Side-scan sonar investigations and marine seismic of identification object

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Abstract. In the process of identifying seafloor objects, the hydroacoustic method using 2 beams, namely ports and starboards in side scan sonar instruments is a very efficient and renewable method in its field, especially in the hydrographic field. This study was carried out at December 2016 on Punggur waters, Indonesia (104°05.6103 E, 1°04.3226 N until 1°03.3977 N 104°07.9100 E, 1°02.2866 N). The side scan sonar used when recording seabed images in this study uses one frequency, 325 kHz covering surface around 4.72 km in Punggur waters, Indonesia. The ship navigates using GPS Trimble 361, which is corrected using beacons, with data retrieval activities when the waves are calm. The gain produced by the side scan sonar instrument will have a relationship that will not be the same at every seabed data collection location. Side scan sonar uses a Baudrate value of 19200 and with a value of 8 bits with a maximum Gain value of 8 dB. Highest result of the time is 13568 cm/second and 104.325 cm in line trace object 4 of side scan sonar imagery. Highest result of line trace is target 1 with 191.88 cm on object 1, and highest of time result is 13568 cm/second on object 4.

1. Introduction
Batam waters, especially in Punggur waters located in one of the waters of Indonesia, still have a minimum level of information on the detection of seabed features using underwater acoustic technology. Worldwide, these marine environments have not been studied using high-resolution hydro-acoustic methods (e.g., bathymetry, and base profiles), useful for investigation of sediment processes, benthic habitats, mineral resources, artificial artefacts, and other features. Remote sensing of the seabed using SSS technology with seafloor data, explains with features and images of changes in sea depth and changes in sea depth in Punggur waters, Batam. This research was conducted in the same place (same location), but with a different identification and discussion with the previous article [1]. In this study, the authors focus on the target value and its relationship to the seismic seabed surface. The numbers of targets identified in this article has only 4 targets while in the previous article [1] used 18 targets, this makes the writer must make the article more detailed in identifying only using 4 targets in this article, by discussing it in a complex manner (seismic line trace, and object mosaic detection). The location of research conducted at coordinates is 104° 05.6103 E, 1° 04.3226 N until 104° 07.9100 E 1° 02.2866 N but the length of the survey track conducted in this article is different
from the previous article. The seafloor imagery, object identification, and image processing with two-dimensional were conducted on the Punggur Sea in 2017 [1,2]. The seabed feature detection instrument technology using Side Scan Sonar can display very complete features using the towfish system when collecting data in water [3].

The main parts of the side scan sonar are basically two transducers on towfish with tilted beams and a recording unit mounted on a ship that function to record graphical images formed from echo traces that describe the state of the seabed in sonographic form [4–6]. Seabed imagery using the Side Scan Sonar instrument will have a seabed result swept in a sweeping path which is a path consisting of visualization results of both the port (left) and starboard (right) transducers with the part not swept in the middle (figure 1) [7–8]. Generally increasing the frequency will increase the resolution image obtained [9–11]. The system contained in the side scan sonar has an oblique transducer location and its recording unit, which can be used to provide underwater imagery information, which can then be interpreted so as to produce underwater information. Side scan sonar is often used in bathymetry surveys combined using single-beam echosounder as an addition to depth data information [12,13]. But surveys using a side scan sonar will always incur very expensive costs, to carry out various procedures in using these tools, for example in the use of ships, the length of time of the survey, and the processing of seabed imagery data. This is very much research on the seabed image in Punggur waters, Batam, Indonesia is still rarely done.

2. Methodology

In this study, the data taken by recording seabed images using side scan sonar is located on one side of the Batam waters, which is called Punggur waters. This study was carried out at December 2016 in the Punggur waters, Batam (104°05.6103 E, 1°04.3226 N until 104°07.9100 E 1°02.2866 N) (figure 2). In this study, data retrieval of seabed features uses seabed remote sensing technology with a C-MAX CM2 instrument with a 50-meter long cable, speed of 6 knots at the 7–16m altitudes above the seabed. The results obtained from side scan sonar recording are with high-resolution seabed imagery, by having a right-sided and left-sided SONAR system and producing detailed seabed object detection. The side scan sonar used when recording seabed images in this study uses one frequency, 325 kHz. Positioning was completed using a GPS receiver (WGS84 datum with zone 48N) and all data were recorded into a computer.

The gain produced by the side scan sonar instrument will have a relationship that will not be the same at every seabed data collection location. Side scan sonar uses a Baudrate value of 19200 and with a value of 8 bits with a maximum Gain value of 8 dB, which is the greatest strength value in the use of side scan sonar in this study. TVG (Time Varied Gain) contained in the side scan sonar system functions to keep the signal strength received by the signal receiver in the side scan sonar instrument. [14–17], and the location of research can be seen on figure 2. The formula for calculating the value of TVG (Time Varied Gain) that uses variations in location and time differences by:

\[
TVG = - (\text{dB} - 30 \log 10 \text{ (range)} - 8.2 \times 10^{-4} \text{ (range)} \) 90/\text{dB (dB)}
\]

where dB is a constant and range is in meters. The voltage ratio is

\[
TVG (\text{range}) = 10 TVG/20
\]
Figure 2. Research location and seabed image recording path using side scan sonar in Punggur waters, Batam, Indonesia.

According to Owen et al. [17] discuss methodologies for converting paper seismic records into SEGY format. However, they did not test the use and reliability of this technique in the field.

3. Results and discussion

Data from the side scan sonar recordings that were conducted with research in 1990-2016 shows that the results of the recording of this seabed image result in the identification of objects and seabed features that are specific and have an accurate position. This shows that the side scan sonar instrument is very well used for data collection of seabed features in the water, especially in shallow waters [18–20]. Mosaic of side scan sonar imagery gives many objects (figure 3). This research has identification 4 objects in side scan sonar imagery, in object 1 have distance object is 187.8 m, object 2 has distance object is 137.1 m, object 3 have distance object is 70.9 m, object 4 have distance object is 23.7 m (figure 3). The highest measure distance object is object 1 of side scans sonar imagery, and lowest measure distance is object 4 of side scans sonar imagery, and the grey mosaic of Side Scan Sonar (SSS) imagery can be seen in figure 4 with many items and description. (Suggestion: imagery can be seen in figure 4).

SSS surveys were performed using C-Max CM2 model operating at The results of recording the seabed image produced in this study can be seen in figure 4, by showing seabed objects as well as seabed sediment types detected using side scan sonar which is a high-resolution seafloor image. The height of the side scan sonar tool in the collection of research data is the optimal height of 8-17 m above the seabed. The recording of seabed imagery data is performed using a bit value distance of 5. This result shows the object of concern namely at object 3 and object 4 (figure 4), this is indicated by the extent of the shadow produced by the seabed image, and with the value very large gain which is 8dB.

This survey uses side scan sonar using a 325 kHz frequency, which has a swept area of around 4.72 km in Punggur Waters, Indonesia. The ship navigates using GPS Trimble 361, which is corrected using beacons, with data retrieval activities when the waves are calm. The SSS was towed at a depth between 4-8 m above the bottom, this result can be seen in figure 4. Figure 5 is the result of extracting data from SSS imagery into 2D seismic cross-sections and subsequently identified by seeing detected objects (seismic line trace). The seismic line trace of object detection has 41 numbers of data collections from side scan sonar imagery after processing. The highest of seismic line trace of object detection is object 3 with 1664 (figure 5).
Figure 3. Position of side scan sonar object identification.

Figure 4. Object mosaic detection of side scan sonar investigation.

The resulting output from the mosaicking algorithm is given in figure 3 and figure 4, which shows a mosaic obtained from geo-referencing the data from figure 4. Identification of seismic line trace with the identification object must be important for seismic investigation and analysis. In figure 6 is a picture of the results of processing 2D seismic sections with the left side in the image coloured, while the right side is a seismic cross section with gray colour. The object is shown in blue on the left image on a seismic cross section, while on the right picture is shown in dark gray colour on a 2D seismic cross section (figure 6). Figure of line trace vs time have max data is 200 on line trace and 220 x 103 time in object 2. The highest result of the time in figure 6 is 12928 cm/second and 191.88 cm in line trace object 2 of side scan sonar imagery. The highest result of the time in figure 7 is 9968 cm/second and 57.525 cm inline trace object 2 of side scan sonar imagery. Highest result of the time in figure 7 is 13440 cm/second and 186.615 cm inline trace object 3 of side scan sonar imagery. Highest result of the time in (figure 7) is 13568 cm/second and 104.325 cm inline trace object 4 of side scan sonar imagery. Object 1 has a relationship with results with the highest object detection of side scan sonar imagery (figure 4). The seismic figure of side scan sonar imagery has total line trace is 4479, time: 77.9547 cm/s, and gain: 0.00271091 (figure 7).
Figure 5. Seismic line trace of object detection.

Figure 6. Seismic of side scan sonar imagery.
4. Conclusions

SSS technique could be applied to characterize the seabed identification. In Punggur waters have been identified as much as 4 objects. Their distance object also could be seen of each other. The object of 1 have the highest value of distance object as well as 187.8 m and the object of 4 have the lowest value of the distance object as well as 23.7 m. The increased knowledge about pockmark features have resulted from this survey, it was mainly achieved by the side scan sonar which was towed at an optimum altitude (10–26 m) above the bottom, regardless of the (actual) water depth. Object 1 has a relationship with results with highest object detection of SSS imagery.

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