ANALYSIS OF THE QUALITY OF SOUNDING DATA IN RELATION TO THE DIFFERENCES IN SEABED TOPOGRAPHY

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Abstract

Visualizations of seabed surface topography is obtained from such an activity called sounding survey. Points of measurement of the depth are located sounding line and checkline crossing.

In the research analysis is carried out on the relationship between the quality of the sounding data and the topography of the seabed, which was divided into five (5) criteria, that is, coral (Cr), coral sand (CrS), mud (M), mud sand (MS), and sand (S).In order to know the sounding data quality, is done by comparing the depth of intersection of the sounding line and the checkline crossing which is then referred to as the analysis point. The position and the depth of this point is found by the linear intepolation method.

The result of this research indicate that there are irregularities in the depth of the analysis point, which indicates an error in the measurement accuracy. If viewed from the mistake that occur in the analysis point, the analysis points of the depth profile with the seabed topography of mud sand (MS) has the best accuracy compared to the other profiles. While the analysis poinst in the depth profile of coral (Cr) has the least level of accuracy compared to the others. Thus it can be said that the depth measurement done on mud sand (MS) has the best quality and the depth measurement done on coral (Cr) has the lowest quality.

Keywords : Sounding line, Checkline crossing,, Analysis points, Seabed topography, Depth

INTRODUCTION

Sounding is a measurement activity in the sea to obtain a description of the surface (topography) seabed. Sounding is conducted by creating a profile for the measurement of depth. Depth measurements are made at the points selected to represent the entire area to be mapped by using the depth gauge tool called echosunder.

One of the limitations of the echosounder is the acoustic waves that emanate when using the beamwidth , not a scattered wave that is focused on one point. The use of beamwidth on echosounder can cause depth measurement to the bottom surface waters which is recorded to be false.

Points of depth measurement are on sounding rows which is called sounding line. Sounding on checkline crossing should be conducted to ensure the accuracy of sounding. Spaces of checkline crossing density are made in such a way so that we get the control effect efficiently and comprehensive to the sounding line. As a guide it may be assumed that the interval between checkline crossing, is normally not less than 15 times the space from sounding line (IHO SP-44 5th edition). To determine the quality of sounding data done by comparing the depth of intersection between the sounding line and checkline crossing.

Data quality will be indicated by comparing the sounding data results to their effect on the seabed surface and also the other factors that are thought to affect the accuracy of sounding data.

Problem formulation that appear in this research is how to obtain quality data by comparing the sounding line with the checkline crossing and their relation to different seabed topography.

Problem limitation in the writing of this final task are the results from sounding surveys data, data

results from surveys is divided based on the difference of the seabed topography, determination of the seabed topography is divided based on the grab sampler results, profile of the seabed topography are based on the actual sea floor sediments and divided into five types, namely Coral (Cr), Coral Sands (CrS), Mud (M), Mud Sands (MS), Sand (S), the influences of sounding data quality to the seabed surface, and positioning used DGPS (Differential Global Positioning System) with Real Time Kinematic Methods.

The objectives of the final task are explore the relationship between the error of measurement to the factors that affect the quality of sounding surveys and determine the quality of sounding data from each of seabed surface.

The benefits that are expected from this research is determining the quality of sounding data on the sea floor which has a variable morphology by estimating the accuracy of depth mesurements through the deviation obtained from depth analysis between sounding line and checkline crossing.

RESEARCH METHODOLOGY

There are three study areas taken as location for this final assigment :

1. Semak Daun Island waters, Seribu Archipelago which represents the seabed form of Coral (Kr) and Coral Sands (PKr)
2. Ketapang waters, East Lampung which represents the seabed form of Sands (P) and Mud Sands (LP)
3. Tarakan waters, East Kalimantan which represents the seabed form of Muds (L).
4. Geographically, the third research areas are located on the waters of Indonesia at 95° BT - 141°BT dan 6 °LU - 11 °LS. The sites were selected as being representative to the seabed surface as has been mentioned previously.

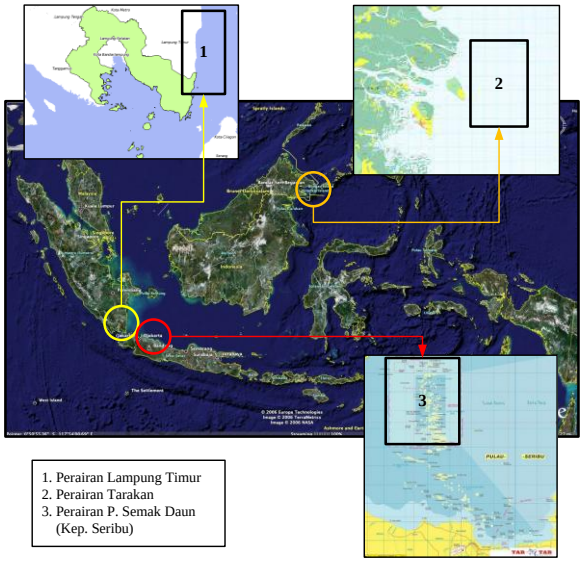

Figure 1 Research Location

Tools

Equipment used in this research are :

1. Hardware
   a. Laptop Intel(R) Pentium(R) Dual CPU T3400 2.16GHz with 1.00 GB RAM for processing data and writing reports.
2. Software
   a. Autodesk Landeskstop 2004 for data processing and calculating.
   b. Microsoft Office Visio 2007 for flow chart making and images editing
   c. Microsoft Office Excel 2003 for data processing.
   d. Microsoft Office Word 2003 for writing reports.

Materials

Material or data used in this research are :

a. Batimetric Chart
b. Grab sampling results
c. IHO SP 44 5th editon, used as a guide determining the standard accuracy of vertical depth.
d. IHO M-13 2005, used as a guide determining the classification of the seabeds.

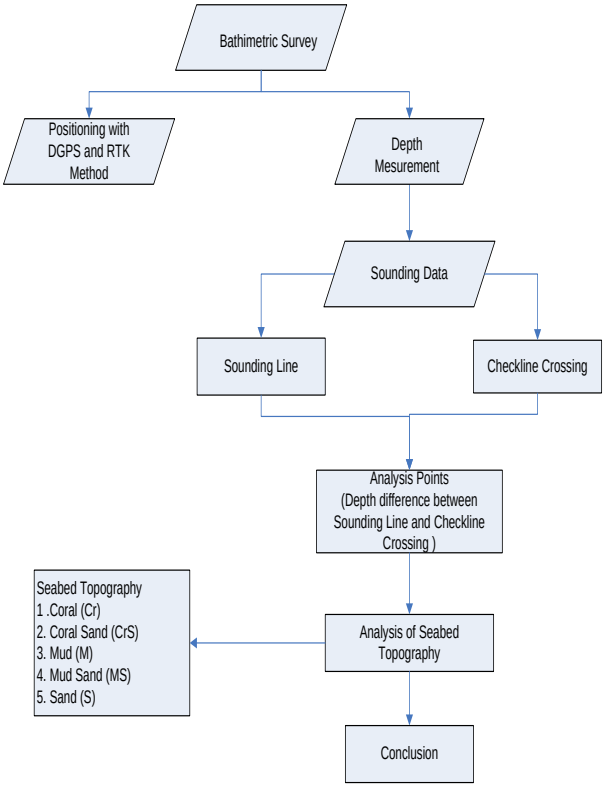

Figure 2 Flow chart of data processing

Data used in this research are :

a. Bathimetric Chart Harbour Sands Planning PT Kumafa Lagun Marina (Ketapang East Lampung) scale 1 :1000
b. Bathimetric Chart Pasir Tarakan Peninsula, Tarakan East Kalimantan scale 1:10000
c. Bathimetric Chart Semak Daun Island waters, Seribu archipelago scale 1:1000.

Data analysis done by comparing calculating data results between sounding line and checkline crossing in every seabed surface which then adjusted to standard accuracy established by IHO.

Analysis points determination

From each of the seabed surface,the defined area which is an intersection between points of sounding line and checkline crossing, then the analysis points were set.

From the calculation,we obtained the position and depth of analysis points from each seabed surface as the table below.

Table 1 Analysis points of Coral (Cr)

No	Analysis Points			
	Position		Depth	
	Easting	Northing	du (m)	ds (m)
1	675226,000	9366224,730	-7,55	-8,00
2	675411,580	9366227,590	-2,83	-2,66
3	675461,790	9366228,980	-9,61	-9,96
4	675623,120	9366227,060	-3,57	-3,97
5	675711,260	9366230,420	-0,72	-0,83
6	675816,260	9366236,940	-0,42	-0,43
7	673915,410	9366233,030	0,19	-0,23
8	675916,880	9366237,000	-0,45	-0,23
9	676013,480	9366240,880	-1,50	-1,61
10	676323,250	9366239,010	-2,02	-1,66

Table 2 Analysis points of Coral Sands (CrS)

No	Analysis Points			
	Posistion		Depth	
	Easting	Northing	du (m)	ds (m)
1	674819,120	9367029,770	-0,80	-0,82
2	675012,000	9367031,200	-1,41	-1,50
3	676815,440	9367028,900	-6,38	-6,10
4	676923,350	9367032,490	-0,59	-0,73
5	677213,170	9367033,960	-0,17	-0,16
6	677422,190	9367033,810	-0,16	-0,16
7	677713,710	9367029,290	-0,11	-0,28
8	677907,100	9367030,320	0,20	0,21
9	678016,720	9367033,240	0,15	0,18
10	678221,090	9367021,910	0,24	0,22

Table 3 Analysis points of Mud (M)

No	Analysis Points			
	Posistion		Depth	
	Easting	Northing	du (m)	ds (m)
1	574876,829	361770,161	2,85	2,91
2	574874,306	361694,244	3,01	3,14
3	574871,510	361612,602	3,21	3,35
4	574871,483	361469,262	3,75	3,73
5	574873,121	361371,733	3,89	4,09
6	574871,958	361296,169	4,13	4,37
7	574871,747	361213,992	4,53	4,67
8	574873,309	361132,010	4,93	5,03
9	574872,630	361053,329	5,28	5,42
10	574872,030	360970,472	5,64	5,82

Table 4 Analysis points of Mud sands (MS)

No	Analysis Points			
	Position		Depth	
	Easting	Northing	du (m)	ds (m)
1	589184,860	9361998,937	3,29	3,35
2	589187,529	9361985,054	3,32	3,45
3	589184,746	9361978,636	3,34	3,44
4	589183,789	9361972,629	3,45	3,30
5	589183,400	9361969,803	3,36	3,45
6	589184,052	9361961,792	3,36	3,51
7	589184,082	9361953,075	3,34	3,37
8	589184,434	9361945,394	3,38	3,47
9	589185,499	9361932,707	3,38	3,49
10	589185,650	9361997,290	3,39	3,46

Table 5 Analysis Points of sands (S)

No	Analysis points			
	Position		Depth	
	Easting	Northing	du (m)	ds (m)
1	588437,929	9362066,364	2,41	2,22
2	588437,541	9362063,561	2,32	2,22
3	588433,246	9362057,790	2,41	2,44
4	588434,445	9362043,820	2,36	2,36
5	588434,361	9362038,042	2,44	2,30
6	588433,064	9362027,617	2,21	2,40
7	588434,664	9362019,864	2,16	2,40
8	588434,156	9362013,796	2,19	2,31
9	588433,833	9362007,087	2,11	2,35
10	588433,588	9362000,393	2,12	2,22

Analysis of Depth Confidence Level

Depth confidence level in hidrographic surveys is absolutely necessary. Test of depth convidence level done by checking depth measured at sounding line and checkline crossing which is determined through analysis points. The depth difference between sounding line and checkline crossing will be compared to the average overall depth. The errors may not exceed IHO SP 44 5th edition.

Depth data were taken from the five types of seabed, there are coral (Cr), coral sands (CrS), mud (M), mud sands (MS), and sands (S) lies on 1a order, which in IHO SP 44 5th edition stated with a = 0,5 m and b = 0,013, d is depth average measured from each point intersection. From the results of the grab sampler of each there are 10 analysis points.

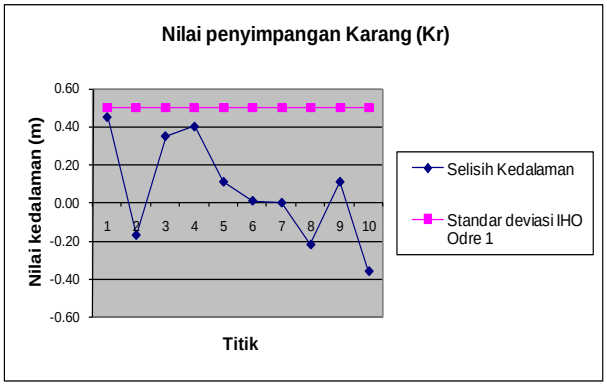

Figure 3 Deviation of the depth difference Values of Coral (Cr) to IHO standards

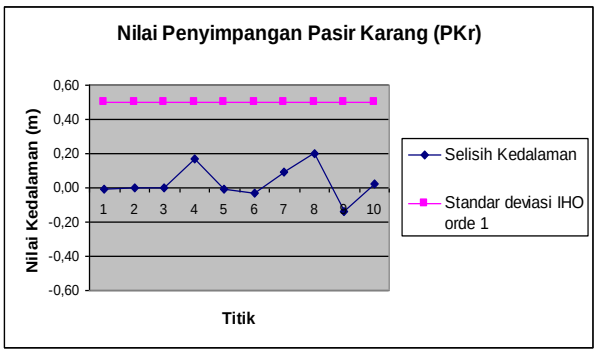

Figure 4 Deviation of the depth difference Values of Coral Sands (CrS) to IHO standards

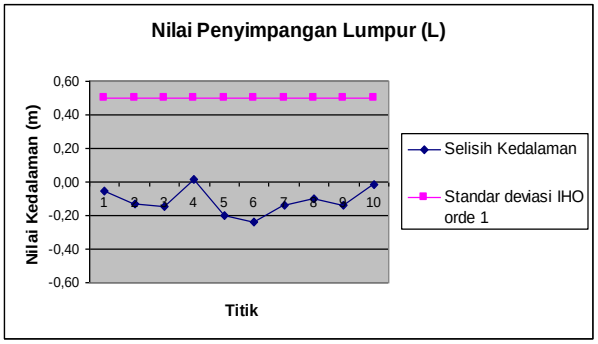

Figure 5 Deviation of the depth difference values of Mud (M) to IHO standards

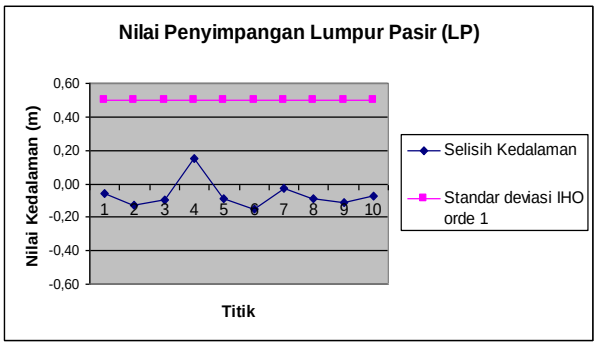

Figure 6 Deviation of the depth difference values of Mud Sands (MS) to IHO standards

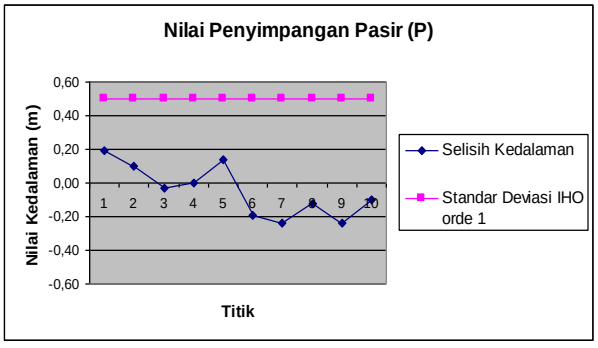

Figure 7 Deviation of the depth difference values of Sands (S) to IHO standards

The calculation of confidence level is amount of data received divided by overall data. From the graph above it shows all the data does not exceed the standard deviation IHO order 1a, so the convidence level of 100%. Percentage convidence level of 100% indicates that the value of the trust is in accordance with the results of the survey, the standard survey IHO SP-44 5th edition of the accuracy of the depth of 95%.

Analysis the spread of errors

Deviation of the depth obtained from the comparison is expressed as the errors (s) :

$$s = d_u - d_s$$

where : d_u : depth analysis on the sounding line

d_s : depth analysis on the checkline crossing

In addition, depth diversion also stated as absolute errors (|s|), relative errors to sounding line ($|s|/d_u$) , relative errors to checkline crossing ($|s|/d_s$), and relative errors to depth average (|s|/d).

Table 6 The average error of the Coral seabed topography

Coral Seabed topography	min	max	mean	δ
(s) (m)	-0,40	0,45	0,11	0,29
(|s|) (m)	0,01	0,45	0,26	0,16
(|s|/du) (%)	2,38	221,05	33,96	67,12
(|s|/ds) (%)	2,33	182,61	34,80	58,95
(|s|/d) (%)	2,35	200,00	33,41	61,34

Table 7 The average error of the Coral Sand seabed topography

Coral Sand Seabed Topography	min	max	Mean	δ
(s) (m)	-0,28	0,20	0,00	0,14
(|s|) (m)	0,00	0,28	0,10	0,10
(|s|/du) (%)	0,00	154,55	30,58	50,08
(|s|/ds) (%)	0,00	90,91	21,15	30,27
(|s|/d) (%)	0,00	87,18	23,76	34,03

Table 8 The average error of the Mud seabed topography

Mud Seabed Topography	min	max	Mean	δ
(s) (m)	-0,24	0,01	-0,12	0,08
(|s|) (m)	0,01	0,24	0,12	0,07
(|s|/du) (%)	0,32	5,82	3,01	1,91
(|s|/ds) (%)	0,32	5,50	2,89	1,81
(|s|/d) (%)	0,32	5,65	2,95	1,86

Table 9 The average error of the Mud Sand seabed topography

Mud Sand Seabed Topography	min	max	Mean	δ
(s) (m)	-0,15	0,15	-0,07	0,08
(|s|) (m)	0,03	0,15	0,10	0,04
(|s|/du) (%)	0,90	4,47	2,91	1,14
(|s|/ds) (%)	0,89	4,55	2,86	1,14
(|s|/d) (%)	0,90	4,45	2,88	1,14

Table 10 The average error of the Sand seabed topography

Sand Seabed Topography	min	max	rata-rata	δ
(s) (m)	-0,24	0,19	-0,05	0,16
(|s|) (m)	0,00	0,24	0,14	0,08
(|s|/du) (%)	0,00	11,37	6,05	3,78
(|s|/ds) (%)	0,00	10,21	5,82	3,46
(|s|/d) (%)	0,00	10,76	5,92	3,86

Analysis of the Error Comparison to Every Seabed Topography.

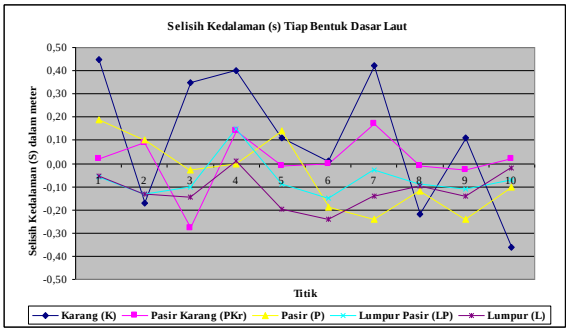

Figure 8 The error (s) comparison based on seabed topography

Table 11 Error values of seabed topography

	min	max	Mean	δ
Coral	-0,40	0,45	0,11	0,29
Coral Sand	-0,28	0,20	0,00	0,14
Mud	-0,24	0,01	-0,12	0,08
Mud Sand	-0,15	0,15	-0,07	0,08
Sand	-0,24	0,19	-0,05	0,16

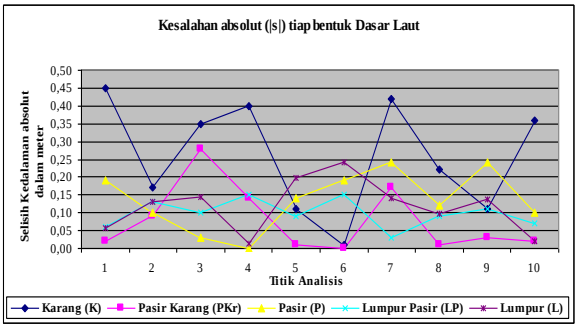

Figure 9 The absolut error (|s|) comparison based on seabed topography

Table 12 Absolute Error values (|*s*|) of seabed topography

	min	max	rata-rata	δ
Coral	0,01	0,45	0,26	0,16
Coral Sand	0,00	0,28	0,10	0,10
Mud	0,01	0,24	0,12	0,07
Mud Sand	0,03	0,15	0,10	0,04
Sand	0,00	0,24	0,14	0,08

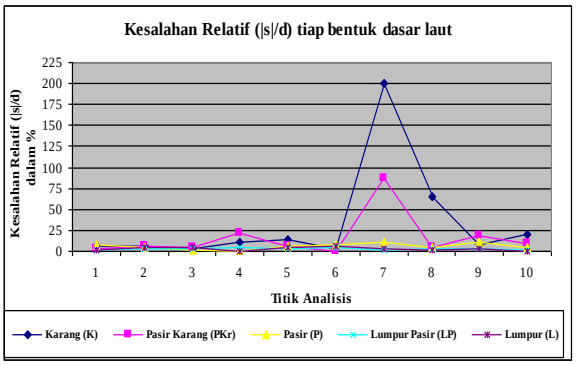

Figure 10 The relative error (|*s*|/d) comparison based on seabed topography

Table 13 Relative Error values toward the average depth (|*s*|/d) of seabed topography

	Min (%)	Max (%)	Mean (%)	δ
Coral	2,35	200,00	33,41	61,34
Coral Sand	0,00	87,18	23,76	34,03
Mud	0,32	5,65	2,95	1,86
Mud Sand	0,90	4,45	2,88	1,14
Sand	0,00	10,76	5,92	3,86

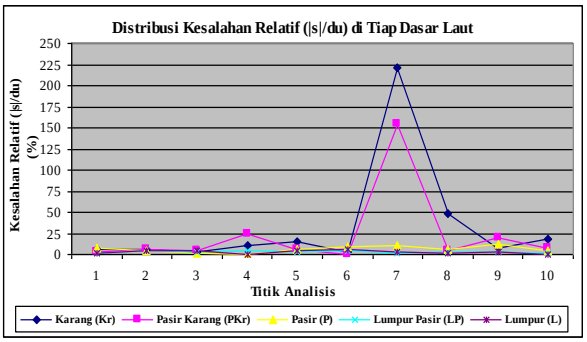

Figure 12 The relative error (|*s*|/du) comparison based on seabed topography

Table 14 Relative Error values toward the depth of sounding line (|*s*|/du) of the seabed topography

	Min (%)	Max (%)	Mean	δ (%)
Coral	2,38	221,05	33,96	67,12
Coral Sand	0,00	154,55	30,58	50,08
Mud	0,32	5,82	3,01	1,91
Mud Sand	0,90	4,47	2,91	1,14
Sand	0,00	11,37	6,05	3,78

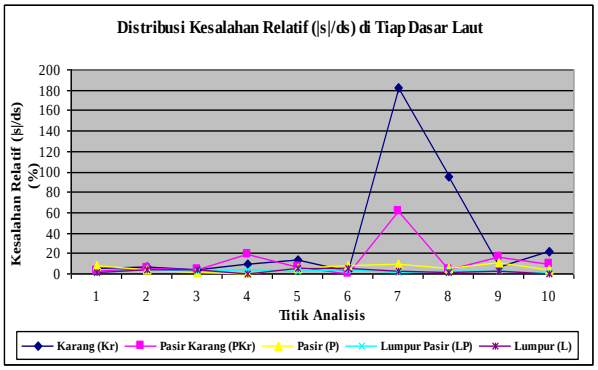

Figure 13 The relative error (|*s*|/ds) comparison based on seabed topography

Table 15 Relative Error values toward the depth of checkline crossing (|*s*|/ds) of the seabed topography

	Min (%)	Max (%)	rata-	δ (%)
Coral	2,33	182,61	34,80	58,95
Coral Sand	0,00	90,91	21,15	30,27
Mud	0,32	5,50	2,89	1,81
Mud Sand	0,89	4,55	2,86	1,14
Sand	2,33	182,61	34,80	58,95

Analysis Correlation Error to Slope

The affects of hyperbolic error that caused by the beamwidth will be bigger if sounding held in area with many variantions of slope. This calculation done in order to know whether the bigger value of slope affect to the error of measurement or not.

Tabel 16 Correlation Error to Slopes

No	Seabed	Correlation	Signified	CD
1	Coral	0,889	0,001	79,03 %
2	Coral Sand	0,824	0,003	67,89 %
3	Mud	0,365	0,300	13,83 %
4	Mud Sand	0,242	0,501	5,85 %
5	Sand	0,316	0,374	9,98 %

From the calculation above, correlation between error to slope show positive value which mean there are strong and the same dirrection correlation. If the correlation are in the same direction, the bigger value of slope, the bigger value of error also.

Conclusion

1. From the calculation, it is found that there are irregularities in the depth of analysis point from sounding for sounding line to checkline crossing.

2. Results obtained show that the highest accuracy lies on the smallest errors, that is seabed of Mud Sands (LP) ,while the worst accuracy is on seabed of Coral (Cr)

3. Echosounder is a tool used for depth measurements using accoustic waves with beamwidth. Variations of seabed surface can have an influence in beamwidth, that is why the seabed of coral (Kr) has the lowest accuracy because of its morphology which is not flat (wavy) while on the mud sands (LP) seabed with a flat morphology has the highest accuracy.

Suggestions

1. Further research should be conducted for other variation of seabed surface (e.g. geoscience or other dicipline)

2. To be more considered in bathimatric surveys, because the Coral (Cr) which has the disjointedness of the form of seabed very influence in the results of measurement.

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