Silica sand identification using alos/palsar full polarimetry at the northern coastline of rupat island, indonesia

Husnul Kausariah[2], Josaphat Tetuko Sri Sumantyo[1] and Hiroaki Kuze[1]

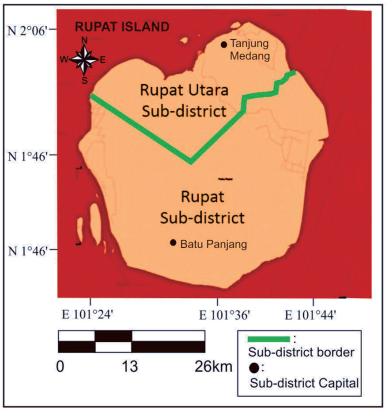
[1] Center for Environmental Remote Sensing, Graduate School of Advance Integration Science, Chiba University, Japan

[2] Engineering Geology, Faculty of Engineering, Universitas Islam Riau, Pekanbaru, Indonesia

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University

CEReS Center for Environmental Remote Sensing Chiba University

千葉大学 Chiba University



Map of Rupat Island, Riau province, Indonesia.

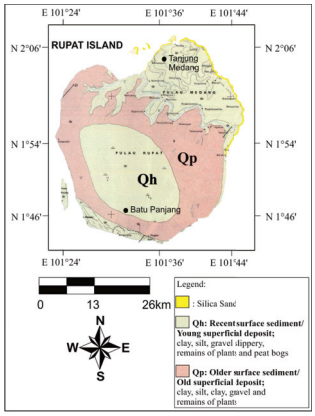
Content

- Overview and summary
- Data and Methods
- Result and Discussion
- Reference

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University

CEReS Center for Environmental Remote Sensing Chiba University

千葉大学 Chiba University



Geological Map of Rupat Island.

Overview and summary

- Silica sand is one of the mineral which relatively abundant in Indonesia. One of the area which has abundant of silica sand sedimentation is Rupat Island, Bengkalis district, Riau province, Indonesia. Silica sand in this island distributes in the north coastline area.
- SAR data is very suitable to use for geological or geoscience study such as surface roughness and soil moisture estimations, because the frequency or polarizations SAR measurements are carried out.
- To identify of the silica sand characteristic, SAR analysis and silica sand properties have been measured using Alos/Palsar full-polarimetery.
- Samples analysis: measurement of the dielectric constant, X-Ray Fluorescence (X-RF), microscopic photograph.
- The purpose of this study are: identification and detection of the silica sand distribution at the northern coastline of Rupat Island by analyzed the physical scattering technique using Alos/Palsar data

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University

CEReS Center for Environmental Remote Sensing Chiba University

千葉大学 Chiba University

Data and Methods

Configuration	Quadpol Alos/Palsar Data	
	Scene 1	Scene 2
Acquisitiondate	May 16, 2010	April 03, 2011
Wavelength	23.5 cm, 1.27 GHz (L-Band)	23.5 cm, 1.27 GHz (L-Band)
Spatialresolution	Az: 4.5 m Ra: 9.5 m	Az: 4.5 m Ra: 9.5 m
Levelproduct	P 1.1	P 1.1
Incidenceangle at scene center	25.752	23.948
Orbitpass	Ascending	Ascending
Noiseequivalent (NEσ^0)	- 30 ~ - 31 dB	- 30 ~ - 31 dB
Absolutegeo-location accuracy	< 200 m	< 200 m
Absoluteradiometric accuracy	0.7 dB	0.7 dB

Specification of Alos/Palsar Full-Polarimetry Data of Rupat Island.

Data and Methods

- From the Fresnel's reflectivity coefficient, the reflectivity coefficient of incidence wave can be described as below:

$$\Gamma^0 = \left| \frac{1-\sqrt{\varepsilon_{rS}}}{1+\sqrt{\varepsilon_{rS}}} \right|^2,$$

$$\Gamma = \Gamma^0 \cos\theta_i,$$

- Furthermore, the backscattering coefficient σ^0 (Tetuko, 2003) is defined as:

$$\sigma^0 = 20\log|\Gamma|$$

- And the backscattering coefficient σ^0 (dB) of ALOS PALSAR at a given polarization mode is:

$$\sigma^0 = 10log_{10}(DN) + CF$$

- Where CF is the conversion factor (-83) (Shimada, 2007)

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University
CERES
千葉大学 Chiba University

Result and Discussion

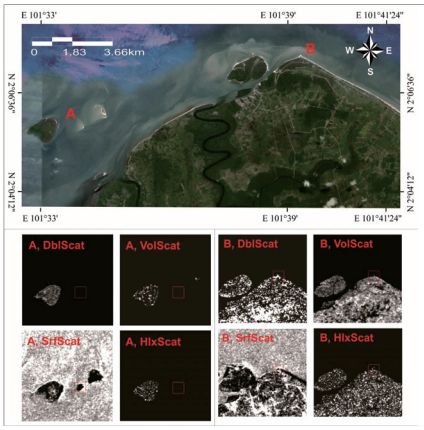
2. Scattering decomposition from four physical scattering models (Double Bounce scattering, Volume scattering, Surface scattering and Helix scattering) shown that surface scattering is the very clear decomposition to show the silica sand identification compare with the others.

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University
CERES
千葉大学 Chiba University

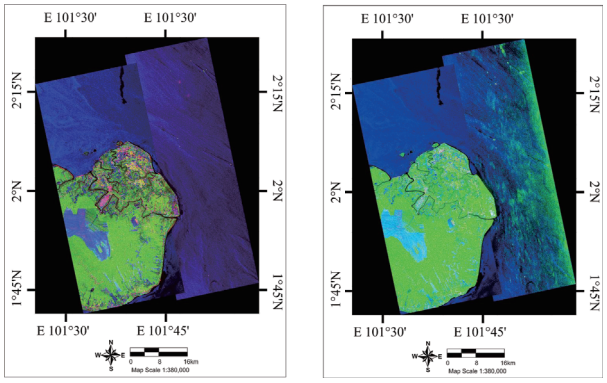
Result and Discussion

1. Freeman-Durdeen and Yamaguchi techniques have been used to get the scattering decomposition of physical scattering from the incoherent object model based.

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University
CERES
千葉大学 Chiba University



Google Earth's Image as the Reference Shown the Silica Sand as White Color Among The Northern Coastline of Rupat Island (A: Beting Aceh area, B: Tanjung Api – Tanjung Punai area). Result from Each Polarimetric Decomposition Shown the most Clear Image comes from Surface Scattering (SrfScat as Labeled).

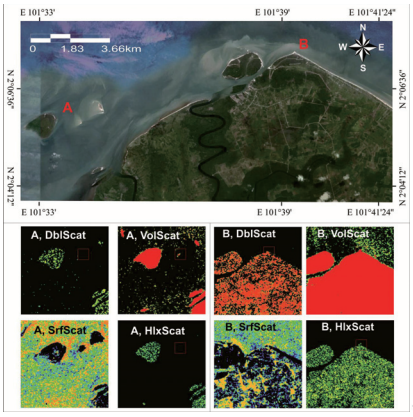


Yamaguchi Decomposition (Left) and Freeman-Durdeen Decomposition (Right) of Two Adjacent Scenes of Rupat Island.

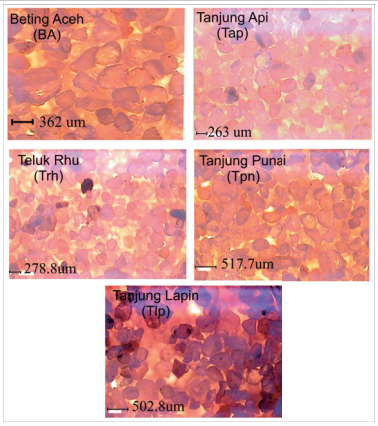
Result and Discussion

3. From surface scattering, backscattering coefficient value of silica sand has been calculated starting from -59 dB until -52 dB. These values were given by the silica sand surface roughness condition, where the roughness is almost flat, this condition supported by the grain size of silica sand particles that have almost the same size, that were conducted by using microscopic photograph testing.

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University
CERES
千葉大学 Chiba University



Backscattering Coefficient from Each Polarimetric Decomposition.



Microscopic Photograph Shown Grain Size of Silica Sand from Study Areas.

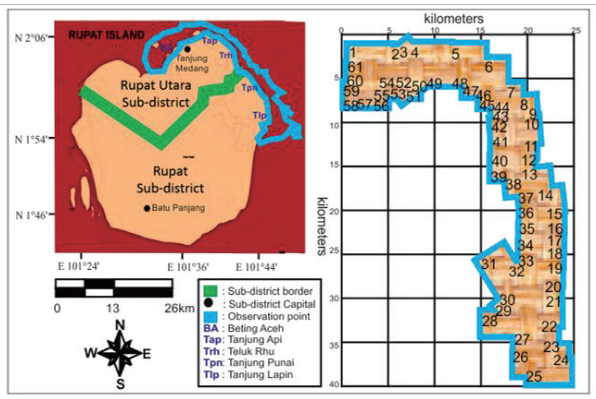
Result and Discussion

4. These values were given by the silica sand surface roughness condition, where the roughness is almost flat, this condition supported by the grain size of silica sand particles that have almost the same size (conducted by using microscopic photograph testing).

Josaphat Microwave Remote Sensing Laboratory
Center for Environmental Remote Sensing, Chiba University

CERES Center for Environmental Remote Sensing Chiba University

千葉大学 Chiba University



Study Area with 61 Observation Points of Silica Sand Presence that Has Been Recognized at the northern coastline at Rupat Island.

Flat Surface Condition Shown from Main Location of Study Area at Northern Coastline of Rupat Island.

Reference

A. Freeman and S. L. Durden, "A three-component scattering model for polarimetric SAR data,"IEEE Trans. Geosci. Remote Sens., vol. 36, no. 3, pp. 963–973, May 1998

Bartholdy, J., & Folving, S. (1986). Sediment classification and surface type mapping in the Danish Wadden Sea by remote sensing. Netherlands Journal of Sea Research, 20, 337–345.

Boerner, W., Mott, H., Luneburg, E., Livingstone, C., Brisco, B., Brown, R., & Paterson, S. (1998a). Polarimetry in radar remote sensing: Basic and applied concepts. In F. Henderson, & A. Lewis (Eds.), (3rd Edition). Manual of Remote Sensing, Vol. 2. (pp. 271–357).

Boerner, W.M., Mott, H., Luneburg, E., Livingstone, C., Brisco, B., Brown, R.J., & Paterson, S. (1998b). Polarimetry in radar remote sensing: Basic and applied concepts. In F.M. Henderson, & A.J. Lewis (Eds.), (3rd Edition). Manual of remote sensing, Vol. 2. (pp. 271–357).

Evans, D.L., Farr, T.G., & van Zyl, J.J. (1992). Estimates of surface roughnessderived from synthetic aperture radar (SAR) data. IEEE Transactions on Geoscience and Remote Sensing, 30, 382–389.

Hugenholtz, C., & Van der Sanden, J. (2001). Polarimetric SAR for geomorphic mapping in the intertidal zone, Minas Basin, Bay of Fundy, Nova Scotia. 24 (Preprint Canada Centre for Remote Sensing).

LHajnsek, E.Pottier, S.R.Cloude (2003) Inversion of Surface Parameters From Polarimetric SAR. IEEE Trans. Geosci. Remote Sens. vol.41, no.4: 727-744.

SABINS, F. F., 1997, Remote Sensing: Principles and Interpretation, 3rd edn (New York: W. H. Freeman).

TETUKO, S. S., J., TATEISHI, R., and TAKEUCHI, N., 2003b, A physical method to analyse Estimating topsoil thickness in Jordan using SAR data 3881 scattered waves from burnt seam and its application to estimate thickness of fire scars in central Borneo using L-band SAR data. International Journal of Remote Sensing, 24, 3119–3136.

ULABY, F. T., MOORE, R. K., and FUNG, A. K., 1986, Microwave Remote Sensing; Active and Passive. Vol. 3, From Theory to Applications (Boston: Artech House).

Yoshio Yamaguchi, Toshifumi Moriyama, Motoi Ishido, Hiroyoshi Yamada .Four-Component Scattering Model for Polarimetric SAR Image Decomposition. IEEE Transactions On Geoscience And Remote Sensing, vol. 43, 2005, PP.1699-1706.

ξ	: Burnt coal seam thickness
σ°	: Backscattering coefficient
Z_{IM}	: The effective impedances of incident wave
Z_L	: Peat-land
Z_C	: Burnt coal seam (including fire scars or tree stands)
θ_i	: Incident angle
Erm	: Electric field of reflected waves
Etm	: Transmitted waves
Ebm	: Waves that are reflected by peatland
E_0	: The intensity of incident wave
E_v^{scat}	: The total reflected wave
Z_0	: The intrinsic impedance
ε_r	: Complex dielectric constant
μ_r	: Complex specific permeability
Γ	: Reflection coefficient