done in a Geographic Information System (GIS). Digital radar processing includes conversion and compression of radar signals in both directions. Azimuth and distance into a format that can be interpreted by the interpreter. In the processing there are steps that include compression range, azimuth compression, signal detection, multilook processing, and data storage [4].

Geometric correction can be grouped into two types namely orbital geometry model and transformation based on field control points [5]. Geometry models can be divided menajdi orbital aspect ratio correction, correction skewness, and correction of the Earth's rotation. While the transformation by GCP (Ground Control Point) consists of geometric correction by rectifying imagery to map and correction of geometric rectification of the image to the image [5]. In general, geometry correction aims to correct the image that has coordinates that correspond to geographical coordinates, matching the position of the image with the image or map that have been corrected or kooordinat transforming the image, and then register the image to the map so as to produce images with a particular projection system.

Radiometric correction radar image is done using filtering techniques. This filtering is a way to mitigate or reduce the appearance of speckle on a radar image. Speckle trlihat as black spots and white or commonly known as 'salt and pepper'. Filters can be done in a variety of window sizes such as 3x3, 5x5, 7x7, 9x9, or 11x11. The larger the size of the window, then the image looks more refined or 'blur'. Here are some techniques filters are often used in research are: (1) Filter Lee used to refine spots or speckle on image to maintain image sharpness and of detail while reducing noise in the image. Pixels that do filter is replaced by the pixel values of the surrounding nearby; (2) Filter Frost serves to reduce noise while maintaining edge on radar imagery [6].

2.5 Metode and Flow Chart

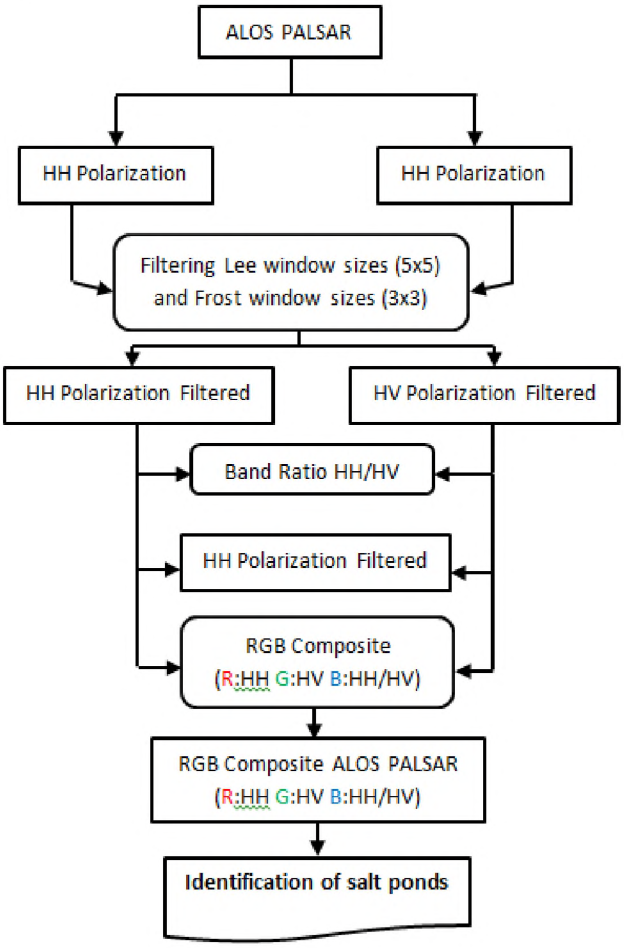

Figure 2. Research flow chart.

3. Processing Data

SAR images are calibrated using a logarithmic scale decibel (dB) and should pay attention to the logarithmic nature of these values when doing statistical calculations. To determine the average value of each part of the image, the calculation should be based on the values of the power scale. The scale power value can then be converted back into a logarithmic scale that represents the values of each pixel dB SAR data [7]. There are three kinds kalibrasipada SAR data and is described in the figure below.

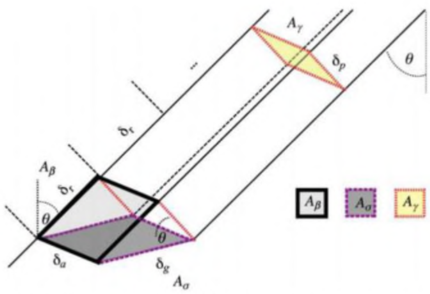

Figure 3. Illustrated of the reference areas for the three radar backscatter beta, sigma, and gamma naught by [8].

To explain the actual equations in each calibration, it must use logarithmic scale with decibels (dB) is 10log10. Thus the equations of the three calibration types in dB units become by [9]:

$$\text{Sigma naught } (\sigma o) = 10 * 10\log10\ (DN2) + CF$$

With a DN is a Digital Number and CF is a predetermined calibration factor of -83 for HH and HV polarization, then the result of sigma naught on the ellipsoid earth model or the Geocoded Terrain Corrected product (GTC), as well as be developed using gamma naught into Radiometric Terrain Corrected (RTC).

$$Gamma\ naught\ (\gamma^o) = \sigma^o \frac{A_{flat}}{A_{slope}} \left(\frac{Cos\ \alpha_{ref}}{Cos\ \alpha_{loc}}\right)^n$$

Aflat is the value of the image pixel size under flat earth conditions, Aslope is the image pixel size based on actual field conditions (topographic variations). Aref is the incident angle calculated at the midpoint of the image scene for ALOS PALSAR image with a large nadir-off angle of 34.3 obtained values for αref = 38.7° whereas for αloc is the local incidence angle of each pixel based on topographic variation. The value of n is a constant adjusted to the depth or thickness of an object ranging from 0 to 1, for the study of vegetation is usually the value of n = 1 because the thickness of the canopy is difficult to determine the depth or thickness of an object ranging from 0 to 1, for the study of vegetation is usually Value of n = 1 because the thickness of the canopy is difficult to determine.

However, ALOS PALSAR RT1 level still influenced by noise (speckle), to overcome this, then do the filtering on each polarization, lee filter with window size 5x5 and frost 3x3. Lee filters are used to smooth the spots or speckle on the image by maintaining the sharpness of the image and detail while reducing the noise in the image. The pixel that the filter does is replaced by nearby pixel values; While Frost Filter serves to reduce noise while maintaining the edge of the radar image.

4. Result

The identification of salt ponds on ALOS PALSAR imagery is more focused on visual interpretation through the ecological spatial approach associated with the tidal coast. The appearance of the salt pond area is more easily identified by looking at the embankment pattern of the pond, in indicating the firm appearance of embankment ponds, the polarization is better than the HH polarization. This is because HH polarization is more sensitive to angular reflections.

Comparison of backscatter scattering values on HH (Top) and HV (Middle) polarization in pond embankment objects is significant, -1db to 2db for HH and -4db polarization to -5db for HV polarization. The image used has been corrected to the terrain level (RTC / radiometric terrain corrected) and calibrated gammanaught. HH polarization is also more sensitive in distinguishing areas of salt ponds that are still in the form of water and ponds that have been dried (no salt).

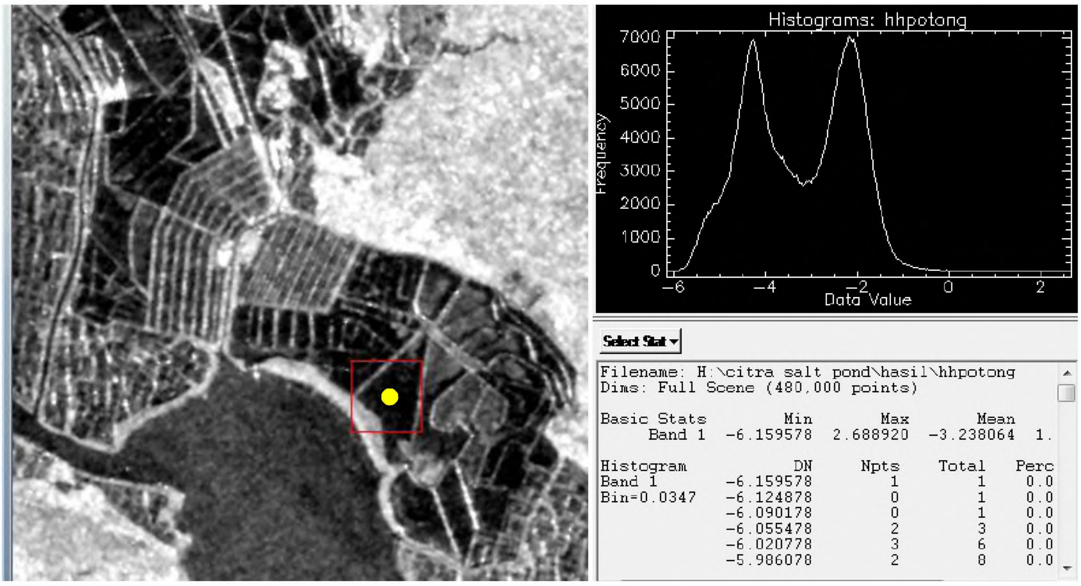

Figure 4. Illustration of HH polarization and histogram digital number

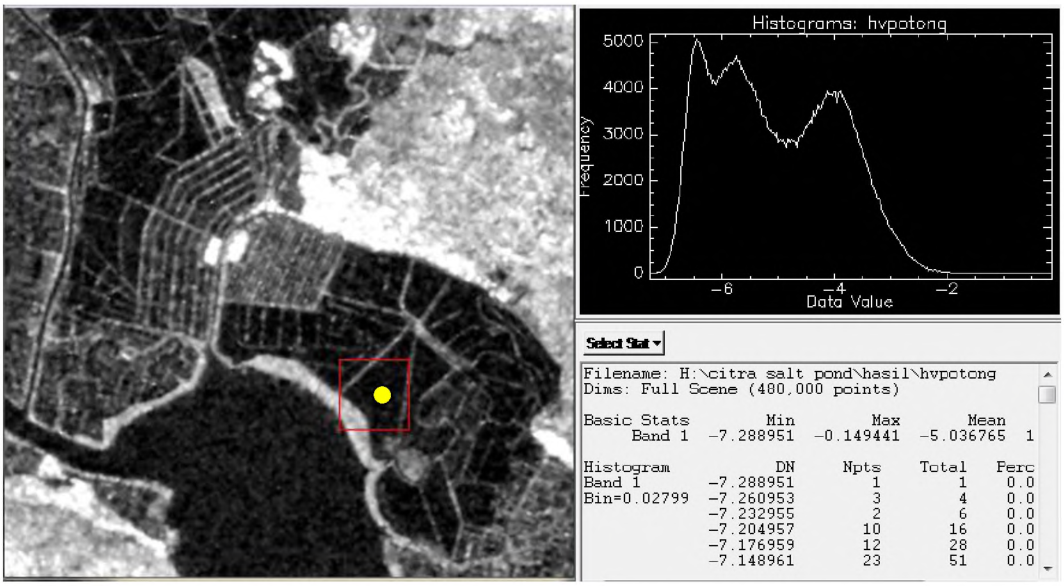

Figure 5. Illustration of HV polarization and histogram digital number

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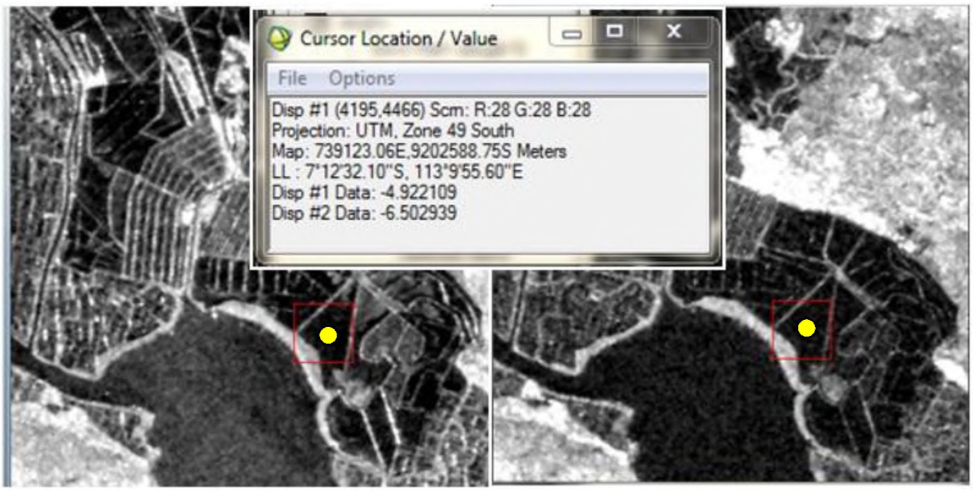

Figure 6. Comparison of digital values (object at the yellow point).

The results of the research are 3 polarization bands R:HH, G:HV and B:HH/HV. ALOS PALSAR with 3 bands then performed band ratio with HH polarization and HV polarization to get the new band. The new band is a ratio of HH/HV, the band was used in this study for the identification of salt ponds.

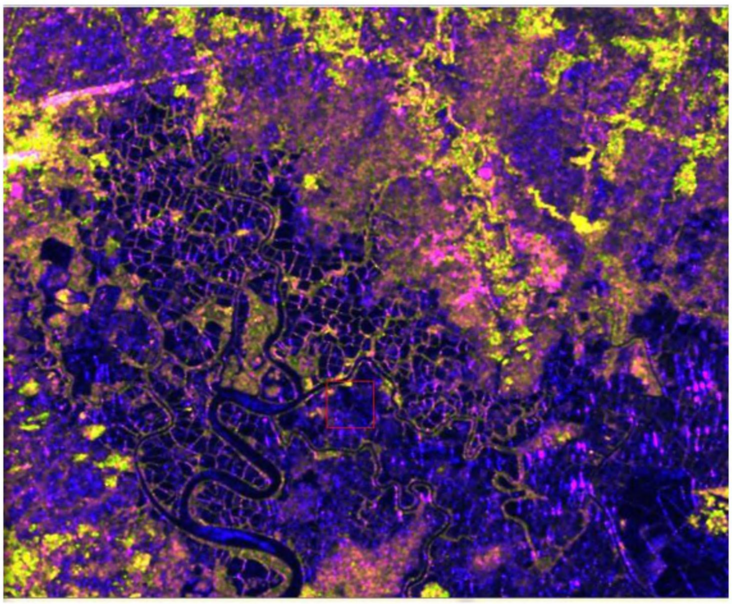

Figure 7. RGB Composite ALOS PALSAR

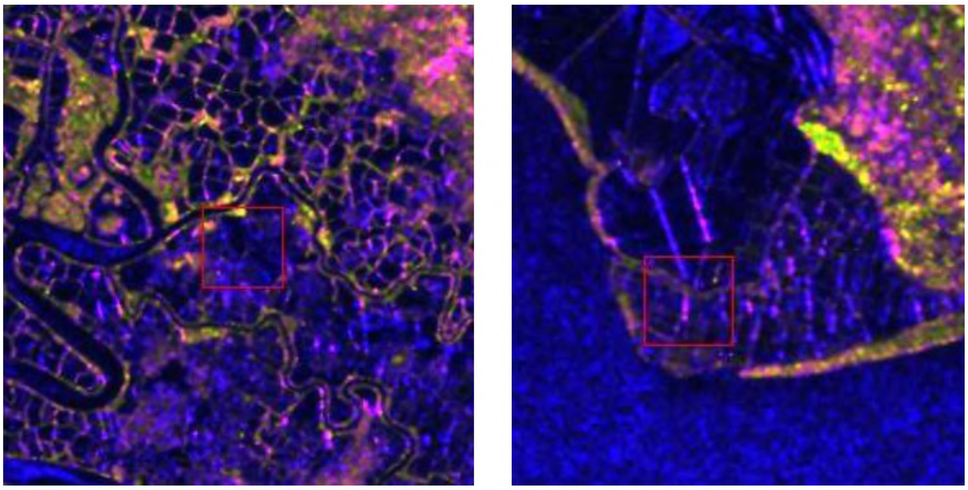

Figure 8. Paddy Field (left) and Salt Pond (right)

HH polarization is colored red, HV is colored green, and HH/HV is colored blue. The result of mixing of 3 colors / bands is obtained, vegetation objects especially forest (dominated scattering volume) will be green. The green color is because HV polarization is sensitive to volume scattering.
The object of the path, or the settlement (dominated by angular reflections) on the blue composite image, the greater the angular reflection that occurs (eg on objects with sharp corners such as bridges, or building corners) the object will be purple. For a water object will display a blue color (reflection mirror), HH polarization is also sensitive to mirror reflections[6].

Salt ponds on composite images have patterns and shapes similar to paddy fields, with plot patterns. What distinguishes is a salt pond in it containing water and open land (when drying) so that the radar image looks blue (mirror reflection). While bunds (dividers between ponds) appear on a purple image, different for paddy fields (farmland) where paddy fields are shrubs or dirt roads interspersed with shrubs and trees (radar images appear green).

5. Conclusion

The conclusion is a visual interpretation of spatial ecological approach ALOS PALSAR can identify salt ponds. Own ecological approach focuses on the shape, pattern and spatial association to the coastal ecology. ALOS PALSAR has featured can penetrate clouds so it is appropriate for the analysis of coastal areas. So ALOS PALSAR can be used for identification, monitoring and calculation of the salt pond area.

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