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INCREASING SAFETY OF NAVIGATION ALONG THE DANUBE RIVER

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Abstract

The rapid development of information technology has mirrored itself also in inland navigation. The technology developments cover all area of interest in inland navigation system, from electronic charts and modern standard of communications to the management of traffic and ports area management.

The Danube River is the largest and longest natural waterway of Europe, with a very important and strategic role in the EU policies for expanding a sustainable intermodal transport chain across Europe. Romania started a large scale project for modernization of the Danube navigation waterway in order to provide the needed infrastructure for the featured increase of traffic good between the North Sea and the Black Sea. The working load is focused on a 200 Km section of the Danube River, between Calarasi and Braila towns.

A team of researchers from our University had participated at the field inspections and evaluation for establishing the location of the traffic monitoring transponders and priorities of the working stages. The aim of this paper is to present the main technical problems that must be solved in the most difficult for navigation sectors of the Danube in order to increase safety of navigation and eliminate de natural bottlenecks.

Keywords: Danube River, Inland waters, traffic management, River Information System.

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INTRODUCTION

There is an increasing need for information exchange between parties in the inland navigation world. In particular, the exchange of traffic related information, dealing with safety, and transport related information mainly focused on efficiency, may benefit to actors involved in both types of activities.

During the last decades, a significant number of services and systems, dealing with vessel traffic and transport management, have been developed and some are in operation.

The inland waterborne transport sector is now faced with the challenge of integrating these building blocks into a common architecture that offers some degree of consistency and synergy across applications.

Comprehensive and international guidelines for River Information Services (RIS Guidelines) were needed, in order to harmonize the already existing river information systems and services.

These RIS Guidelines describe the principles and general requirements for planning, implementing and operational use of River Information Services and related systems. These RIS Guidelines are equally applicable to the traffic of cargo vessels, passenger vessels and pleasure craft.

In Romania, the RIS system will be implemented in short time, the project being financed by the Romanian Ministry of Transport, the IT infrastructure is provided by the Romanian Asesoft and UTI Groups and the VTMIS software will be make available by the HIT Traffic company from Holland.

The concept for Inland ECDIS has been developed in the German ARGO project in co-operation with INDRIS. The concept for RIS architecture has been developed by the WATERMAN thematic network, a research action under the 5th framework programme of the EU in the fields of VTMIS (maritime navigation) and RIS. Using these achievements, the RIS architecture has been elaborated comprehensively and in detail the R&D-project COMPRIS of the European Union in 2003.

THE ROMANIAN DANUBE RIVER INFORMATION SYSTEM (RIS)

Key functions of the Danube RIS

VTS centres for local traffic management by means of a tactical traffic image on shore will be established for the safety of navigation in difficult local situations and the protection of the surrounding human population and infrastructure from potential dangers of shipping. It emphasises on traffic organisation. The difficult local sectors may be:

(a) Narrow fairway and/or shoals
(b) Narrow bends
(c) Narrow and/or many bridges

(d) Fast water currents and/or cross currents
(e) Fairway with traffic regulations, e.g. one-way-traffic
(f) Conjunction of waterways
(g) High traffic density

The tactical traffic image (TTI) is produced by collecting shore based radar and vessel tracking and tracing information, and displaying the vessel information on an Inland ECDIS. The standards for Inland ECDIS and inland vessel tracking and tracing should be used. For a long river stretch and heavy traffic, the TTI may be enhanced by target tracking.

Navigational support is the generic term for some services to assist inland navigation.

In the traffic arena, navigational support is provided by pilots to prevent the development of dangerous vessel traffic situations on board or in special circumstances on shore. Nautical support is provided by tug boats or boatmen to assist in safe navigation and mooring. In the transport arena, *vessel support services* are services given to the skipper by e.g., bunker boats, waste oil removal boats, vessel equipment firms, and repair organisations.

RIS should optimise the traffic flow by:

(a) Support of the lock/bridge master in short term decisions for planning of the lock and bridge cycle by presentation of an electronic lock diary, by a database, and by registration of waiting times
(b) Support of the lock/bridge master in medium term decisions by data exchange with the neighbouring locks
(c) Support of the skipper by transmission of waiting times
(d) Optimising of lock circles by calculation of ETAs/RTAs for a chain of locks, transmission of RTAs to skippers

A vessel tracking and tracing system with a database and appropriate means of communication (e. g. VHF, GSM - voice and data) is recommended to be established in order to enhance lock and bridge planning.

In case of an accident, the RIS centre delivers the data without delay to the emergency services.

Depending on the risk assessment, a calamity abatement service may register only certain types of vessels and compositions or all vessels.

It should be the responsibility of the skipper to report the required data.

A ship reporting system with a database and appropriate means of communication should be established.

Position and sailing direction of the vessel should be reported:

(a) When entering or leaving the area of a RIS centre
(b) At specified reporting points within the area of the RIS centre
(c) When the data has been changed during the voyage

(d) Before and after stops of longer than a specific period

Logistic applications of RIS comprise:
(a) Voyage planning
(b) Transport management
(c) Inter-modal port and terminal management
(d) Cargo and fleet management

Voyage planning is the task of the skipper and the vessel owner. Voyage planning comprises the planning of the loading and the draught of the vessel, as well as the planning of the ETA and of possible loadings or unloading during the voyage. RIS should support voyage planning by

(a) Fairway information service
(b) Strategic traffic information
(c) Lock and bridge management

Transport management means the management of the transport chain beyond the scope of navigation driven by freight brokers and transport service quality managers. It is aimed at:

(a) Controlling the overall performance of the contracted fleet managers/skippers and terminal operators
(b) Controlling the progress in the contracted transports
(c) Monitoring unexpected threats for the reliability of these transports
(d) Finalising the transport (delivery and invoice)

The competent authorities should design their information systems in a way that the data flow between public and private partners is possible.

Communication and information exchange between private and public partners in RIS for logistic applications should be carried out according to the procedures and standards that are being agreed for RIS.

The competent authorities should provide ample room for logistics applications within the bounds of their possibilities, such as:

(a) The exchange of information between users and customers relating to vessels and terminals
(b) Fleet planning support
(c) ETA/RTA negotiations between vessels and terminals
(d) Vessel tracking and tracing
(e) Electronic market places

The competent authorities should indicate the data structure in use to application builders.

Implementation of Danube RIS system

In accordance with the Romanian and EU policies, implementation of the RIS System on the lower Danube started in 2004. Environmental impact assessment, model and field studies were performed between 2004 and 2006. Professors from Constantza Maritime University-College of River Navigation participated on the multidisciplinary teams that evaluate on the field the practical solutions for monitoring the Danube River traffic and to increase safety of navigation.

In accordance with the feasibility study findings, all the river and maritime ports along the Danube will have a number of 22 VTS local cells that will generate RIS inputs that will be collected in four VTMIS Regional Centers at: Tulcea and Galatzi dor the maritime Danube and at Giurgiu and Drobeta Turnu Severin for the middle part of the Danube River.

The first section of the system (Drobeta Turnu Severin area) was launched in 2005 and all the system will became fully operational in 2008, with a total cost of 4.600.000 €.

Based on an own development programme, VTMIS Transponder was designed by the Romanian UTI Group, manufactured and commissioned in less than 10 months by UTI research and development team, in compliance with the client's specific requirements.

VTMIS Transponder & Base Station are products dedicated to vessel monitoring on territorial waters, developed in compliance with the relevant international standards. VTMIS Transponder & Base Station have a very flexible implementation platform, which was especially designed so as to meet any naval operational needs. All system is based on AIS communication protocols.

Technical features of the equipment implemented on the Danube River, including Danube-Black Sea Channel

VTMIS Transponder works as a stand-alone equipment, with internal power supply using batteries with 48h autonomy and internal management of consumption regimes. Radio communication with Base Station are done on AIS frequencies , using FATDMA communication protocol with information updating each 3 seconds.

VTMIS Base Station provides full coverage for operation areas of VTMIS transponder equipment and communication with VTMIS transponder equipment on AIS frequencies. Using the same transponders, VHF communications with other Base Stations is enabled as well as format conversion and asynchronous channel and LAN transmission to the management software application and differential corrections for VTMIS transponder equipment.

MODERNIZATION OF THE LOWER DANUBE WATERWAY

Evaluation of the necessary measures for improving navigation on Danube in Romania, started with the most difficult sector on the Romanian Danube, respectively between Calarasi and Braila (km 375 to km 170). This study was ordered by the Romanian Transport Ministry, ISPA Implementation Unit and was conducted by several interdisciplinary research teams, including professors from Constantza Maritime University, Faculty of Navigation and College for River Navigation.

The Danube sector which is the study subject is placed in south east of Romania and represents the last 200 km of Danube river navigation area. The sector analyzed is approximately situated between city of Calarasi in the upper part and city of Braila in the lower part. The sectors starts at km 375, located at 5 km upper of Borcea channel entrance, in front of Chiciu village on Romanian side and Silistra city on Bulgarian side. The studied sector ends at km 170, located on main Danube arm, right in the lower part of Cremenea Arm (main Danube arm) and Macin Arm confluence. As administrative the sector studied, km 375 to km 170, is placed inside or at the limits of Calarasi, Ialomita, Braila and Constanta regions.

The necessity of improving navigation on Danube River between Calarasi and Braila

Danube sector between Calarasi and Braila (km 375-km 170) is an important sector of the 7th Pan-European Corridor. At the same time this waterway ensures connection between Danube River with Danube-Black Sea Canal and Maritime Danube sector.

Recommendations of Danube Commission for Calarasi-Braila sector mention to have a navigational channel with minimal depth of 2.5 meters and a width of 150-180 meters.

On summer–autumn season, the water flows are considerable reduced in this sector, so the navigation conditions become very difficult.

As follow, on the main Danube arm, exactly downstream of km 346 on old Danube (Bala channel junction), the 2.5 meters reference depth is not assured for a period around 160 days each year, channel depth being reduced in some critical point up to 1.5-2 meters. Figure 1 shows the Danube River section between Calarasi and Hirsova, where the most critical points are concentrated (numbered from 1 to 10).

For this reason, during these periods, the navigation have to be deviated on the Bala-Borcea secondary route, where there are a higher water flow and depths are higher than Old Danube channel, but, navigation is more difficult because the waterway is narrow and with many curves.

Using this secondary route, the distance between Calarasi and Cernavoda becomes longer with 105 km for ship's intended to go or to come to or from Danube – Black Sea Canal. In the same time, as follow of reduced dimensions and sinuous way of navigation channel on Bala and Borcea channels, in some areas navigation can be done only on one way. More, larger convoys have to be broken and barges must to be passed one by one.

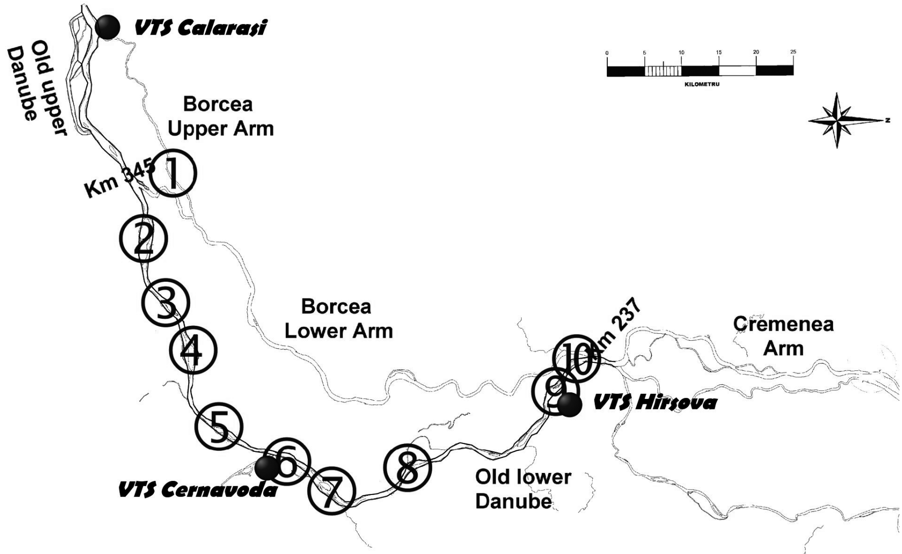

Figure 1. The most difficult sector of the Romanian Danube, between Calarasi and Hirsova, with ten critical points for navigation.

Therefore, the ship's carrying goods between maritime Danube ports of Braila, Galati, Tulcea or Ukrainian ports on Danube and Danube – Black Sea Canal or Constanta port, cannot be loaded at full capacity during 5 months annually.

This very unfavorable situation for navigation is caused in principal by morphological and hydrological phenomenons produced at Bala channel bifurcation (km 346) with following negative effects:

- — Time evolution of water distribution between Bala channel and Danube River unfavorable for main channel of Danube – on way to Cernavoda, this taking only 20% to 40% of total flow during dry season.
- — Constant degradation of Danube bottom (Cernavoda – Harsova – Braila sector), consequence of reduction of water current energy and low capacity to carry sediments, resulting in sand bank forming, secondary channels and continuously reduction of navigation channel section.
- — Degradation of Bala channel together with shore constant damage follow the strong current.

These phenomena's are increased by the Parjoaia submersion rock, situated on right side of the river at km 347, inducing modification of flow direction to Bala channel.

Flows redistribution problem in Bala channel inlet area has been treated in many studies after for different scopes. Through international programme PHARE was realized a series of preliminary studies inside "Study for improvement of navigation on Danube in Bulgaria and Romania" programme, which final report was elaborated in 1999. This study analyzes the critical points for navigation on lower Danube, including Calarasi – Vadul Oii sector.

The new research study used the results and conclusions of study made in 1999 by Harris and others, and the problems were detailed and actualized, including development of a new mathematical model of flows. Is appreciate that this model will not modified conceptual the study solutions but will be able to provide dates for solutions ending. The final solution will show if the Parjoaia rock blow-up integrally or partially, represents the optimal solution for maintaining as long as possible the required depth of water.

Solutions for improving navigation on Calarasi – Braila Danube River sector

The on field measurments and mathematical model findings showed that in order to secure a fluent and low risk river navigation on the Calarasi – Cernavota – Hirsova – Braila route, a dregged fairway with a width of 180 meters and a minimum depth of 2.5 meters Mean Water Reference Level (MWRL) must be maintained. Assuming also an additional water depth of 0.5 meters to cover the first year sedimentary deposits – net dredging depth will be 3.3 meters MWRL for calibrate dredging.

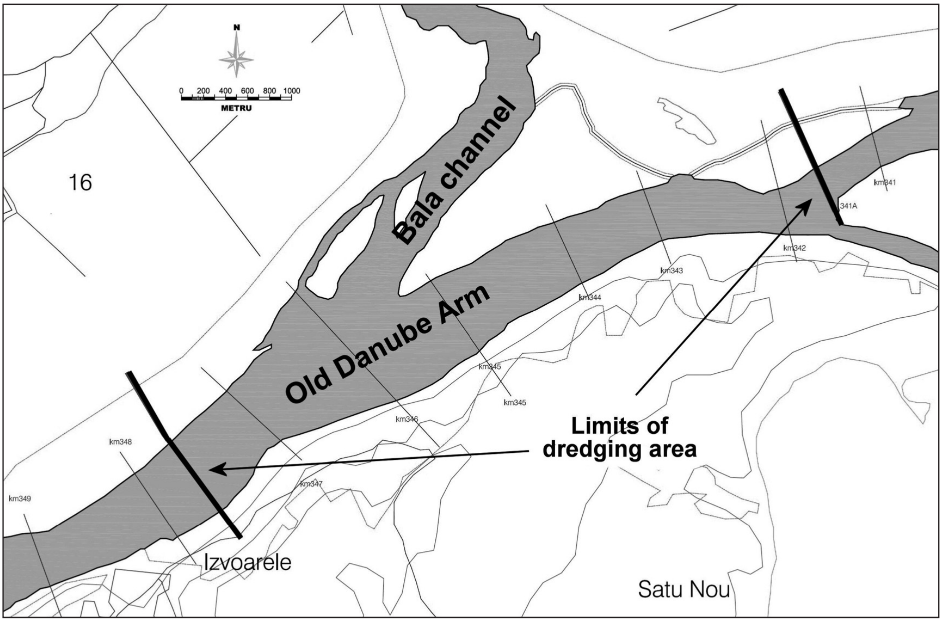

Figure 2. Area Turcescu-Bala, between km 341 and km 349.

In this paper we will discuss only four critical points, marked on the map from figure 1 as #1, #4 and #7.

Location #1 is known as Bala-Turcescu area and the Caragheorghe sandbar. A bottom pavement must be built on Bala channel at MWRL -1.85 meters and building bottom protection against erosion of the pavement on a distance of 300 meters downstream. Additionally on the Bala channel a conduct dyke must be build up to projected level of MWRL +5 meters and upstream to the limit bottom protection of the pavement. Shore defenses for the head of Turcescu Island protection and hydro technical constructions for water flow regularization are also needed at the Bala inlet (see figure 2 and figure 3).

Locations of other working areas for dragging operations are related to other critical points for navigation around Epurasul, Seica, Ceacaru, Tiu, Fermecatu, Fasolele islands. Supplementary constructions will be definited as position and solution after detailed study on water flow mathematical model and sediments carriage on analyzed sector.

Annual dredging operations for maintenance on upper part of Borcea channel to assure navigation to Calarasi port and for local traffic will be a constant operation along this part of the Danube.

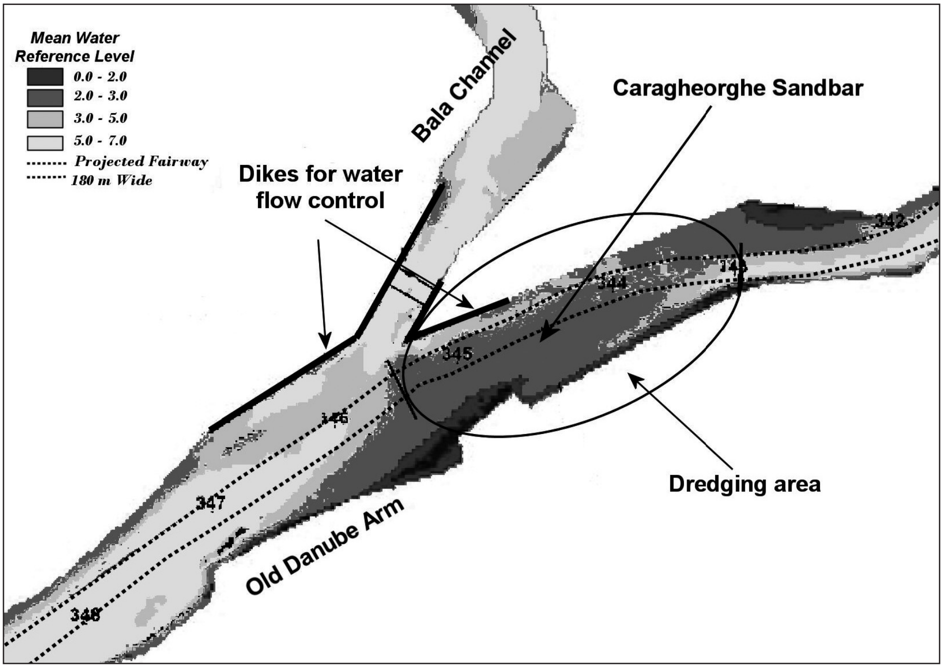

Figure 3. Area Turcescu-Bala, actual depth of water expressed as MWRL

Regarding proposed solutions for improvement of navigation conditions on studied sector Calarasi – Braila dredging operations for navigational channel calibration will have to be done in other nine locations, identified as critical points (figure 1). These locations are:

— location # 2 – Lebada, km 341-336;
— location # 3 – Mirleanu, km 329-325;
— location # 4 – Fermecatu Island (upper and lower part), km 323-318;
— location # 5 – Cochirleni, km 310-307;
— location # 6 – Cernavoda, km 297-296;
— location # 7 – Fasolele Island, km 292;
— location # 8 – Alvanesti, km 276;
— location # 9 – Harsova, km 250;
— location # 10 – Giurgeni, km 245-242;

Figures 4 and 5 depicts the geographical and hydrographical situation around Fermecatu Island (location #4).

The dredging volumes are important for channel calibration, these volumes are appreciate at 585,167 – 1,181,039 sqm, the difference represented the volume of dredging operations to deepen the channel from 2.50 meters to 3.50 meters.

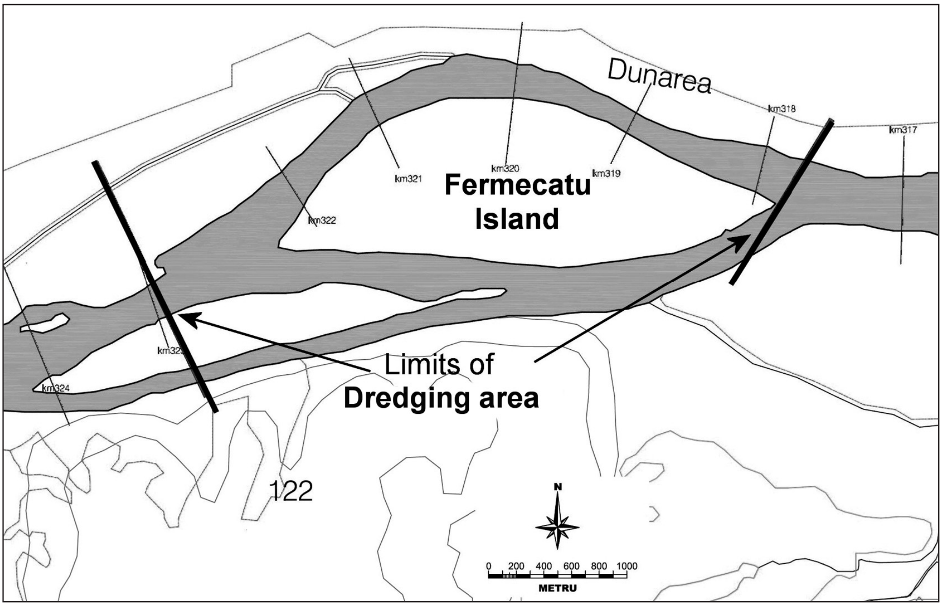

Figure 4. Area Fermecatu Island, between km 317 and km 324.

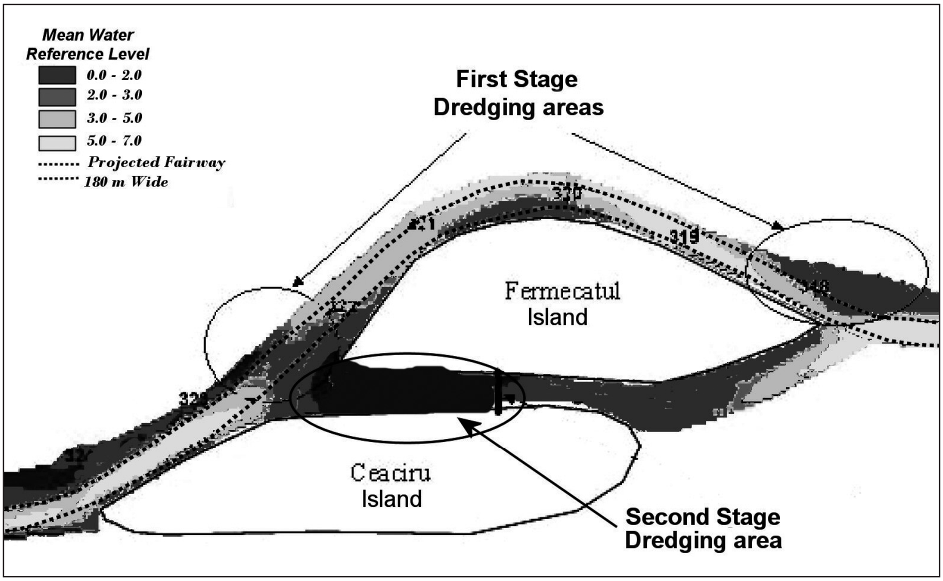

Figure 5. Area Fermecatu Island, actual depth of water expressed as MWRL.

The volume of maintenance dredging is appreciate to be 350,000 cm per year. Dreg material is formed by fine sand generally and medium sand as subsidiary. This material is characterized by a low pollution potential, his storage on shore or in water doesn't create pollution problems.

According with the last study appreciations (including Harris and others), through these hydrographic works will provide all the required water volume on Danube during the period of low flows, necessities represented by navigation, irrigation, water supply and cold system with water for Cernavoda nuclear power plant.

Regarding consolidation/defenses shore projects, the research included solid defenses projects, with special elements for protection, only in sectors with special critical risks. Are considered in this category that shore areas where the errosion process is very active and present a real danger for important economic and environmental objectives. In total, shore defenses are stipulated for around 4000 meters length. Dike's totally length is around 1700 meters and of the bottom sills around 1900 meters.

CONCLUSIONS

River navigation on the Danube is regaining the primary role played before the starting of the war in former Yugoslavia. Increasing of cargo flow along all parts of the Danube is a direct consequence of the transport policies promoted by EU and designation of the Danube River as the 7th Pan-European Transport Corridor.

Romanian governmental authorities are trying to recover the delays in modernization of the Danube river navigation infrastructure and multimodal transport facilities, in order to eliminate the natural bottlenecks along the river and to increase the cargo operation capacities of the river ports.

In our paper we underlined the last investments and research done for increasing safety of navigation along the lower Danube. These activities were focused on two main directions:

— Traffic management and monitoring, using latest technological facilities for implementation of the VTMIS system;
— Dredging and hydrographic construction work for rehabilitation of the navigation fairway at a uniform standard of 150-180 meters wide and at least 2.5 meters depth of water, all over the year.

Regarding the VTMIS system, it will become fully operational in 2008. Based on AIS technologies, it will cover almost all the length of the Danube River, focusing on the ports area and the most difficult navigation sectors.

On field evaluation and research analysis, including mathematical flow models, were used to establish the best actions to de done for creation and maintenance of the navigation waterway at the prescribe parameters. These type of civil engineering works are concentrated in the Calarasi – Hirsova sector, on the old Danube arm. Importance of this sector is increased by the inbound/outbound traffic of the Danube-Black Sea channel, the short route that could connect the maritime ports from the Romanian Black Sea with the North Sea ports.

Electronic navigation charts for the Romanian Danube were also produced. The only practical problem that still must be solved is related to the continuous update of these charts, in accordance with the day by day water level. This problem will be solved using also the VTMIS capabilities, that include monitoring and data collection from automatic water level sensors.

In parallel with the hydrographic construction work on the ten critical point located between kilometers 107 and 375, installation of new and modern navigation aids will start for marking the safe navigation waterway.

REFERENCES

Barsan E., (2002) - Maritime and Inland Waterways transportation systems, a priority for Europe - *Conference "TECHNONAV '2002"*, ISSN 1223-7221 - Constantza, Romania, 2002

Jansen, J.R., Rutchey, K., Koch, M.S., Narumalani, S., (1995), Inland Wetland Change-detection in the Everglades Water Conservation Area 2A Using a Time Series of Normalized Remotely Sensed Data. *P.E. & R.S.*, 61 (2),

Bujis L., Uzunov Y., Tèankov K. (1992) - Water quality profile of the Danube river along the Bulgarian-Rumanian stretch - *ICWS Report*, Amsterdam

Zinke Environment Consulting & Unesco/Inweb (2004): Internationally Shared Surface Water Bodies in the Balkan Region - Characteristics and State of Policies of River Basins. *Prepared for the German Federal Ministry for Environment and UNESCO*, Thessaloniki.

Jean-Philippe BEDEL et al, (2003) - Proposition d'une methodologie d'evaluation des risques ecotoxicologiques lies a la mise en depot sur sol ou en graviere de sediments de dragage - *Bulletin des laboratoires des Pont set chaussees*, LCPC, nr.244-245

Harris et al., (1999), The study to improve navigation on the Danube in Bulgaria and Romania - *Phare multi-country transport programme,* Ministry of Environment Press, Bucharest

I.N.H.G.A. – Institutul Naþional de Hidrologie şi Gospodãrire a Apelor, (2004) -

Asistenþã tehnicã pentru modelarea matematicã, hidrologicã si morfologicã a Dunãrii în sectoarele: Cãlãraşi-Brãila (Km 175-Km 375) şi Batin (Km 521-Km 531); Bucharest

ICPDR (International Commission for the Protection of the Danube River), (2002) - Water quality in the Danube River Basin - *TNMN yearbook 2001-2002*

Arsenie P.C., Hanzu-Pazara R.I., (2006) - Traffic management for inland waters according river information system - *Jubilee conference of the Naval Academy*, Varna, ISSN 1310-9278

Visited WEB sites:

Danube Commission: /www.danubecom-intern.org/
Danube RIS in Austria: doris.bmvit.gv.at
Electronic Waterway Information System, Germany: www.elwis.de
Federal Waterway Authority, Germany: http://www.wsv.de
Finnish Maritime Administration: www.fma.fi