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Abstract. Siak Regency is one of the areas in Indonesia that has peat areas. Events of forest fires occurring in Indonesia caused by the dryness of peatland attracted the attention of many parties to pay attention to this land as a serious matter. From this study, we found variations in soil moisture conditions around 11 - 50%, associated with soil content, the limiting pH parameter in peatland is about 3 to 4. With the approach of remote sensing microwave technology and field validation measurements by counting humidity, sample properties, it is known that the character of the peatland as well as produce the latest geological map for the distribution of peat and the region contained within the Regency of Siak.

1. Introduction

Indonesia has peatland area with the total of 14.91 million hectares (Ha) spread over Sumatra with 6.44m Ha (43%), 4.78M Ha in Kalimantan (32%), and 3.69M Ha (25%) in Papua [1]. Important factors of peatland for agriculture are closely related to the nature and character of soil, water, and emissions from greenhouses. These factors should be considered in making decisions or policies and agricultural utilization [2].

Utilization of peatland for agriculture in Indonesia has a long history base. Starting with the success of local people who see peatland as a source to produce traditional food crops, fruits, and spices [3]. Then they grow into large-scale plantations managed in a modern way to get better income like oil palm plantations, but it must be managed appropriately. Given the issue of greenhouse gas emissions, it also motivates local governments to limit the use of peatland, as some emissions come from peatland.

In today, many applications for agriculture and hydrology, groundwater knowledge of moisture is essential: For example, this is an important piece of information to predict peat fires and precise peatland measurements. Therefore, in the last few decades, groundwater content retrieval from multiangle, multifrequency, or multi-polarization SAR data has been the subject of extensive research [4,5].

In practice, soil parameters, such as Soil Roughness and Soil Moisture, are mostly obtained as a single point of measurement, which is to wireless sensor networks in case of soil moisture to increase field-scale monitoring. In addition, soil moisture sensors on this scale can be approached by geophysical methods, such as Ground Penetrating Radar (GPR) and Time Domain Reflectometry (TDR), Ground Albedo Neutron Sensing (GANS) using cosmic-ray probes. As for soil roughness sensor, laser scanning or needle profiler is widely applied [6,7].

The increase of spatial scale from the measurement of a point or wide to a large-scale field is very non-linear, remote sensing extends the retrieval of soil information from field studies to spatial investigations in sub-catchments or entire catchment areas, including highly isolated areas.

Optics of remote sensing for soil properties depend on daylight and clear weather conditions, RADAR-based methods turn into weather and independent lighting that support sustainable land monitoring strategies. Therefore, Synthetic Aperture Radar (SAR) is used on platforms that are in the air or in outer space.

In this study, we tried to extract soil moisture from peatlands at several centimeters depth and ground roughness called surface parameters with the help of the ALOS-2 SAR [8] satellite and also the soil contents associated with fertility conditions to produce more appropriate agriculture. To verify the application of our methods on peatlands, we collected in-situ soil moisture data through field surveys during the rainy and dry seasons, and soil sampling [9,10].

The objective of this study is to develop a soil moisture retrieval model from peatland using L-Band microwave remote sensing frequency, to develop a model for extracting soil content from peatlands using L-Band microwave remote sensing frequencies, and to make the new geological map for the Regency of Siak and the distribution of peatland area [11,12].

2. Methodology

The methodology for this study is shown in the work flowchart for this study, as follows:

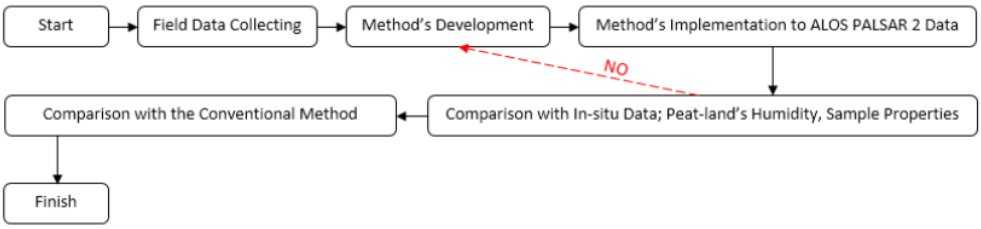

Figure 1. The framework of the research.

The overall data processing flow found in this study is illustrated in Figure 1. Full polarimetric measurements [13] of PALSAR-2 (Phased Array type L-band Synthetic Aperture Radar 2: the onboard sensor name onboard ALOS-2) were obtained simultaneously with field measurement dates, and with so we can compare the two results appropriately. PALSAR-2 is launched in 2015 on board the ALOS-2. PALSAR-2 is a follow-up of PALSAR which is the first satellite to observe satellites to carry a full polarimetry mode, and this provides complete radar information (backlinks) of the intensity and phase of the signal. It is a great advantage to get a complete comprehension factor that controls radar backscatter in the area especially with complex scattering mechanisms, such as low vegetation, where the impact of vegetation is estimated to be minimal in L-band. In addition, it is also important to get a strong algorithm to estimate soil moisture levels, as well as other parameters. In Table I, we summarize the observations of PALSAR-2.

Among several models to obtain soil moisture, we chose a polarimetric-based SAR approach theoretically, the result using an inversion algorithm using two-component decomposition.

Table 1. Formatting sections, subsections, and subsubsections.

PALSAR-2 (ALOS-2 satellite)	Rainy season (Mar.)	Dry season (Aug.)
Observation date	2017. 03. 25	2017. 08. 02
Mode	Quad polarimetry 28°	Quad polarimetry 28°
Direction	Ascending	Descending

3. Result and Discussion

3.1. Field survey

The field survey research was conducted in March and August 2017 in Siak Regency, Indonesia. The main objectives of this research are in-situ data collection, soil moisture, soil roughness, soil content, and vegetation characteristics collected over selected areas within Siak peatland. The selected study area is an open area with sparse vegetation, and thus the forested peatlands are not considered at this time.

There are 11 area points during the survey which run on March and 23 points in July - August 2017, soil moisture measurement is done in various areas by TDR (IMKO) probe at some depth (0cm, 10cm, 20cm) to know which depth most correlated with SAR Signal. Soil roughness measurements were also performed by needle profilers developed by Chiba University (design) and Universitas Islam Riau (construction). Roughness information is also useful for our method.

The field survey on peatland on the Apit River, Siak was conducted on March 23-26, 2017 for the first survey and 26 July - 14 August 2017 for a second field survey. Members of the field survey for March, 2017 led by Prof. Josaphat Tetuko Sri Sumantyo, Ph.D, Dr. Ayaka Takahashi and the team are supported by the Islamic University of Riau headed by Husnul Kausarian, Ph.D and the team as well as the Siak Regency Government.

3.2. Sample location

The position of the survey sample is shown in the visible point of the map (Figure 2).

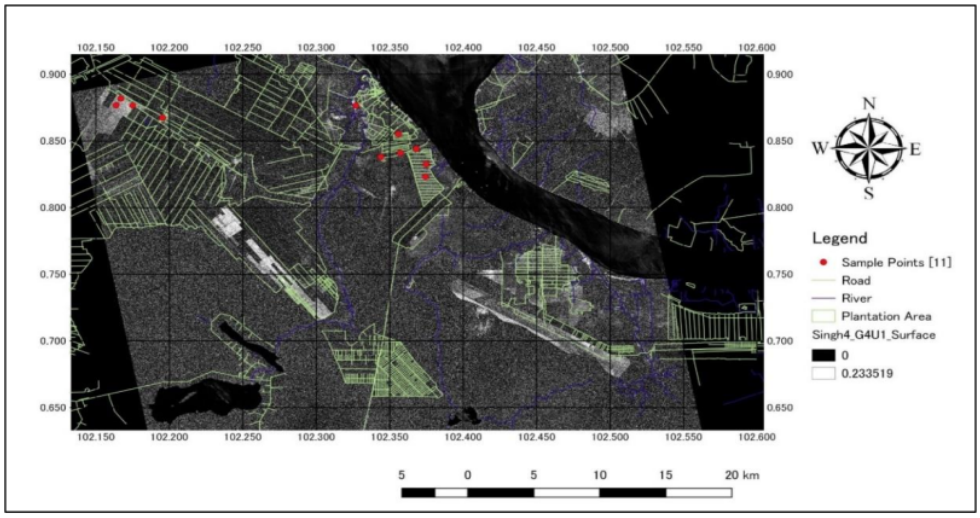

Figure 2. Point Sample location in March 2017 survey.

For the March survey, 11 sample points were taken and also took coordinate positions using the Global Position System. Soil moisture was also measured in this field survey using TDR (Time Domain Reflectrometry) 350 Soil Moisture Meter. Survey locations in the Apit River, Siak Riau. The location of the open land is owned by residents and companies.

For land owned by the company are PT. Triomas and PT. Arara Abadi. In this second survey, we have obtained 23 samples and soil moisture measurements using TDR 350.

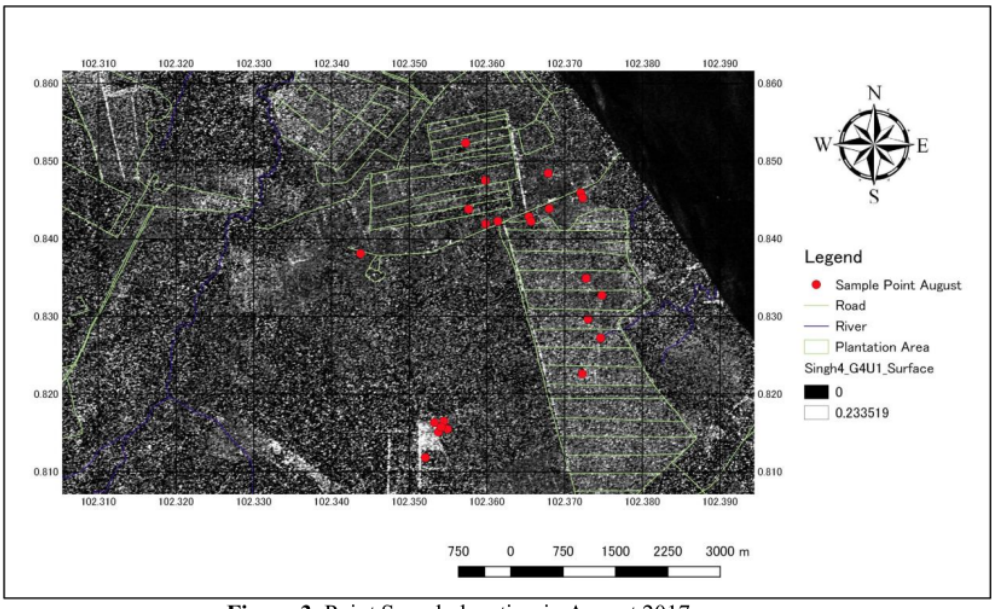

Figure 3. Point Sample location in August 2017 survey.

Figure 4. Measurement field. (left) Measurement of soil moisture with TDR, (right) Measurement of soil roughness with needle profiler.

3.3. 3D model of research area

Surveys using an unmanned aerial vehicle which known well as the drone has been developed. Here are some models of research areas that have been produced (Figure 5). From the results of 3D models that have been analyzed, then the entire research area in a flat condition. By using 3D Model, Field circumstances, and roughness of the ground.

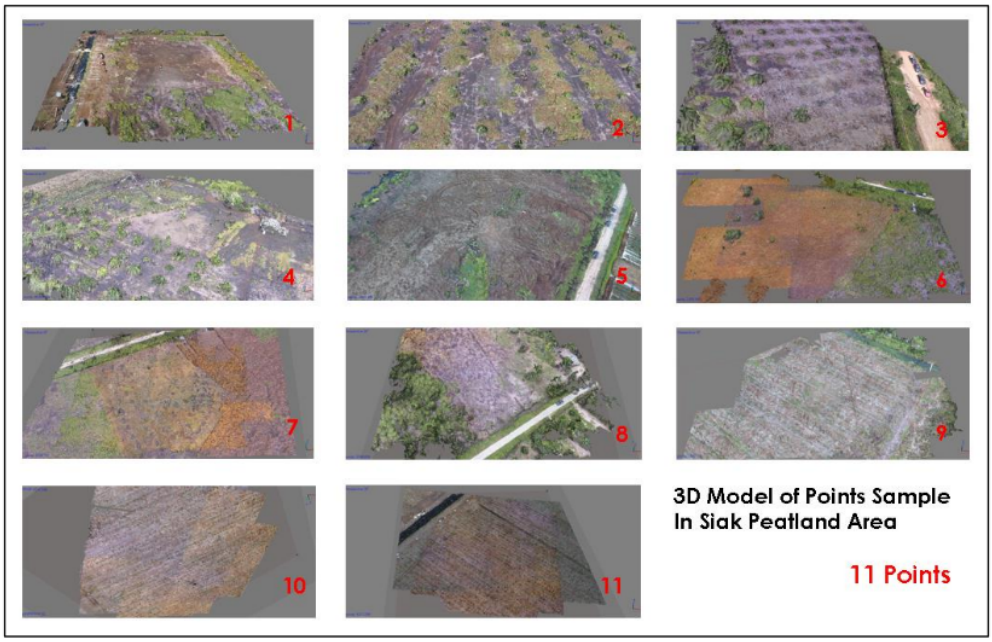

Figure 5. 3D Model of research area.

3.4. Image processing of synthetic aperture radar (SAR)

For SINGH4-G4UI decomposition component has been assembled and developed in this research. This is used to bring backscattering into four components: double bounce, volume, odd (surface), and helix scattering. Odd Scattering is a priority on this surface because its main focus is the scattering of the surface area. Other models will also be developed in addition to the decomposition model.

The result of the Odd Scattering analysis pointed out in Figure 6 and 7 shows that there is a very open peatland area beside the river and the color of the darker areas. This study focuses only on this field. Open areas show peatlands after being burned and no agricultural activity. This is a potential area that can be utilized to improve agricultural activities and economic levels of the community in the future. In the subsequent analysis in this study, in addition to soil moisture, will develop a soil moisture model for land suitability assessment for subsequent agricultural recommendations in shallow areas in Siak and in areas after burning.

From this survey, we found that there are variations in soil moisture conditions around 11 - 50%. Associated with soil content, the limiting parameter in peatlands is a pH of about 3 to 4. This condition is very acid for plants to grow well. This is the reason why farmers usually burn peatlands to make the soil more alkaline before planting. From that model, there is a good relationship between backscattering coefficiency and pH conditions. In the future, it is possible to conduct land suitability assessment on peatland using microwave remote sensing.

3.5. Distribution of peatland in Regency of Siak

From the results of observation and mapping in the field and adjusted with the latest satellite data used, the new distribution map of peatland in Regency of Siak can be seen on the map below:

There are many unused open areas in the Peat Area, in Siak regency. The humidity of the soil is on average dry in the dry season and will very easily become a forest fire. From the soil content, the pH conditions are very acidic. More effort is needed to make normal pH for agricultural activities. Microwave remote sensing has the opportunity to assess future land sustainability.

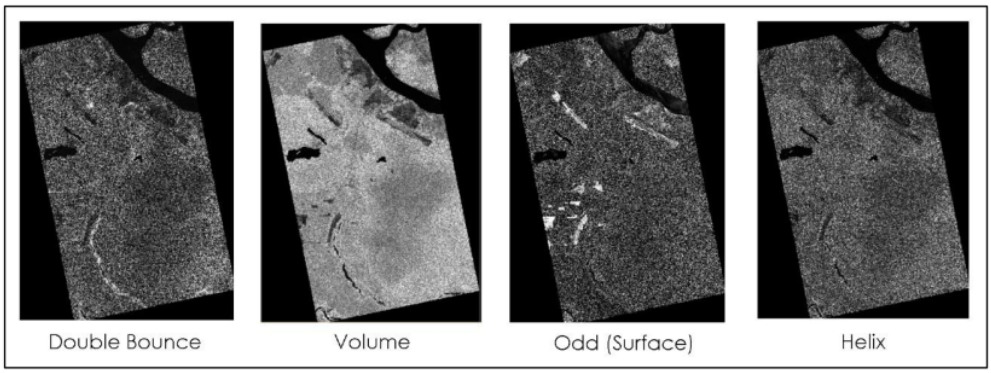

Figure 6. Four Components Decomposition from SINGH4-G4UI.

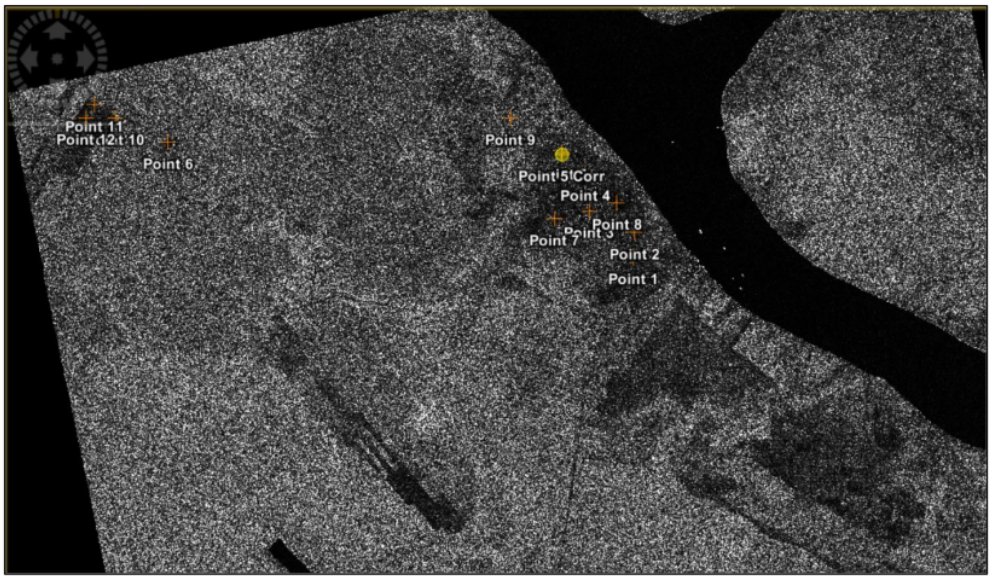

Figure 7. Odd/Surface Component Decomposition from SINGH4-G4UI.

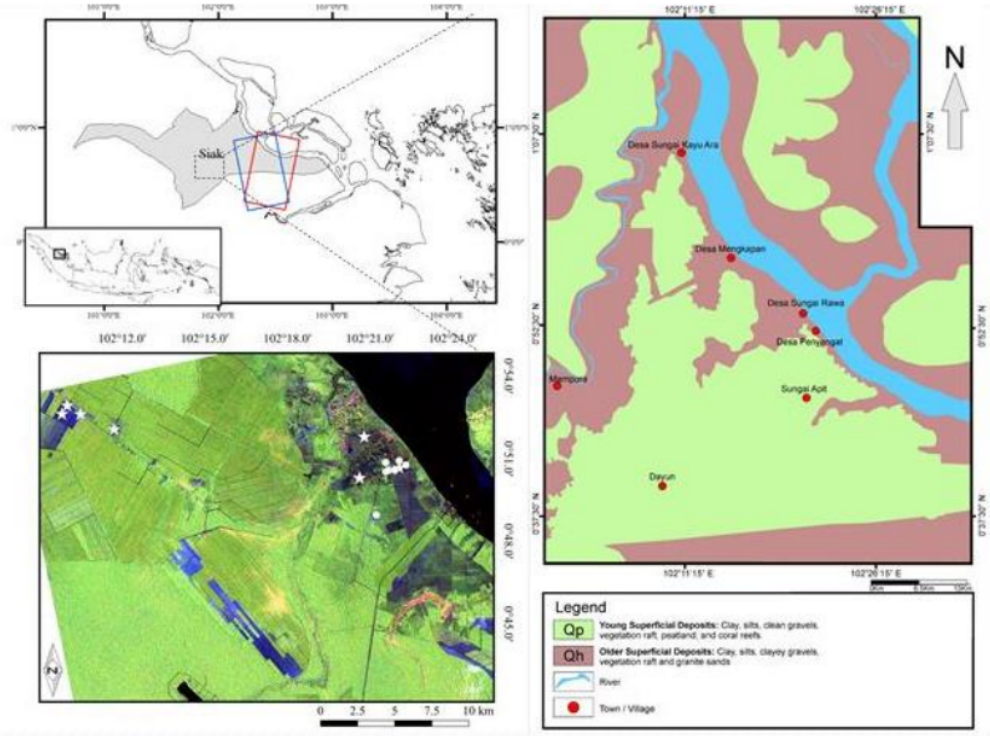

Figure 8. The New Geological and Peatland Distribution Map in Regency of Siak, Riau Province, Indonesia.

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