

# COMPOSITION OF DATA VISUALISATIONS BY SUB-BOTTOM PROFILER AND MULTIBEAM ECHOSOUNDER IN MATLAB

GRAŻYNA GRELOWSKA, EUGENIUSZ KOZACZKA,  
KRYSTIAN BUSZMAN

Polish Naval Academy  
81-103 Gdynia, Smidowicza 69 Street, Poland  
krystian\_buszman@o2.pl

*This paper contains description of procedure, which was elaborated in a numerical computing environment Matlab. The result of these procedures is a graphical composition of images obtained from two different hydroacoustic devices. It enables to compare different types of visualisations for the same geographical position and simultaneous work with graphical representation of all data types.*

## INTRODUCTION

All of the hydroacoustic devices using both to investigations and to navigation targets are cooperating with a convenient software for them to record and data visualisation. These systems may significantly differ from themselves in terms of functionality and parametric. The cardinal parameters which influence for kind of application are frequency, sounding pulse length, horizontal and vertical beam or beams width and acoustic power. These kind of parameters decide that the unit will be used for temporary sea depth, objects localisation in water, sea surface visualisation or sediments structures investigations [1,4]. It applies a convenient visualisation to each of named systems. Where many hydroacoustic systems are installed on a single vessel, it is handy to present all of recorded soundings on common visualisation.

## 1. FUNCTIONS AND PROCEDURE DESCRIPTION

Different images may aggregate in postprocessing stage for the investigation targets. There are many sophisticated applications, which supply this kind of functions. Inter alia there are not so cheap. It appears a similar problem during simultaneous using multibeam and parametric echosounder. Therefore it was written a procedure in Matlab environment for this kind of submission. The application cooperations only with files with “ses” extension

(Innomar parametric echosounder SES2000) and “all” extension (Kongsberg multibeam echosounder EM3002). Kongsberg echosounder is controlled by Seafloor Information System (SIS) application.

Script was written based on afforded data in instruction added in application (Tab.1.):

- data description,
- format,
- valid range

This procedure processes depth value information for particular beam, pitch angle, roll angle and heave value for multibeam echosounder EM3002. There were also used echo signal from whole area between the antenna and seafloor. This kind of visualisation is called Water Column and it shows the biomass image with a small floor penetration. There is also set of data which comes from GPS receiver with an actual time. In the other side the data from parametric echosounder contain all information about unit setting and data from the same GPS receiver in header.

Tab.1. The way of depth data recording

Data Description	Format	Valid range
Number of bytes in datagram	4 U	-
Start identifier = STX (Always 02h)	1 U	-
Type of datagram = D(epth data) (Always 44h)	1 U	-
EM model number (Example: EM 3000 = 3000)	2 U	-
Date = year*10000 + month*100 + day	4 U	-
Time since midnight in milliseconds	4 U	0 - 86399999
Ping counter (sequential counter)	2 U	0 - 65535
System serial number	2 U	100 -
Heading of vessel in 0.01°	2 U	0 - 35999
Sound speed at transducer in dm/s	2 U	14000 - 16000
Transmit transducer depth re water level at time of ping in cm	2 U	0 - 65536
Maximum number of beams possible	1 U	48 -
Number of valid beams = N	1 U	1 - 254
z resolution in cm	1 U	1 - 254
x and y resolution in cm	1 U	1 - 254
Sampling rate (f) in Hz	2 U	300 - 30000
<b>Repeat cycle — N entries of :</b>	16*N	-
Depth (z) from transmit transducer (unsigned for EM 120 and EM 300)	2 S 2 U	-32768 - 32766 1 - 65534
Acrosstrack distance (y)	2 S	-32768 - 32766
Alongtrack distance (x)	2 S	-32768 - 32766
Beam depression angle in 0.01°	2 S	-11000 - 11000
Beam azimuth angle in 0.01°	2 U	0 - 56999
Range (one - way travel time)	2 U	0 - 65534
Quality factor	1 U	0 - 254
Length of detection window (samples/4)	1 U	1 - 254
Reflectivity (BS) in 0.5 dB resolution)	1 S	-128 - 126
Beam number	1 U	1 - 254
<b>End of repeat cycle</b>		

Transducer depth offset multiplier	1 S	-1 - 17
End identifier = ETX (Always 03h)	1 U	-
Check sum of data between STX and ETX	2 U	-

## 2. DATA VISUALISATION FROM MULTIBEAM ECHOSOUNDER

The procedure which was described in chapter 1 may be shared to three parts. First of them there is a cooperation with files from SIS application (“all”). The operation relies on file opening and cyclic checking the beginning bytes of header (number of bytes in datagram, start identifier and type of datagram). Where the data type agrees with the type used to further processing, application sorts next bytes in according with the scheme showed in Tab.1. (only for seafloor visualisation, others data types are described another schemes) until the program comes to end identifier bytes and check sum. If the data type is not agree in beginning stage, program skips number of bytes specified in the beginning and it checks next header. In this case all needed information have been sorted and ready for the next stage. In respect of working with files which size is equal even 1,5 GB, program records simultaneous the most significantly information in files which may be processing in Matlab in quite short time without making operations on big files with “all” extension again.

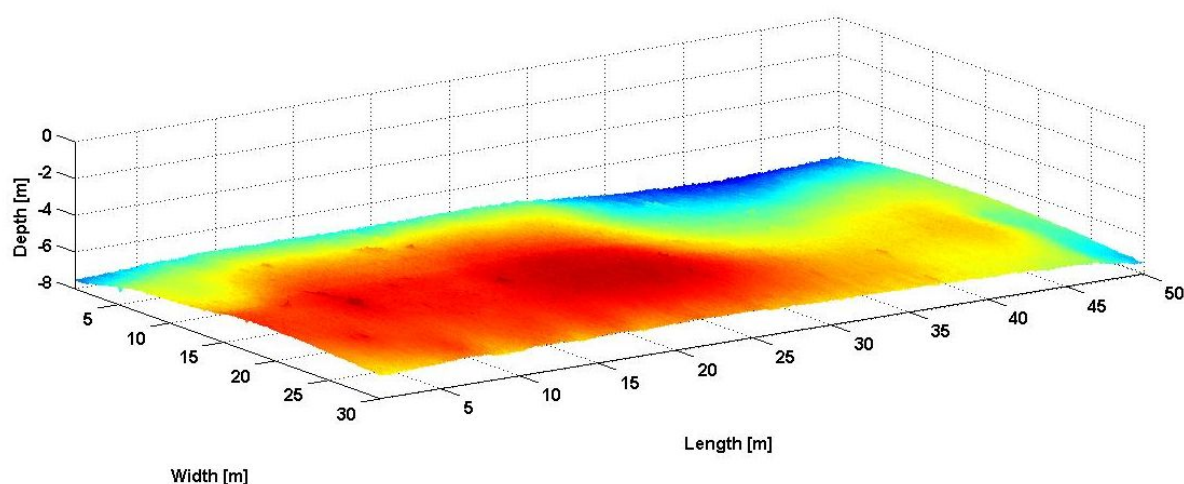


Fig.1. Seafloor surface visualisation by multibeam echosounder EM3002

The Fig.1. shows seafloor surface visualisation in three dimensions for 254 beams. There was used whole colour scale from Matlab colourmap “jet” (RGB) to create an image. Therefore there are significant colour changes for small depth differences. It causes, that an image is quite more detailed and distinct. This example doesn’t take into account the geographical position, because it is used to show the way of seafloor surface visualisation, therefore an image isn’t true equivalent of reality. Seafloor surface with geographical position is shown in Fig.2.

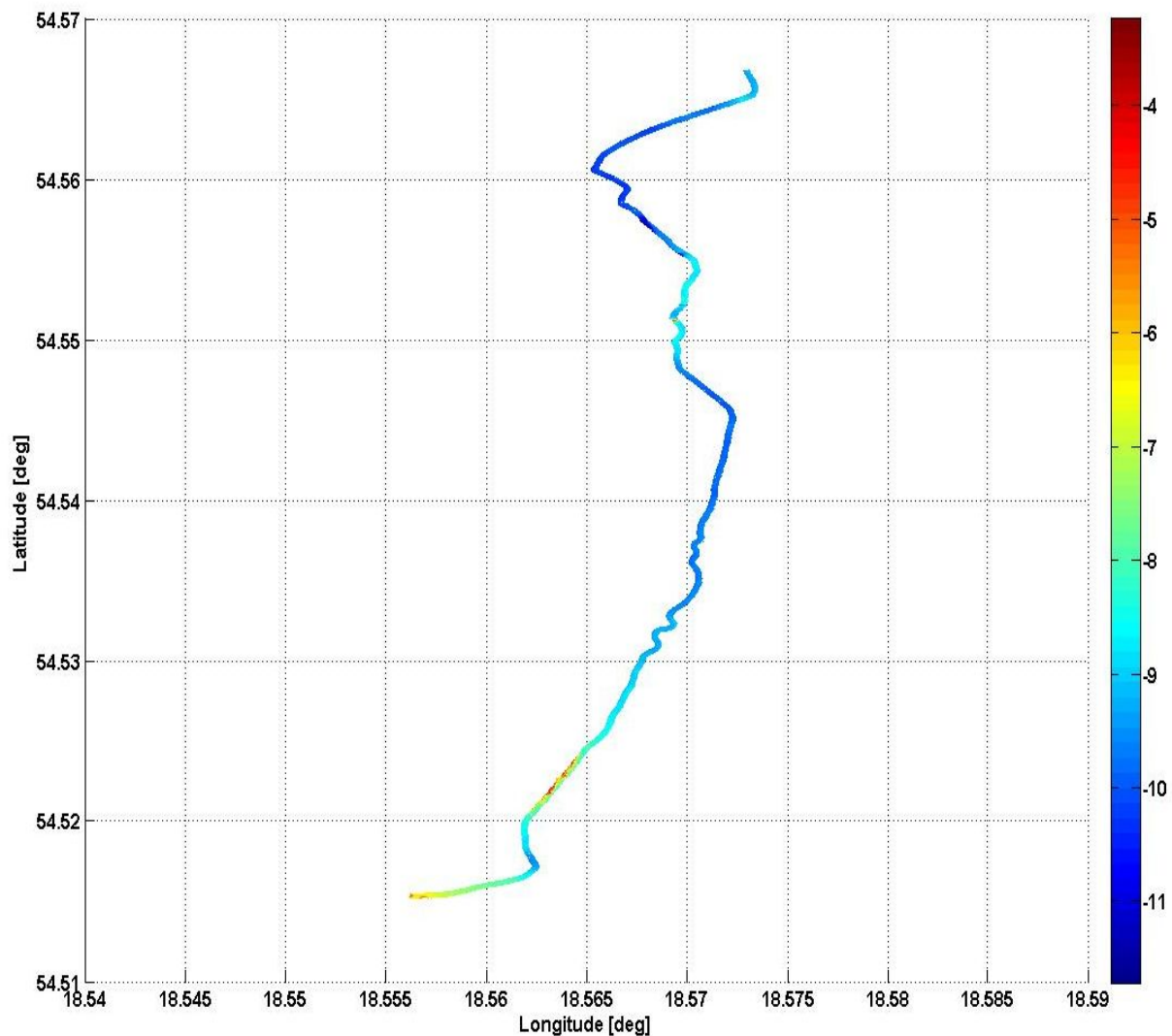


Fig.2. Image of seafloor surface from multibeam echosounder superimposed on grid

Imposition of seafloor soundings results on previously calibrated satellite picture of researched area is an additional possibility of Matlab procedures (Fig.3.). The top part of this picture shows north side. There is a irregular seafloor related with a small distance to breakwater. There are also many bigger objects on the bottom, but only in the middle of this imaging, what is matching to reality. Analogical function is applied in Seafloor Information System software such as “Geographical” type, but in SIS software data could be connected with a digital map instead of satellite pictures.



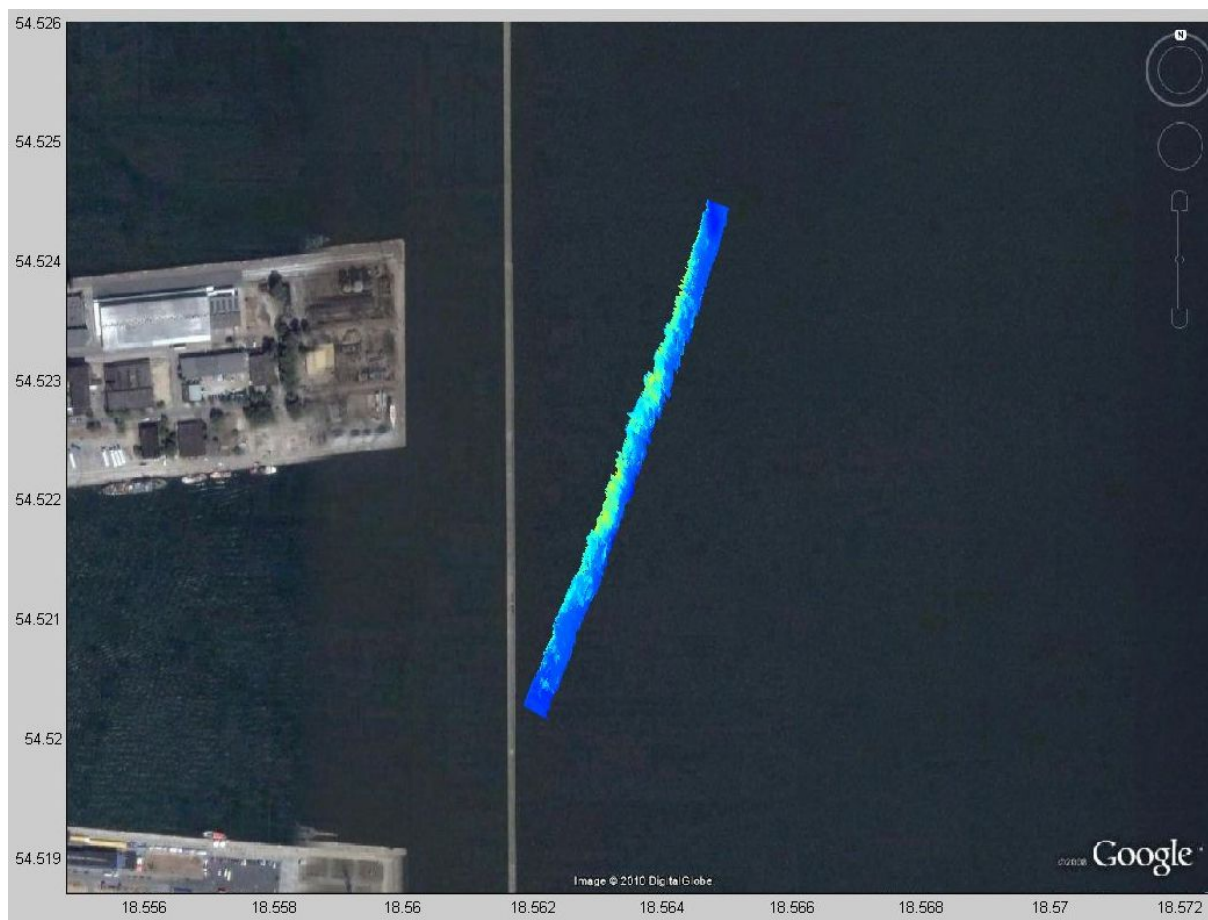


Fig.3. Imaging of seafloor surface from multibeam echosounder superimposed on satellite image from Google Earth

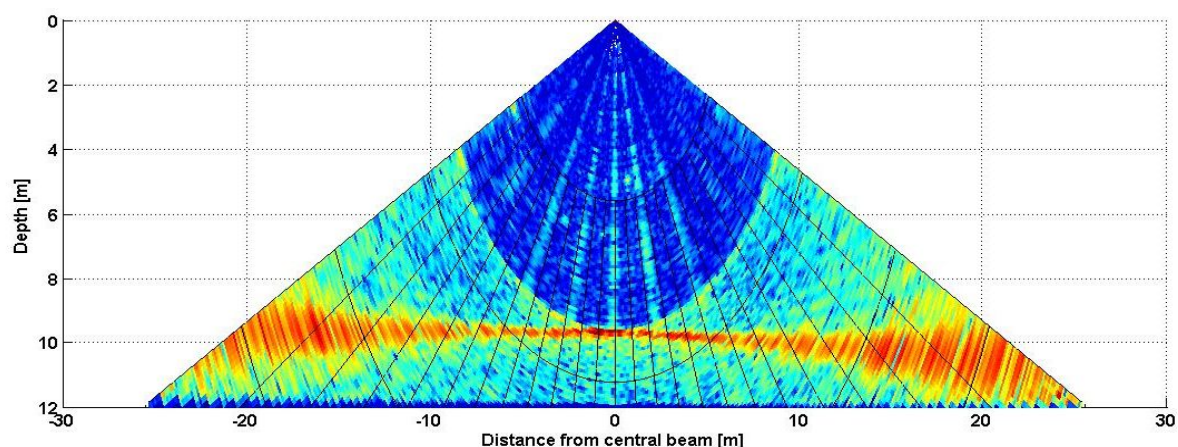


Fig.4. Visualisation type called „Water Column”

The cross section shown on Fig.4. is the result of using procedure to connect Matlab surface function with polar coordinates. This visualisation type conforms the real range of investigated area. Obtained image is 3D fullness, where the voltage value of particular probe is assigned appropriate colour in RGB scale. Data are shown like a top view of three dimensions image, so it changes it to colour two dimensions. Imaging is more detailed in

small angles range rather than in marginal values. It is caused by limited sampling of echo signals at distance difference between seafloor and the antenna for different angles of transmitted beams.

### 3. PARAMETRIC ECHOSOUNDER DATA VISUALISATION

In continuing the description second stage of procedure is responsible for cooperation with files with “ses” extension (results of parametric echosounder SES2000 soundings). Data importing is analogical such as for multibeam echosounder, but in this case length of data frame is always constant, so program hasn't to check data number of bytes every time. Otherwise sorting and parallel data recording is executed in the same way as for files from SIS software. The algorithm result is presented on Fig.5. with RGB colour range.

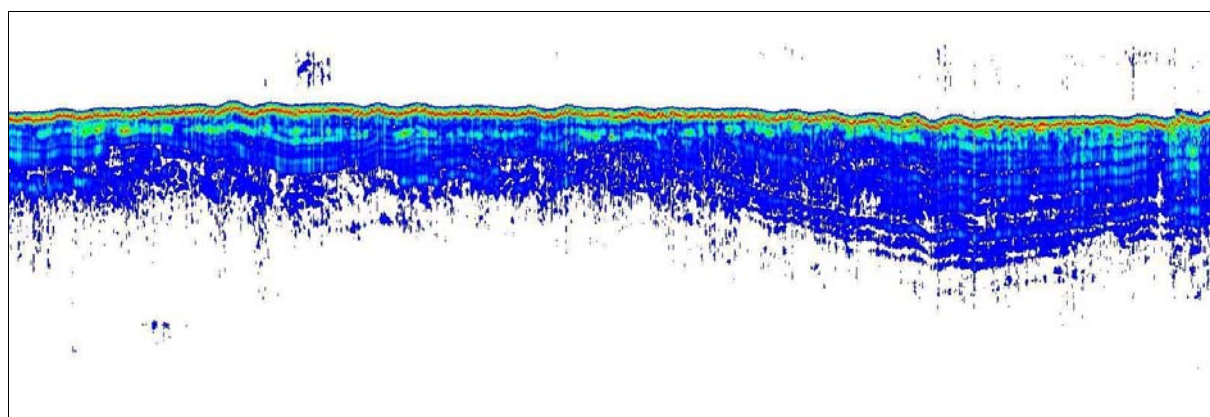


Fig.5. Sediments image from parametric echosounder soundings obtained in Matlab

The image may be modified on basic level (operation on recorded data) by functions like: resolution changing, colour changing, various filtrations, thresholds changing, colour setting, colour scaling, gain, attenuation, automatic gain control (AGC), time variable gain (TVG), etc. One of using function result is visualisation shown on Fig.6.

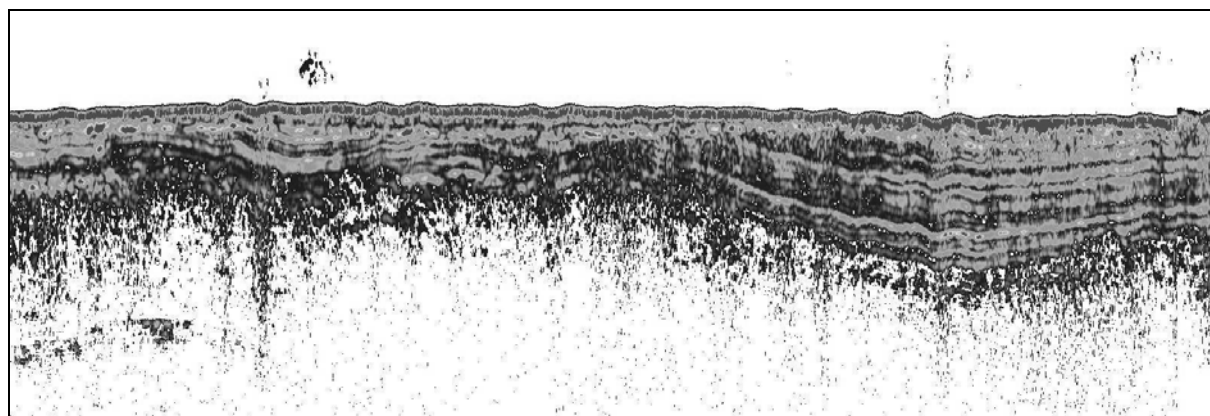


Fig.6. Result of data processing in Matlab (the same cross section as in Fig.5.)

### 4. COMPOSITION OF DIFFERENT VISUALISATION TYPES

The last part of the procedure is responsible for connection of described visualisation types. The main goal is an information about mutual antennas location of used hydroacoustic systems, because of appropriate images location against themselves. Imaging of all results on

common visualisation is really baffling, because each image has quite good resolution, so it increases the order to computing power of graphical processing unit (GPU). This problem was solved as follows. The bottom surface (e.g. Fig.1.) is shown without any changes, but image “Water Column” and sediments cross section were imported such as textures on earlier prepared surfaces. This solution has near the same result as really images. Final result is presented in equal colour scale to increase numbers of details.

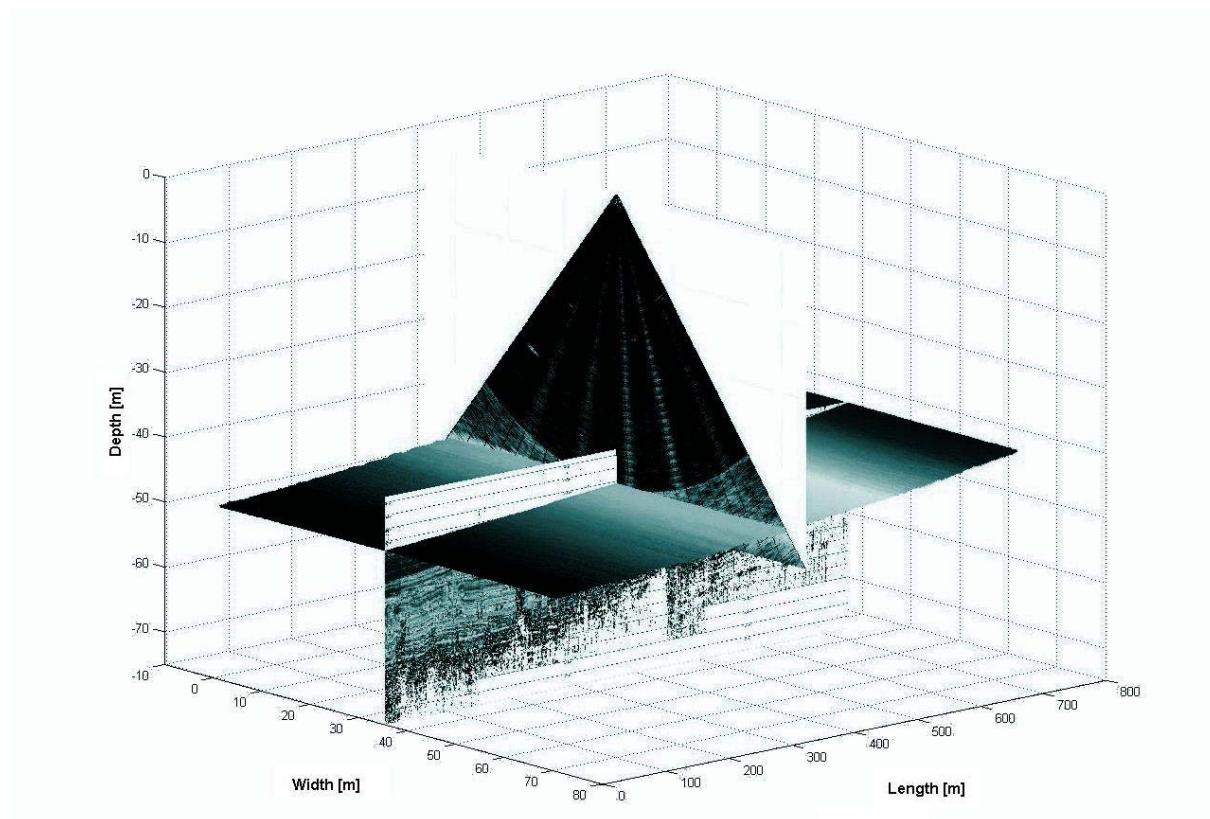


Fig.7. Three imaging types on one visualisation

Graphic represent which is shown on Fig.7. near the same as in reality, but it isn't clearly. Cross sections are covering mutually, so many details are invisible. The problem was solved by view only some parts of texture, which displays covered parts (Fig.8,9.).

## 5. CONCLUSIONS

The elaborated procedure is a complementary one to used typically for visualisation of the data obtained by each particular device. It allows to show in one figure the details of the sea bottom possible to extract by means of all applied measuring methods. Additionally the image of sea bottom is connected to the precisely defined position.

## ACKNOWLEDGMENTS

The investigation was supported by the Ministry of National Defence (Grant No DNiSW/U/13/BN/1.21/2008/848).

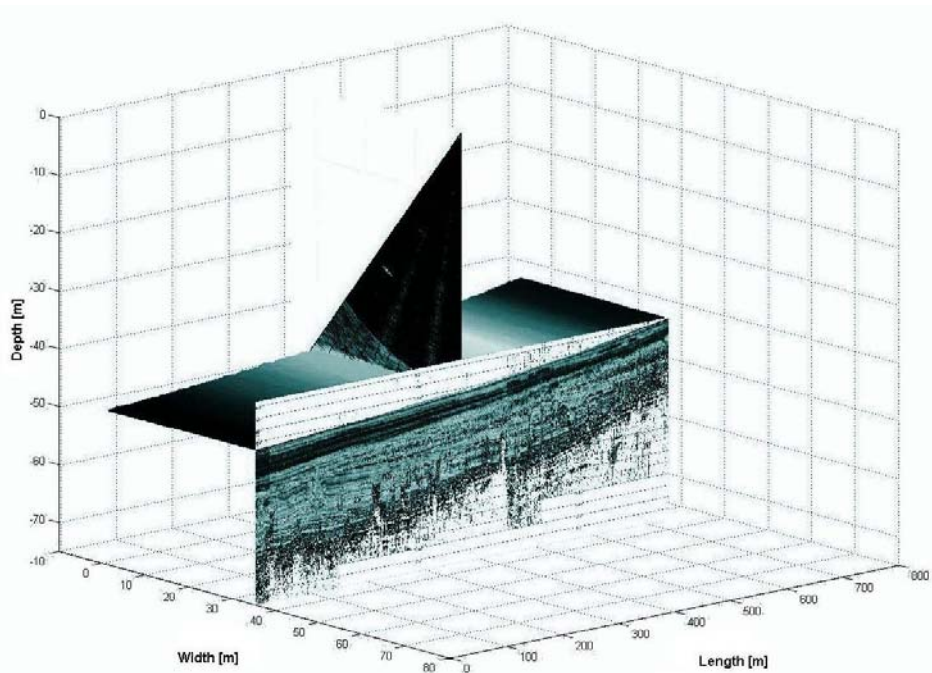


Fig.8. Three types of data cut visualisation

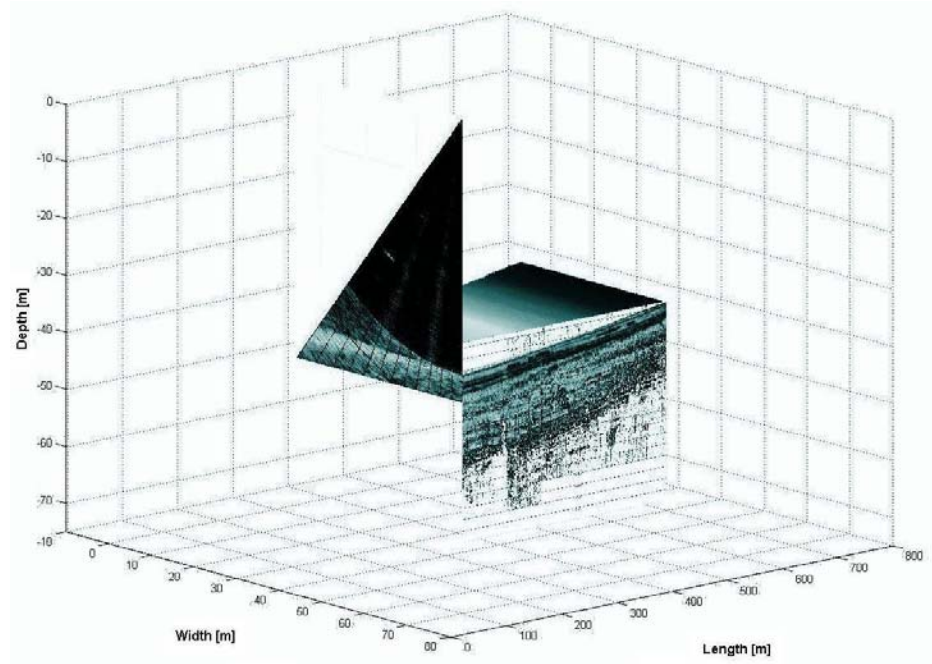


Fig.9. Three types of data cut visualisation

## REFERENCES

- [1] G. Grelowska, S. Kozaczka, W. Szymczak, Some methods of the sea bottom recognition, *Hydroacoustics*, Vol. 12, 69-76, 2009.
- [2] Innomar SES2000 Standard manual, 2008.
- [3] Kongsberg EM3002 and Seafloor Information System manual, 2004.
- [4] W. Szymczak, K. Buszman, Examination of the co-operation between echosounder and motion sensor during sea trials, *Hydroacoustics*, Vol. 12, 217-226, 2009.