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Usage AIS Data for Analyzing Ship's Motion Intensity

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ABSTRACT: In preliminary unit of report were introduced order, structure and format of VDM code sended by the AIS VHF data link. Described the process of decoding combination of binary chains sentences describe from ITU R M. 1371.In principle unit analyse of ships intensity of movement in Gulf of Gdańsk used coded isoline on background of map as well as transverse intersection on a approach to harbour of Gdynia. Authors presented new generated and used method of processing of regular GRID net - designed to description of spatial expansion of ship intensity of movement. Authors circumscribed method of utilizations the VerticalMapper software Systemu to calculation the izoline of even ships intensity of movement, intersections of transverse, as well as principles of visualizations coded isoline on background of the map, according the author's software.

1 INTEGRATED NAVIGATION

The state of safety at sea can be rate towards vision range of movement of ships and surface units. All information about the ships movement in dependence of location of sea area is possible to obtain used various methods of observation, with the help of the AIS system. The description of movement of ships, acquisition in the AIS, refer to geographical position, courses, construction parameters of ship as well as kind of transportation, should be presented in figure of simplified diagram: space /time. Diagrams these illustrate ships density of movement under specified sea area, on which they shift ships. Multi-criteria analyzes of such diagrams lets the possibility of improvement of organization human activity at sea which can create threat for ships movement, the human life and sea environment.

2 AIS DATA DECODING METHODS

Determined, that in aim of creation of diagrams of ships movement intensity, the AIS data will be converted to files of type: *.mif, *.mid as well as *.txt . The first two files be used become in programme GIS - MapInfo to display position and information descriptive fixes of monitored ships, however third file - in programme MI Vertical Mapper to transfer in the GRID to describe the spatial expansion of analysed parameter (the intensity of movement of ships).

Realized above mentioned, was worked out specialist software attend to conversion of files from AIS data, which be coded fin accordance ITU – R. M. 1371, to files type: *.mif, *.mid, and *.txt.

The decoding and interpreting process compose of three leg:

– transformation in binary chains mark chains, which represent it,

– the organization in packets of message the binary chains peaceably from ITU – R.M. 1371,
– the mapping of organized guided packets of message on suitable information.

It below example - mark chain and transformed binary chain was presented. Figure this is the visual help, which can facilitate the understanding of process of decoding of AIS message. Line astern on left hand drawing 10 entitled "Bit positions VDM" is information about accurate position - binary chain of message the information about bit exact position. However line astern after right side entitled "The binary representation of sign" it motion the information about binary representation of message.

The median line astern contains next the signs of chain of message. Decoding VDM chain has begun for first sign in chain. There in this case sign is "1", and answering him binary chain "000001". The fix of individual bits of binary chain has be presented on left hand as value since 1 to 6.

Second sign of chain "P" the binary chain represents "100000". The fix of individual bits of binary chain has be presented in left line astern as value since 7 to 12. The same the process follows for every sign of chain of message.

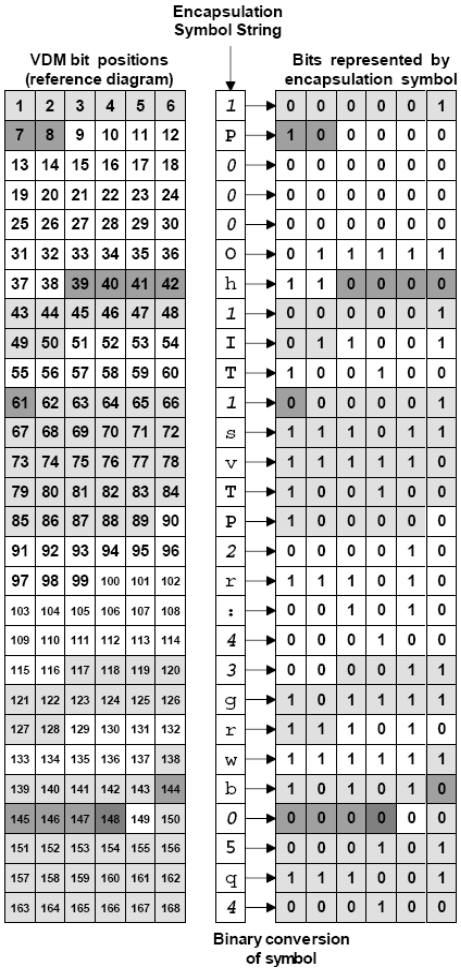


Fig. 1. Example - mark chain and transformed binary chain (IEC 2002)

Bits 1-6 = Identifier for this message
000001 = **message 1** (Reference Annex E of ITU-R M.1371-1:2000 to interpret following bits 7-168.)
Bit 7-8 = Repeat Indicator
2 = **message repeated twice**
Bits 9-38 = MMSI number of broadcasting unit
000000000000000000000001111111 = **127**
Bits 39-42 = Navigational status
0000 = **underway using engine**
Bits 43-50 = Rate of turn (equation used)
00000101 **= +1.1 degrees/minute**
Bits 51-60 = Speed over ground
1001100100 = **61.2 knots**
Bit 61 = Position accuracy
0 = **low (greater than 10 meters)**
Bits 62-89 = Longitude in 1/10000 minutes
00001111011111111010010010000 =
27 degrees 5 minutes East
Bits 90-116 = Latitude in 1/10000 minutes
00000101110100010100010000 =
5 degrees 5 minutes North
Bits 117-128 = Course over ground in 1/10 degrees
001110111111 = **95.9 degrees true**
Bits 129-137 = True Heading
101011111 = **351 degrees true**
Bits 138-143 = UTC second when report generated
110101 = **53 seconds past the minute**
Bits 144-147 = Regional Application
0000 = **no regional application**
Bits 148 = Spare
Bit 149 = RAIM Flag
0 = **RAIM not in use**
Bit 150-168 = Communications State
00 = **UTC Direct**
001 = **1 frames remaining until a new slot is selected, UTC hour and minute follow,**
01111001000100 = 01111:0010001 = **15 : 17 UTC**
Bits 167-168 not used for UTC Sub-message

Table 1. Messages 1, 2, and 3 (position reports) (ITU 2001)

Parameter	Number of bits	Description
Message ID	6	Identifier for this message 1, 2 or 3
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Refer to § 4.6.1; 0 - 3; default = 0; 3 = do not repeat any more
User ID	30	MMSI number
Navigational status	4	0 = under way using engine, 1 = at anchor, 2 = not under command, 3 = restricted manoeuvrability, 4 = Constrained by her draught; 5 = Moored; 6 = Aground; 7 = Engaged in Fishing; 8 = Under way sailing; 9 = reserved for future amendment of Navigational Status for HSC; 10 = reserved for future

		amendment of Navigational Status for WIG; 11 - 14 = reserved for future use; 15 = not defined = default
Rate of turn ROT[AIS]	8	127 (–128 (80 hex) indicates not available, which should be the default). Coded by ROT[AIS] = 4.733 SQRT(ROT[IND]) degrees/min ROT[IND] is the Rate of Turn (720 degrees per minute), as indicated by an external sensor. + 127 = turning right at 720 degrees per minute or higher; - 127 = turning left at 720 degrees per minute or higher
SOG	10	Speed over ground in 1/10 knot steps (0-102.2 knots) 1023 = not available, 1022 = 102.2 knots or higher
Position accuracy	1	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10 m; Autonomous Mode of e. g. GNSS receiver or of other Electronic Position Fixing Device); default = 0
Longitude	28	Longitude in 1/10 000 min (±180 degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 min (±90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
COG	12	Course over ground in 1/10° (0-3599). 3600 (E10 hex) = not available = default; 3601 – 4095 should not be used
True Heading	9	Degrees (0-359) (511 indicates not available = default).
Time stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which should also be the default value, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 61 if positioning system is in manual input mode or 63 if the positioning system is inoperative)
Reserved for regional applications	4	Reserved for definition by a competent regional authority. Should be set to zero, if not used for any regional application. Regional applications should not use zero
Spare	1	Not used. Should be set to zero
RAIM-Flag	1	RAIM (Receiver Autonomous Integrity Monitoring) flag of Electronic Position Fixing Device; 0 = RAIM not in use = default; 1 = RAIM in use)
Communication State	19	
Total number of bits	168	

3 PRINCIPLE OF THE SHIPS MOVEMENT INTENSITY DIAGRAMS CREATION

In programme implemented the algorithms to determination of number of ships spending in sub-area (formed with division of inspected area on smaller fragments - point of grid net) in time definite slice. Parameter this be described as value definite in node of GRID net. It was determined in result of analysis of mutual location next intervals of ships cruses and intervals limiting the individual point of GRID net.

Processed application possesses following main window (cardinal port).

In this picture - PC window the strainer cores (filters) are to sharp-tuning of individuals selection ships as well as the editorial ports (window) fixable to the parameters of net GRID. Strainer cores permit on of individuals selection ships according to:

- MMSI number,
- type,
- dimensions,
- the velocity of motion (speed),
- draught,

giving in this the way the possibility of constructing the GRID net with expansions of intensity of movement chosen group of individuals ships. The size and resolution of net be established in window "the parameters of GRID net ". It influence on resolution, appointive from grid in programme VerticalMapper, isoline of analysed parameter and the same on quality their display in programme MapInfo.

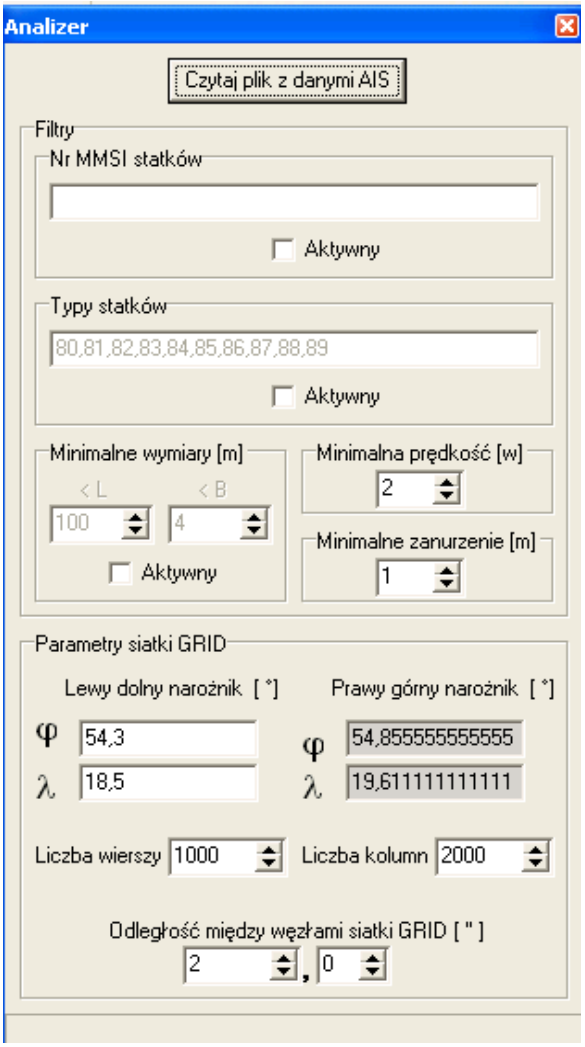


Fig. 2. Main window – programme cardinal port

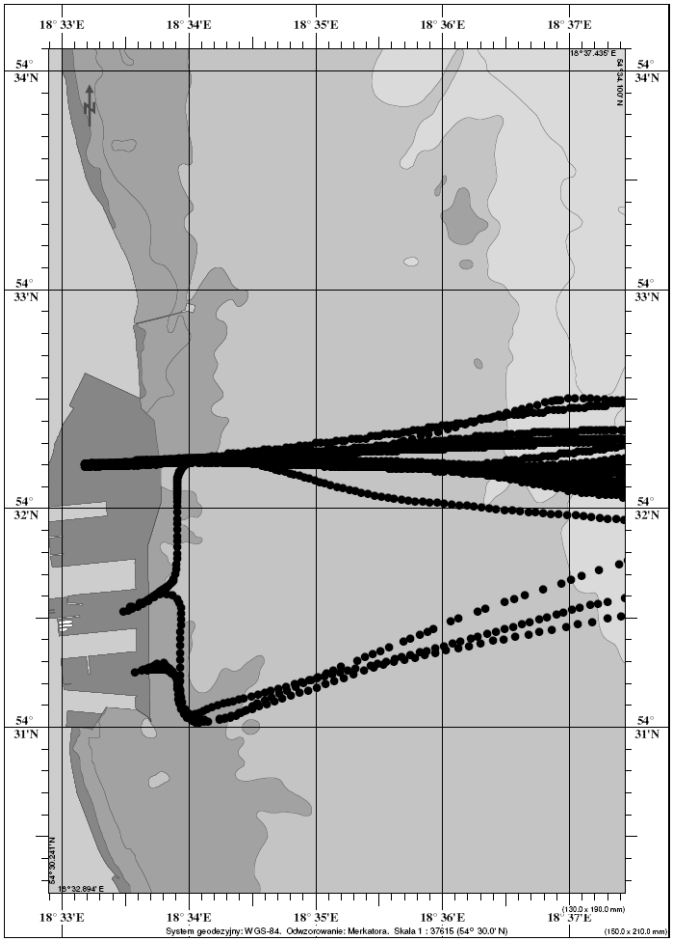
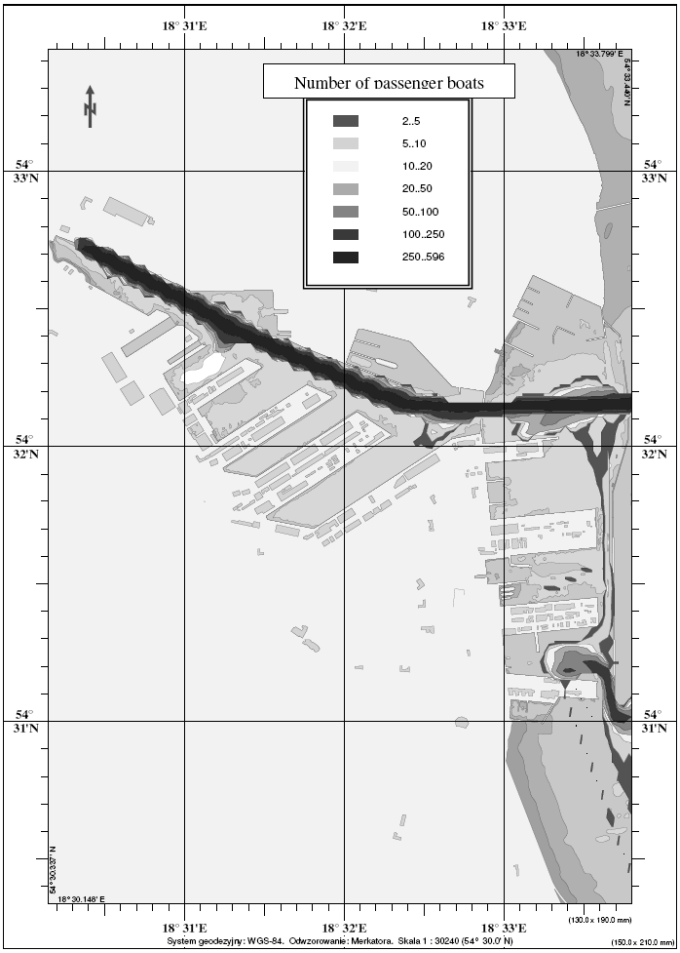


Fig. 3. The trajectories of passenger ships in one week period

It below represented the example - file of *.txt type with calculated value of node GRID net.

```
ncols         10
nrows         10
xllcorner     18.00000000
yllcorner     54.00000000
cellsize      0.00027778
NODATA_value  0
0 0 0 0 2 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0
0 0 0 0 1 0 0 1 0 0
0 0 0 0 0 0 0 2 0 0
0 0 0 0 0 3 0 0 0 0
0 0 0 2 0 0 1 0 0 0
0 0 0 2 0 0 1 0 0 0
0 0 2 0 0 0 1 0 0 0
0 0 2 0 0 0 0 1 0 0
2 2 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 1 0
```



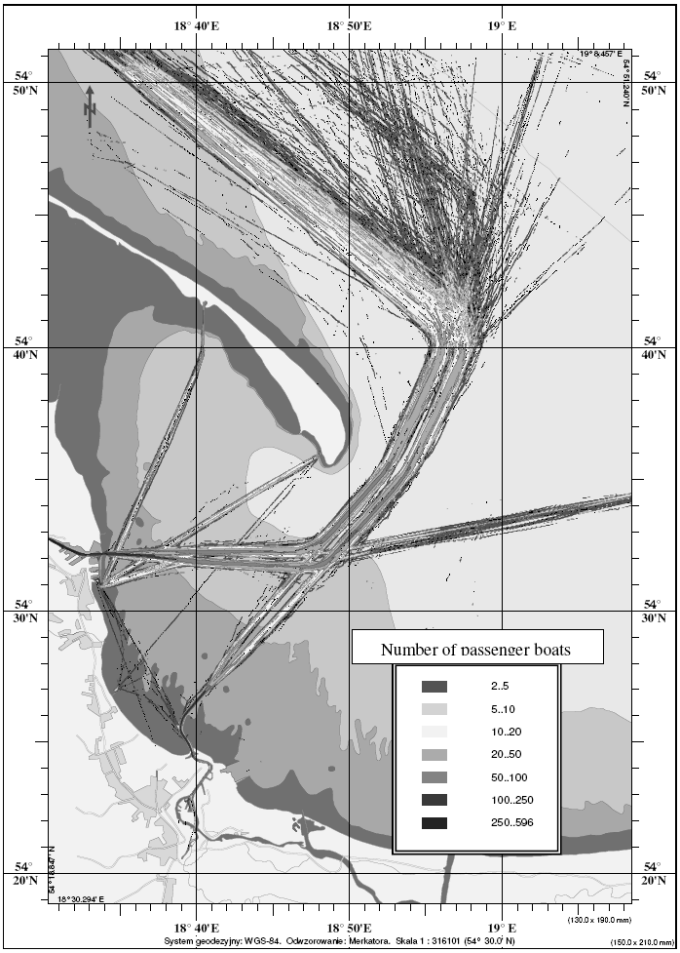
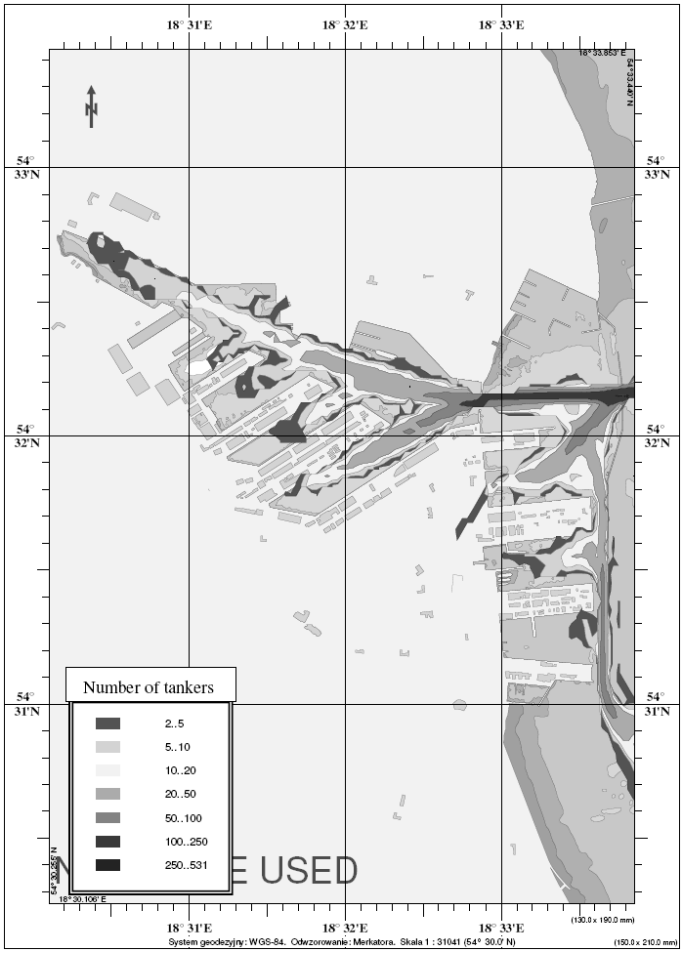


Fig. 4. The analysis of passenger ships movement intensity with speed above two knots (kn) from 24.IV.2006 to 06.IX.2006



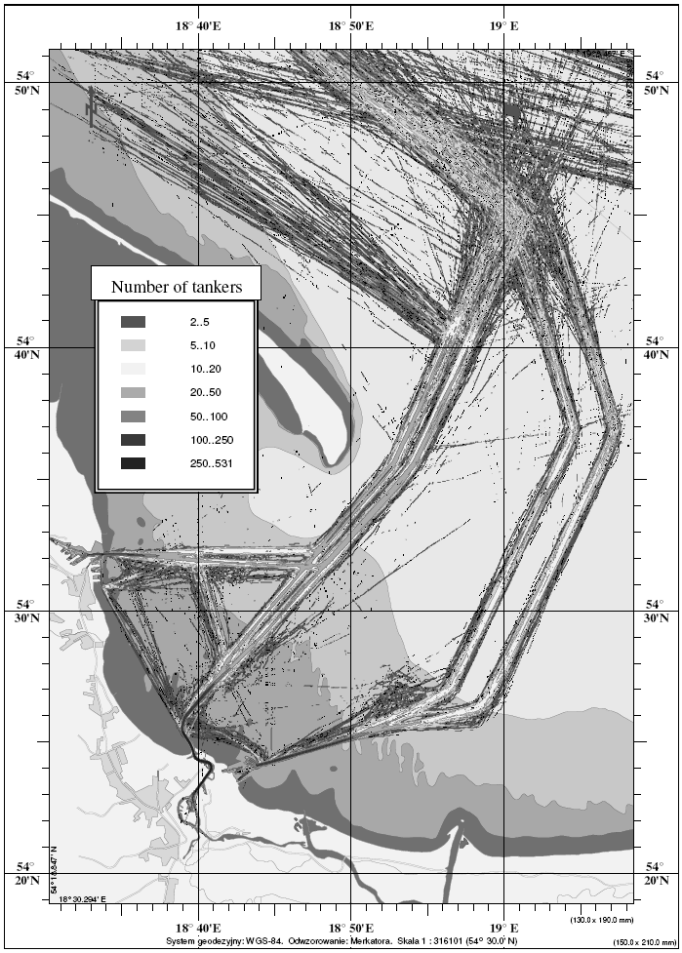


Fig. 5. The analysis of tankers movement intensity with speed above two knots (kn) from 24.IV.2006 to 06.IX.2006

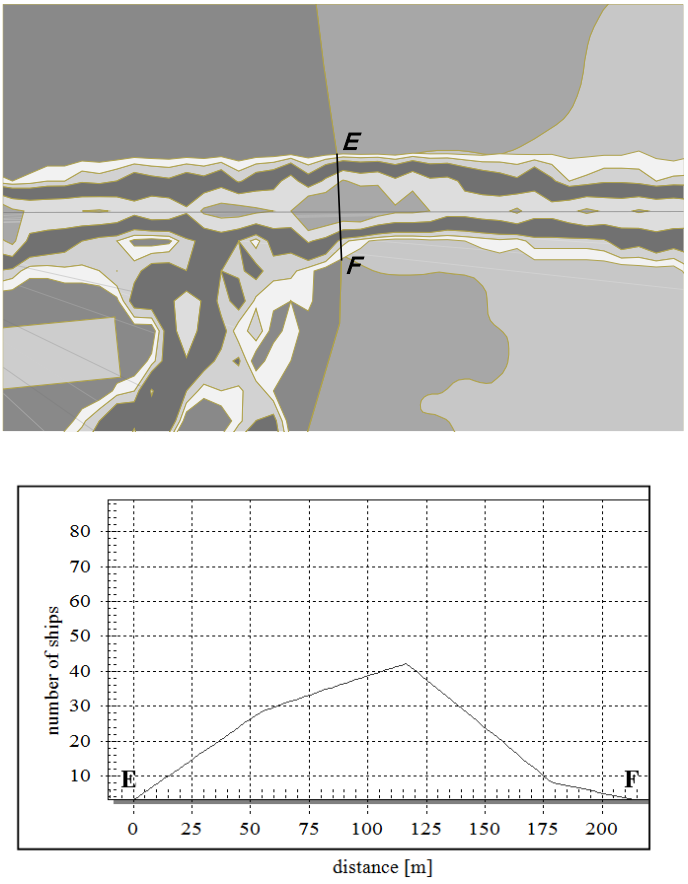


Fig. 6. The analysis of ships movement intensity on $\overline{EF}$ section from 24.IV.2006 to 06.IX.2006

4 CONCLUSION

The safety at sea describes the state of sea environments, objects in movement as well as the organization and principle of realization of human activity at sea. The diagrams of ships movement intensity should permit on quantitative qualification of security - safety level, connected directly with kind of area as well as exploited thereon with types of ships at sea. It should facilitate the guidance of tests the relating of local regulation, among other things: the principles of ships movement, especially determination of ships distances, principle of passing and crossing each other on the NavArea fairways.

REFERENCES

IEC, Maritime navigation and radiocommunication equipment and systems – Digital interfaces - Part 100: Single talker and multiple listeners - Extra requirements to IEC 61162-1 for the UAIS, 2002.

ITU, Technical characteristics for a universal shipborne automatic identificationsystem using time division multiple access in the VHF maritime mobile band - M.1371, 2001.