ACOUSTIC CHARACTERISTICS OF SIDESCAN SONAR ALONG PROPOSED POWER CABLE ROUTE, DUMAI – RUPAT ISLAND

KARAKTER AKUSTIK SIDESCAN SONAR SEPANJANG USULAN RUTE KABEL BAWAH LAUT DUMAI - PULAU RUPAT

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ABSTRACT: Cable power installation along the route with bedforms-sediment structures sometimes potentially to have problems in the future or near future. In order to mitigate the cable from exposure because of currents, it is important to know a detailed understanding of the seabed and its mobility. Seabed characteristics, either textures or sediment structures, could be interpreted from acoustic characters, one of which is based on sidescan sonar images. An automatic interpretation to classify seabed characteristics can be done by using an image processing software. Image processing has been done on sidescan sonar images along power cable route between Dumai and Rupat Island. The image processing was using simple textures and Grey-Level Co-occurrence Matrix (GCLM) textures. Manual interpretation of sidescan sonar images classifies the acoustic characters into six; (1) fine sand waves with ripple marks, wave length 2.5-4 meters, (2) fine sands, (3) fine sand waves with ripple marks, wave length 5-9 meters, (4) fine sand with ripple-mega ripples, (5) coarse sands with ripple-trawl marks, and (6) very fine sands. The results of automatic classification show that image processing with simple textures is unable to identify the textures and structures of sediments properly, but by combining simple texture classification and GCLM types of sediment textures and sediment structures are better identified. This classification results are in agreement with the results of manual interpretation of sidescan sonar images.

Keywords: Ripple, Sonar, Image Processing and Classification

***ABSTRAK**:* Pemasangan kabel listrik di sepanjang jalur dengan dasar laut yang memiliki struktur sedimen terkadang berpotensi mengalami masalah di masa mendatang atau dalam waktu dekat. Untuk mencegah kabel terekspos akibat arus laut. Penting untuk memahami secara rinci tentang dasar laut dan mobilitasnya. Karakteristik dasar laut baik tekstur maupun struktur sedimen dapat diinterpretasikan dari karakteristik akustik, salah satunya berdasarkan citra *sidescan sonar*. Interpretasi otomatis untuk mengklasifikasikan karakteristik dasar laut dapat dilakukan dengan menggunakan perangkat lunak *image processing*. Pemrosesan citra sudah dilakukan pada citra *sidescan sonar* di sepanjang jalur kabel listrik Dumai-Pulau Rupat. Pengolahan citra yang digunakan adalah *simple textures* dan *Grey-Level Co-occurrence Matrix* (GCLM) *textures*. Interpretasi manual citra *sidescan sonar* mengklasifikasikan karakter akustik menjadi enam; (1) gelombang pasir halus dengan tanda riak, panjang gelombang 2,5-4 meter, (2) pasir halus, (3) gelombang pasir halus dengan tanda riak, panjang gelombang 5-9 meter, (4) pasir halus dengan riak-mega riak, (5) pasir kasar dengan tanda *ripple-trawl*, dan (6) pasir sangat halus. Hasil klasifikasi otomatis dengan pengolahan citra menunjukkan bahwa pengolahan citra dengan *simple textures* tidak dapat mengidentifikasi tekstur dan struktur sedimen dengan baik, tetapi menggabungkannya dengan GCLM jenis tekstur sedimen dan struktur sedimen dapat teridentifikasi dengan baik, dengan hasil klasifikasi yang relatif berkorelasi dengan hasil interpretasi manual terhadap citra *sidescan sonar*.

***Kata Kunci:** Riak, Sonar, Pengolahan Citra dan Klasifikasi*

INTRODUCTION

A bedform is a morphological feature formed by the interaction between a flow and cohesion less sediment on a bed (Nichols, 2009). Bedforms frequently observe in estuaries, coastal and offshore region. Bedforms can occur on cohesive and non-cohesive sediment (Poppe et al., 2002; Viekman et al., 1992; Blondel, 2009). Well-known bedforms on cohesive sediments (silt, clay and mud) is furrows and bedforms on non-cohesive (sand-gravel) that are mega ripples, ripples and sand waves. Erosional or depositional bedforms are influenced by sediment supply, current, waves or tides.

Bedforms on non-cohesive sediments is more dynamic, this meant that mobility of sediment will be easier and faster to follow the direction of current flow. Morphological changes that associated with bedforms on non-cohesive sediments have to be studied extensively because they may lead to hazards to navigation and offshore constructions.

Cable power installation along the route with bedforms sometimes potentially to have problems in the future or near future. Cable traversing a sand wave or mega-ripple field may experience a local stress build-up due to an uneven strain. It is well known that cables possibly to exposed on the seafloor may experience local scour, which in some cases may be sufficient to undermine the cable, causing a free span. When combined with sand wave migration the risk of free spanning increases. Besides a local stress build up and free span, it also experiences vortex induced vibrations (Roetert et al., 2017). Therefore, it is important to have a detailed understanding of the seabed and its mobility. Practically, morphological changes or dynamic bedforms should be considered during cable engineering in order to anticipate or mitigate power cable from exposure because of scouring and finally damage due to fishing or shipping activities.

A detailed mapping of bedforms must be carried out prior to cable laying or cable installation. Quick mapping of bedforms along the proposed cable route can be done by acoustic survey either sidescan sonar, sub bottom profiling or multibeam echosounder survey.

Proposed power cable route from Dumai to Rupat Island located in the Rupat Strait, Figure 1. The Rupat Strait is a narrow strait that separates the island of Sumatra and the island of Rupat, it was estimated that the near bottom current is quite strong. Based on bedforms classification by Morelissen et al. (2003) and Knaapen (2005), commonly near bottom current associated with existence of mega-ripples and sand waves. Because it is very important to know about the existence of bedforms for submarine cable installation then identification and mapping of bedforms have been carried out in this route by conducting an acoustic survey of sidescan sonar. Data

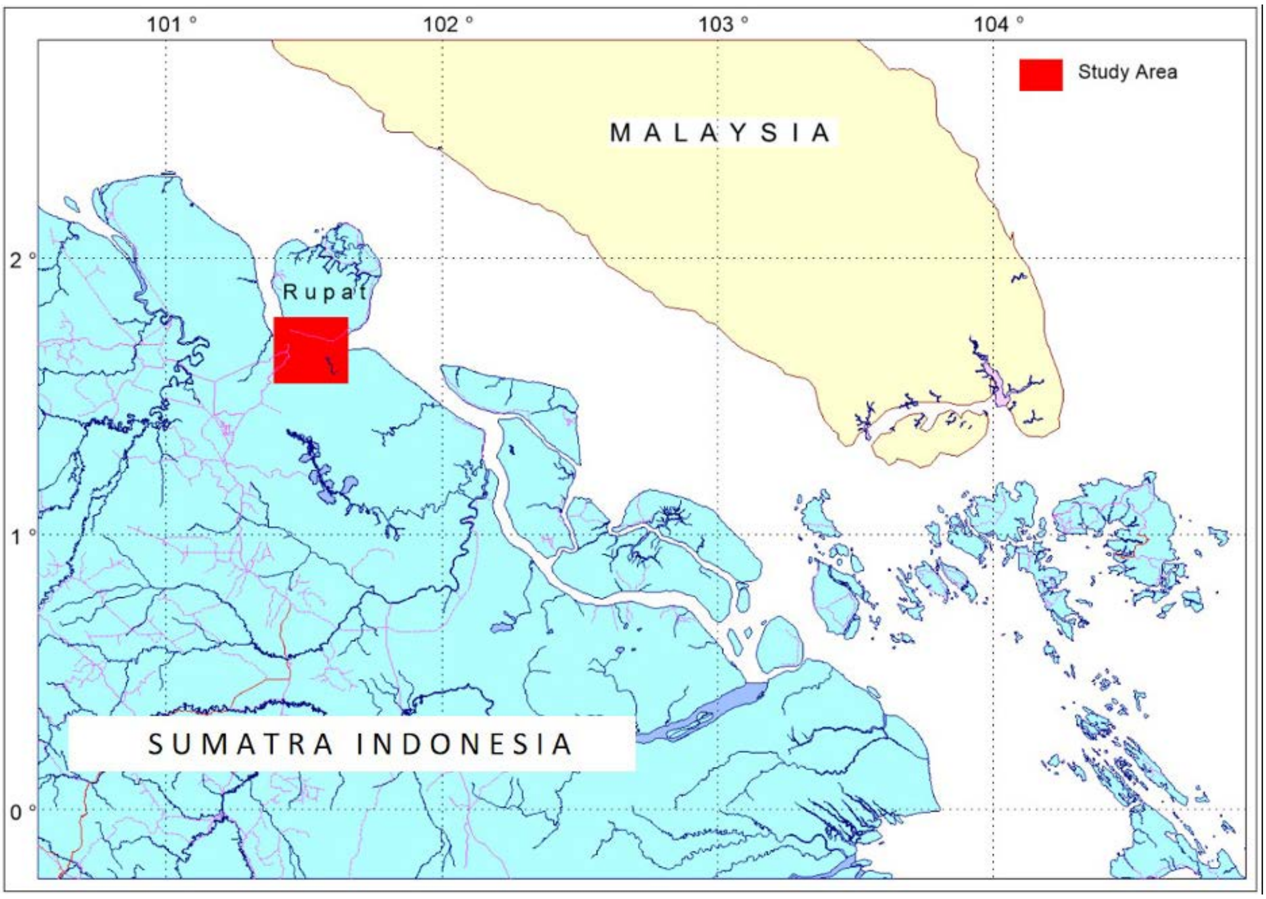

Figure 1. Study area of power cable route, Dumai – Rupat Island

analysis has been carried out to obtain acoustic characters of several identified bedforms.

METHODS

Acoustic characteristics related to bedforms were extracted from sidescan sonar data by using classification module on post-processing of Sonarwiz 7 software. This classification was processed with image processing that applied to sidescan sonar imagery as an output of data processing. Sidescan sonar imagery was computed from acoustic backscatter intensity that converted into pixel values, commonly 0-255, of a grayscale image (Subarsyah et al., 2021).

Classification use five parameters of image processing. Three parameters are simple textures consisting of intensity, entropy and standard deviation, while two more parameters are Grey-Level Co-occurrence Matrix (GCLM) textures (Chesapeake Technology, 2017).

The GLCM method was used to classify the sonar images into regions of different texture. This technique has been used for post-processing of sidescan sonar imagery for about 40 years (Pace and Dyer, 1979; Reed and Hussong, 1989; Keeton, 1994; Blondel et al., 1998). GLCM is an image processing technique developed by Haralick et al. (1973) which analyses texture and tone. Tone refers to the backscatter amplitude (the gray scale) of image pixels, with dark tone indicating lesser backscatter return than light tone. Texture refers to a repeating pattern, such as sand ripples. In this study only one GLCM used that is homogeneity.

RESULTS AND DISCUSSIONS

Distribution of sediment textures along Rupat Strait classified into three classifications, which is coarse silt, very fine sand, fine sand, medium sand and very coarse sand (Girsang and Rifardi, 2014). The sediment samples were taken using grab sampler. Based on this literature sediment texture along proposed power cable routes only classified into fine sand.

Manual interpretation of sidescan sonar images along power cable route in generally defined into six patterns; (1) fine sand wave with ripple marks, wave length 2.5-4 meter, (2) fine sands, (3) fine sand waves with ripple marks, wave length 5-9 meter, (4) fine sands with ripple-mega ripples, (5) coarse sands with ripple-trawl marks, and (6) very fine sands (Figure 2). Location of each character can be seen on Figure 3. Mosaic image on Figure 3, shows that dark zone has high intensity while bright zone has low intensity, or the grey color was inverted.

Detailed information about sediment textures distribution and sediment structures along proposed power cable required as consideration for cable engineering and protection. Lack of detailed information regarding the distribution of sediment textures and sedimentary

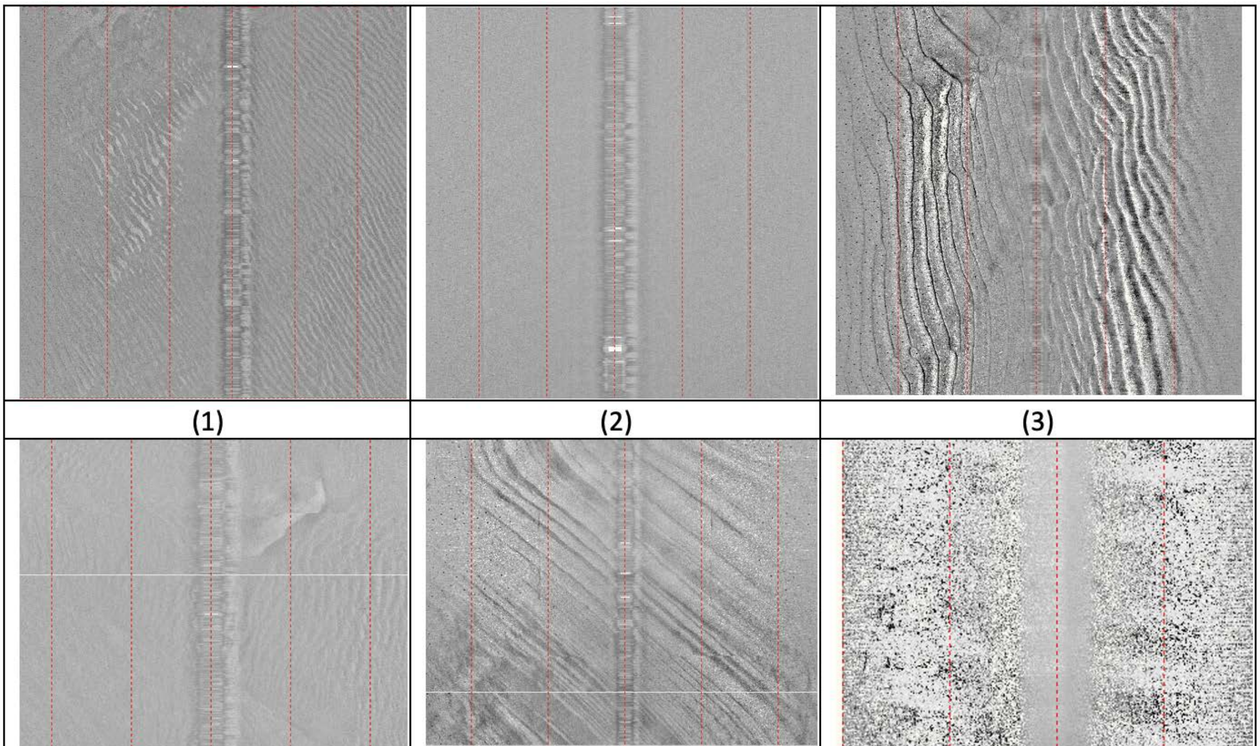

Figure 2. Acoustic patterns along proposed power cable route, Dumai - Rupat Island

structures along proposed power cable route is a challenge to carry out studies related to seabed classification, automatic classification and mapping of sediment textures and sediment structures.

Classification based on image processing with simple texture; standard deviation, entropy and intensity has classified seabed into six classes, Figure 4. Class 1 (red color) minor identified generally nearby coastal zones. This class has lowest intensity and highest entropy, and associated with coarse silt or shadow zone due to ripple marks. Class 2 (green color) has low intensity and high entropy and is distributed close to the coastal zone and shadow zone due to ripple marks. Class 3 (blue color) is a dominant class and it has medium intensity and entropy. This class is distributed on fine sand without ripple marks also fine sand with short wavelength ripple marks. Class 4 (magenta color) has high intensity and low entropy, this class distributed on coarse sand with ripple-trawl marks.

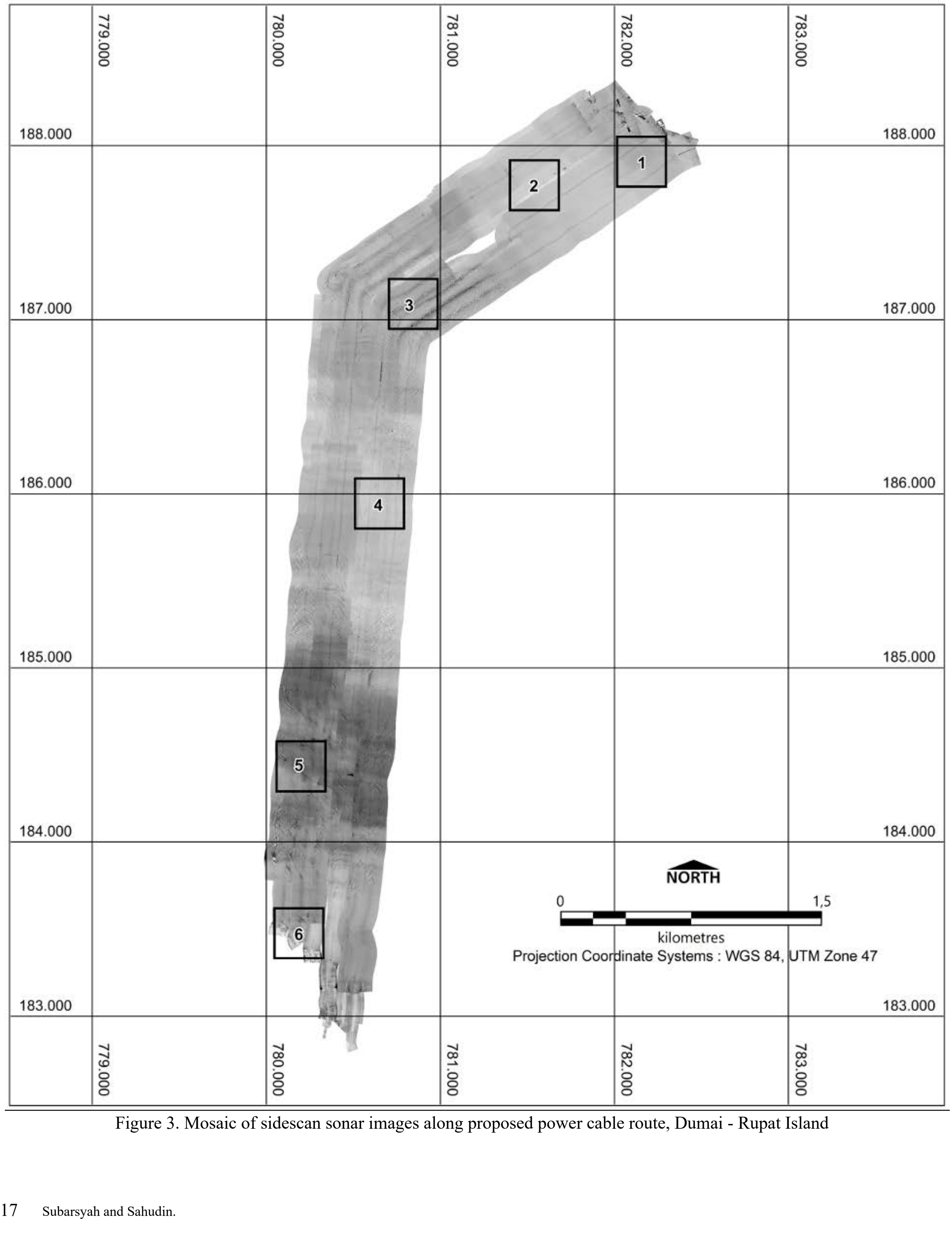

Figure 3. Mosaic of sidescan sonar images along proposed power cable route, Dumai - Rupat Island

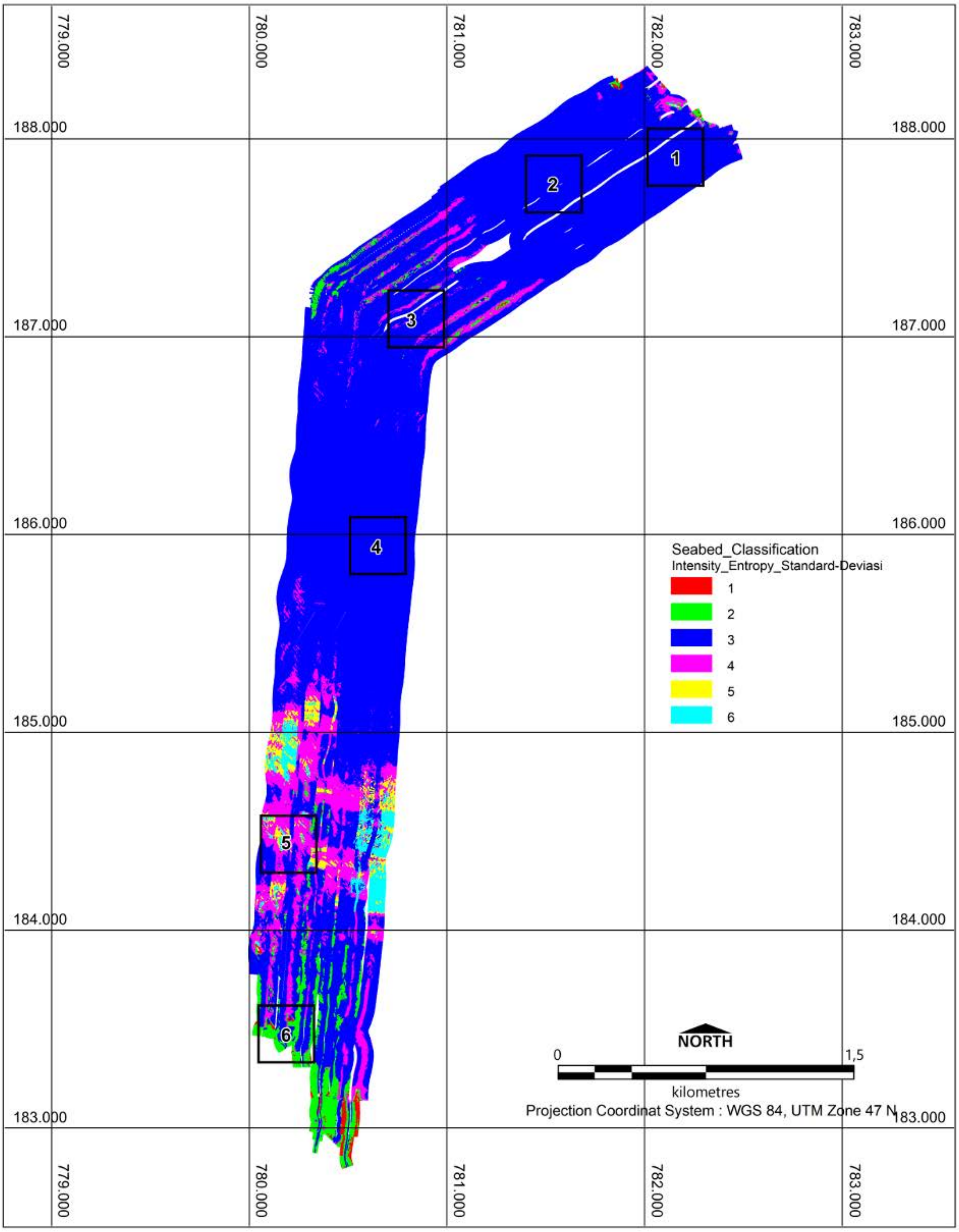

Figure 4. Seabed classification using simple textures.

Class 5 (yellow color) is distributed on coarse sand with ripple-trawl marks. This class has high intensity and low entropy. Class 6 (light blue) has high intensity and low entropy and is distributed on coarse sand with ripple-trawl marks. Class distribution has distortion at small part especially in the southern part due to artefact or acoustic distortion.

Sediment structures along the route can not be well defined by simple texture image processing, especially the short wavelength ripple marks and mega ripple. Class distribution to mapping sediment structures conducted by combining simple texture-intensity and GLCM-homogeneity image processing.

Seabed characterization by combining simple texture-intensity and GLCM-homogeneity classify seabed into five classes, Figure 5. The first class (red color) is distributed almost in the southern part that has homogeneity on high intensity, this region associated with coarse sand. Small part of this class is distributed in the part of ripple marks which will give a high acoustic intensity value. The second class (green color) is relatively similar to the first class but has a lower intensity value. Most of this class is distributed in the southern part of the first class and at the outer region of the ripple mark with wavelength 5-9 meters. Homogeneity of the third class (blue color) is in medium intensity, this class almost found along the power cable route included in the ripple marks zone that have wavelength 2.5-4 meters. The fourth and fifth class are identified in the upper part and middle part of the power cable route. Both classes have homogeneity in low acoustic intensity.

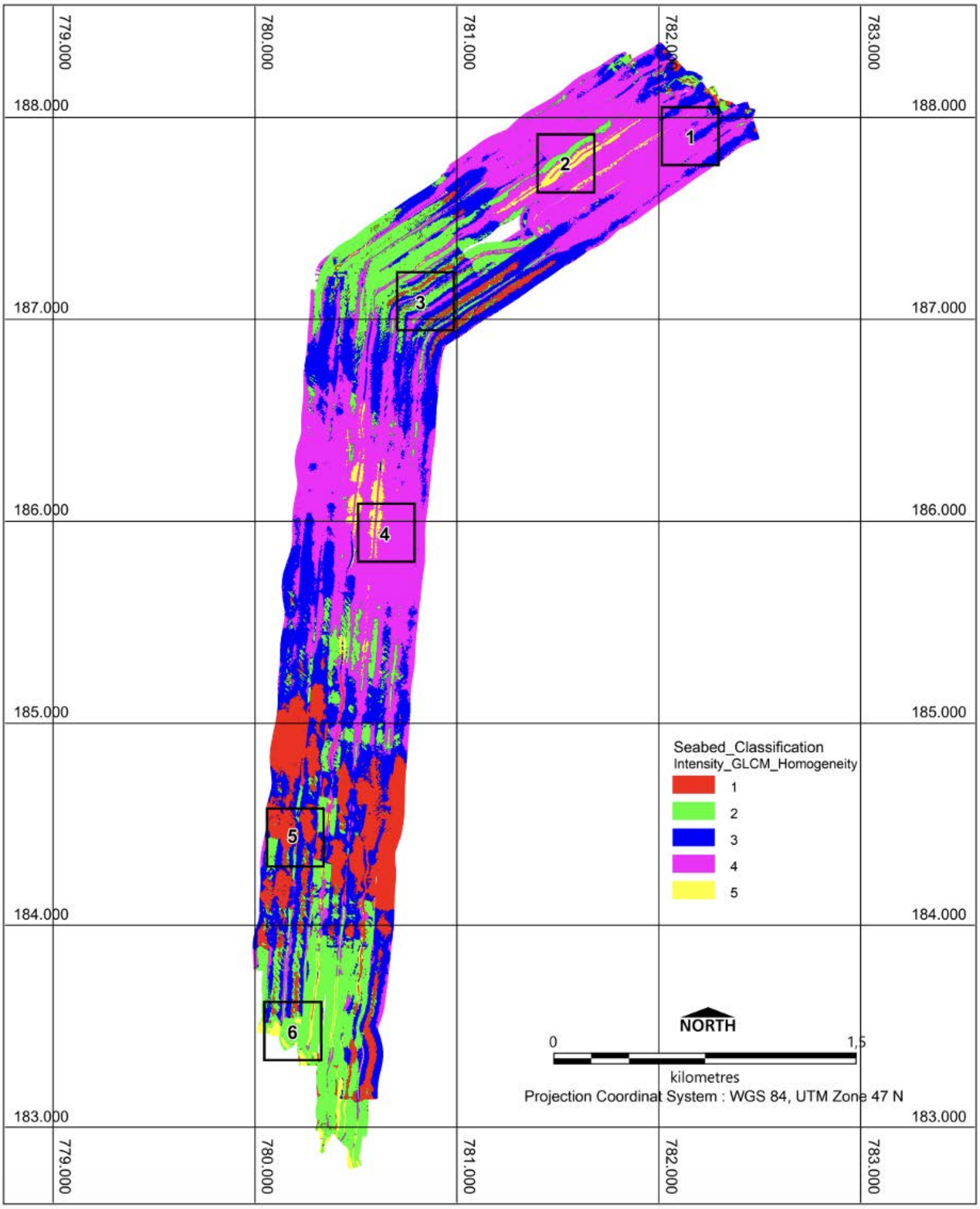

Figure 5. Seabed classification using simple texture and GLCM-homogeneity.

Based on the result of sediment structures identification through its acoustic characteristic, mapping of sediment structures affected by wave length and height of the ripple marks. These two parameters will contribute to low and high intensity distribution. Besides the two things mentioned above, the selection of parameters in image processing both window size and window step also will affect the result.

CONCLUSIONS

Manual interpretation of sidescan sonar image classifies the acoustic characters into six; (1) fine sand wave with ripple marks, wave length 2.5-4 meters, (2) fine sand, (3) fine sand wave with ripple marks, wave length 5-9 meters, (4) fine sand with ripple-mega ripple, (5) coarse sand with ripple-trawl marks, and (6) very fine sand.

Based on acoustic characteristics, automatic seabed classification of sediment textures cannot be clearly identified and its distribution does not correlate with the results of the interpretation manual. But implementation of image processing combined with simple texture and GCLM produced seabed classification that correlated with manual interpretation.

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