25 October 2013

ABSTRACT BOOKLET

23 - 27 September 2013 - *Maastricht / Liège*

PIANC - SMART Rivers
Conference 2013

Edited by Philippe Rigo and Milou Wolters

SMART RIVERS 2013

Maastricht - Netherlands
Liege ï Belgium

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ABSTRACT BOOKLET

Conference Organised by
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SMART RIVERS Conference 2013

LIST OF SESSIONS

Wednesday 25th September

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	18	CARIS A, LIMBOURG S, MACHARIS C, COOLS M	BE	197	ESCALANTE R. S .	ARG	94	VITS Werner	BE	158	HU Ya'an, LI Z., LI Y., XUAN G., XUE S.	China	119	HOFMANN Benjamin, VAN DER WERF Hans	CCNR
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The five workshops are:

1- Mechanical and Electrical Engineering, Lessons Learned ; INCOM WG 138
2- Values of Inland Waterways - INCOM WG 139
3- Design Guidelines for Inland Waterways- INCOM WG 141
4- Ship Behaviour in Locks and Lock Approaches- INCOM WG 155
5- Dynamic Traffic Management;

#	NAMES	Country	Session	TITLE
1	GORDON Rogelio A.	PA	**C3**	Premises for the selection of the rolling gates for the Panama Canal Post Panamax Locks
2	WONG Johnny	PA	**C4**	Lessons Learned on the Design-Build for Navigation Projects ï Experience of the Panama Canal Third Setof Locks
3	FASTENBAUER Michael	AT	**E3**	Future Innovation in Inland Navigation
5	HASENBICHLER Hans-Peter, TOEGEL Robert	AT	**D2**	Controversial approaches between IWT and nature protection: finding the right balance (based on experience from the Integrated River Engineering Project on the Danube East of Vienna)
6	MATZNER Bettina, HARTL Simon	AT	Poster	Danube logistics ï green transport for a green economy
7	PUTZ Lisa-Maria, SCHAUER Oliver	AT	**A5**	Building up REWWay (Research & Education in Inland Waterway Logistics)
8	MERTENS Johan, BELADJAL Lynda, SCHALLEY Wim, HENDRICX Wilfried, VAN HAUTE Frederik	BE	**B5**	Accelerated Low Water Corrosion (ALWC) ï a myth or not?
9	SEEMANN Lukas, KAUFMANN Mario	AT	**E1**	International RIS data exchange ï The enabler for added value logistics services
10	NEMETH Johannes, ZWICKLHUBER Thomas	AT	**A6**	RIS Navigation Support Services ï Can new services make navigation safer?
11	HEUVEL Jasper van den, ROOVERS Geert	NL	**E2**	Increasing need for cooperation in navigation calls for new skills of organizations and staff
12	PLASIL Christoph	AT	**E4**	Recent developments in FIS - how to make different services work together
13	SATTLER Mario, MASLIAH-GILKAROV Helene	AT	**E2**	Network of Waterway Administrations ï Network of RIS Providers and RIS Authorities
14	ZWICKLHUBER Thomas, TROGL Jürgen	AT	**A1**	The chaos with ñuniqueòvessel data within RIS - practical experiences and proposals for improvement
15	BAYART P, ADAMS Roeland, DOORME Sarah	BE	**E1**	Capacity of Inland Water Transport systems, from a single lock model to a network model
16	VERBELEN Jeroen, DE BEUKELAER-DOSSCHE Michael, VAN LOOVEREN Ronny	BE	**B3**	Tidal End of the Scheldt in Gentbrugge-Melle: Restoration of Navigability In the Sedimented River Arm, and Design of a New Lock.
17	BAYART Pierre, GRONARZ Andreas, BOUSMAR Didier	BE	**D4**	Navigation simulations on a new CEMT VIb lock in Ampsin-Neuville on the Meuse river in Wallonia
18	CARIS An, LIMBOURG Sabine, MACHARIS Cathy, COOLS Mario	BE	**A5**	Integration of inland waterway transport in the intermodal supply chain: a joint research agenda

19	COUNASSE Clément, MONFORT David	BE	**C1**	Design of the new lock of Lanaye
21	MOMMENS Koen, MACHARIS Cathy	BE	**A2**	Location analysis for the modal shift of palletized goods to the West-European inland waterways
23	SORINI Olivier, NIHART Raoul	BE	**B1**	Smart Rivers flows through Smart Cities : Run-off river hydroelectricity
25	VANTORRE Marc, ELOOT Katrien, GEERTS Stefan	BE	**D4**	Inland vessels at sea: a useful contradiction to solve missing links in waterway systems
26	DECROO Daniel, TORO Fernando	BE	**D1**	Technical solutions for improving the navigation conditions on the common Bulgarian-Romanian sector of the Danube
27	ELOOT Katrien, VERWILLIGEN Jeroen, VANTORRE Marc	BE	WG141	Detailed design for inland waterways: the opportunities of real-time simulation
28	SALMON Frédéric, LIMBOURG Sabine	BE	**A2**	Empty Container Management in Benelux Waterways
29	MAES Ellen	BE	**C2**	The Seine-Scheldt project in Flanders ï The lock of Harelbeke
30	McCARVILLE Jim	US	**E5**	Challenges and opportunities to convert towing vessels to burn natural gas and to create a maritime natural gas corridor in the Port of Pittsburgh.
31	HUTHOFF Fredrik, BARNEVELD Hermjan, PINTER Nicholas, REMO Jonathan, EERDEN Henk	NL	**D6**	Optimizing design of river training works using 3-dimensional flow simulations
32	RABELLO Jose Esteves Botelho	BR	**C6**	Triangular-Shaped Front Barges in Convoys
33	FAZIO (de) Andre, GRECO Eduardo	BR	**E1**	Port-Hinterland Logistic Networks and Integration: The Case of Brazil
34	PAULI Gernot	CCNR	**D2**	Possibilities for reducing fuel consumption and greenhouse gas emissions from inland navigation
35	WU Peng, XUAN Guoxiang, CAO Fengshuai	CN	**D5**	Water Depth on Sill and Vesselsôdraft Control of Three-gorges Lock
37	WÖFFLER Theide SCHÜTTRUMPF Holger	DE	**---**	Ship-induced loading and stability of estuarine waterways structures
38	HAASS Heiner	DE	**B1**	Networks for nautical tourism at smart rivers
40	LATTNER Jorg, VASTERLING-WILL A.	DE	**E6**	The Ports of Bremen/ Bremerhaven ï Hinterland Traffic/Inland Shipping
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43	SMIT Erik, BESJES Rob, DEURINCK Frederik	BE	**A7**	Technical installation for controlling locks and bridges on the river Meuse
44	SPITZER Detlef, SÖHNGEN Bernhard	DE	WG141	On the longitudinal dynamics of ship entry and exit at locks
45	THORENZ Carsten	DE	WG155	Evaluation of ship forces for a through-the-gate filling system
46	WOHLFART Sven	DR	---	Waterways as basins for pumped-storage hydroelectricity
47	KUNZ Claus	DE	**C7**	Semi probabilistic design of hydraulic inland structures - PIANC WG140
48	HOLM Olli	FI	**A5**	The Role of IWT in Customer Orientated Transport Chain
53	HUISMANS Ymkje, VAN DER SLIGTE Robin, GOOSSENS Hans, YOSSEF Mohamed	NL	**B6**	Rapid assessment tool for designing the optimal river navigation channel route and dimensions
54	DELEU Benoît, CORDIER Yvan, GUESNET Thomas, GRONARZ Andreas	FR	**C2**	Optimum width of a navigation canal bridge taking into account ship maneuverability and side wind effects

55	LEVASSEUR Luc, MATHURIN Jean-Louis, BRAISE V.	FR	**E3**	The ñRhone modelò or what evolution of the multipurpose development of the Rhone river, 80 years after its starting ?
56	THANG Le Huy, MATHURIN Jean-Louis , SINOU Jean	FR- VN	**E7**	Waterways improvement of the red River delta (Vietnam): The Northern Delta Transport Development Project
57	HOPPE Michael, SANDLER Martin	DE	**A6**	Electronic Height Control System to avoid Bridge Collisions on Inland Waterways
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59	KUNST Marjon	NL	**A3**	Organisation of Vessel Traffic Management Centres of the future. From local services to an integrated traffic management approach.
60	VAN DER MAAREL Christiaan	NL	**A3**	Designing the Traffic Management Centre of the future
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62	VELDMAN Johannes Jan, DUBBELMAN Jean-Pierre, IJMKER Egbert Lambert	NL	**D4**	Room for the River, cross-currents and inland navigation
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78	McGOWAN Deirdre	US	**D6**	Nautical Depth Solutions to Fluid Mud in Channels
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80	MAEGHE Koen, VAN ROODE Mirjam	BE-NL	**C1**	Cross border cooperation on river management along the river Meuse
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82	KUEHLEWIND Rolf	DE	**C6**	Mechanical and Electrical Engineering Lessons Learnt from Navigation Structures - PIANC WG138

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Criteria for the selection of the rolling gates for the Panama Canal Post Panamax Locks

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Lock gates are steel structures used to separate lock chambers from adjacent chambers, lakes or oceans. In their closed position, they must hold the water and withstand the pressure resulting from the difference in water elevation of the adjacent bodies of water. Afterwards, when water levels are equalized, the gates must open to allow vessel passage. Both ofthe Post Panamax Locks Conceptual Design Studies concluded that the only feasible alternatives for Post Panama lock gates were the (1) rolling gates and the (2) miter gates. Other types of gates such as sector gates, tainter gates, vertical lift gates, bottom hinge gates and submersible lift gates were evaluated and discarded in the early stage by the conceptual design studies.

During the construction of the existing Panama Canal (1904-1914), the same dilemma was addressed. Back in those days, only two types of lock gates were evaluated: miter gates and single-leaf gates (rolling or floating caissons). Miter gates were the standard in those days for canals, and their past performance record was excellent. Rolling gates were common in dry docks and other harbor applications, but rarely used in waterway locks. Same as today, the other types of gates were discarded because they did not have a proven history of successful service. For the selection process, five (5) criteria were used to evaluate both alternatives: type of construction, costs, gate resistance to collision, weight and complexity, and operating time. The final selection of the miter gate for the existing Panama Canal was based on the experience and technology available in the early 1900's.

Since the construction of the existing Panama Canal, the technology for designing, building and operating lock gates has evolved to overcome must of the initial uncertainties. With modern design methods and the use of welding, the design and fabrication of rolling and miter-type gates has improved during the past decades making them very common in today's maritime and inland waterways. This new reality made it very difficult for the Panama Canal to decide between the two gate types for the new Post Panamax Lock.

The comparison analysis to reach a decision on the best alternative for the new locks included technical aspects related with the operation, safety, maintenance and construction of the gates. Additionally, for the comparison of the two lock gate types, the following factors were systematically evaluated:

a. Compatibility in system
b. Overhaul impact
c. Construction costs
d. Operating times
e. Service life
f. Reliability
g. Water use

h. Operation
i. Maintenance
j. Traffic on top of gates

After weighing the advantages and disadvantages for each gate type of the above, the rolling gates were preferred by the Panama Canal for the new Post Panamax locks. Later, some of the criteria used for the comparison analysis were expanded and incorporated into the performance specifications for the design, fabrication, installation and operation of the rolling gates.

Presently, the rolling gates are being successfully built by CIMOLAI in Italy. The first set of gates should be arriving at the Isthmus by the second quarter of 2013.

SMART RIVERS Conference 2013

- ABSTRACT 02 –

Lessons learned on the Design-Build for the Panama Canal Third Set of Locks (to date)

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This paper will discuss the lessons learned to date on the Third Set of locks project of the Panama Canal. The project is estimated to finish in 2015 and will double the capacity of this route, allowing for the transit through the Canal of larger ships, now called New Panamax. Two new locks are being built, each with three chambers measuring 55m wide, 458m long and 30m tall, with three water-saving basins (WSB) per chamber. The locks will have eight rolling gates, 68 valves each, to control water flow in the main culvert (measuring 8.30m wide by 6.50m tall), secondary culverts and WSB conduits.

The planning stage of all projects is critical to their success. The Panama Canal Authority (ACP) conducted nearly 150 studies with renowned international firms in all areas including market, demand, capacity, navigation, hydraulics, conceptual designs, water management, environment, finance and economics, and developed an expert panel as well as carrying out a consultation with stakeholders to put together the best option for expanding the waterway. The results of the comprehensive study were reflected in the Panama Canal Authority's Master Plan 2005-2025 (copy available in www.pancanal.com).This Master Plan was summarized and presented to the public, who approved the proposal by a referendum held in October 2006.

Planning the tender process was the next step. The Panama Canal Authority chose to use the FIDIC guidelines to open for international bids, adopted for a design-build type contract to properly distribute the risks among the owner and contractor. A single contract was proposed to cover both the Atlantic and Pacific locks, and performance specifications were developed with the guidance of reputable program management, technical and legal advisors.

The project was marketed to interested experienced and knowledgeable firms to participate in the process and to allow for competition. The Panama Canal tender process for the project was initiated and prequalified four consortia. Individual meetings were held with these consortia to clarify issues and answer questions related to the Request for Proposal. Amendments to the Request for Proposal were made as deemed adequate. Final bids were received, technical evaluations were first made and price proposals were then included to select the winning consortium.

Project start up and execution phases needed to be monitored closely. After all guarantees required by the Contract were presented, the order to proceed was issued and design and mobilization phases started. Project managers emphasise aspects of safety and environmental compliance throughout the execution of the work. Compliance with the design requirements throughout the different final design phases is enforced. Quality of work is monitored and assured. Regular progress meetings are held and reports are issued on the different aspects of the work. Progress payments are jointly revised and issued.

The current status is that the locks design is almost complete, with civil works approximately halfway advanced. The gates and valves are being manufactured as well as electromechanical components, which are arriving on site for future installation. The plans and the work continue toward the successful completion of the Panama Canal Third Set of Locks.

SMART RIVERS Conference 2013

- ABSTRACT 03 -

Future Innovation in Inland Navigation

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Within FP7 (the Seventh Framework Programme of the European Community for research, technological development and demonstration activities) several projects were (and still are) addressing innovative "Smart Rivers" topics. Within the project PLATINA, a Strategic Research Agenda for Inland Waterway Transport, "Navigator 2020", has been developed.

Navigator 2020 addresses the challenges ahead by proposing four action areas:

- Logistics efficiency: Smart and intelligent logistics solutions and cost-efficient transhipment support multimodal, seamless transport and just-in-time delivery of a vast range of cargo over short and long distances. Inland waterways are a logical and fully integrated choice within the multi-modal mix, leading to decreasing energy costs, less carbon emissions and reduced congestion in a lean and green supply chain.

- Infrastructure: A well maintained and climate change resilient inland waterway network without bottlenecks forms the backbone of a reliable European transport infrastructure.

- Vessels: A new generation of smart, clean, innovative and climate change adapted vessels enables sustainable transport with low impacts on the environment and forces the use of alternative and sustainable energy sources. The existing fleet needs to be retrofitted in order to enhance its energy efficiency and its environmental sustainability.

- Education and qualification: Highly qualified and skilled crews ensure safe and reliable transport services. Sophisticated approaches such as simulators and e-learning efficiently support education and qualification. Inland waterway transport offers challenging jobs and attracts and retains qualified staff and talent.

Besides Navigator2020's content, its context will be described, namely mentioning European Union policies for transport, environment and research, the economic development of waterway transport operators and the financial situation of waterway infrastructure managers together with the interrelation of different stakeholder communities which are active in shaping the sector's future.

The presentation will give an overview of the current research situation and it is intended to create attention for forthcoming developments which need active participation of a number of people and organisations - research institutes, education & training institutes, transport industry, shippers, governments, administrations, infrastructure managers etc.

SMART RIVERS Conference 2013

- ABSTRACT 005-

Controversial approaches between IWT and nature protection: finding the right balance (based on experience from the IntegratedRiver Engineering Project on the Danube East of Vienna)

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The approximately 48 km long section of the Danube between Vienna and the Austrian-Slovakian national border constitutes the most significant weak point for inland navigation along the Austrian Danube. Insufficient fairway depths during low water periods and strongly varying fairway conditions are hindering the smooth passage of inland navigation. Therefore, a substantial maintenance effort is needed to assure competitive and safe inland waterway transport.

At the same time, this free flowing section is extremely valuable from an environmental point of view and therefore highly protected. The Danube Floodplains National Park, located in this area, covers a total area of 100 square kilometers and incorporates a 36 km reach of the Danube, all of which is in a Natura 2000 protected area. It is one of the last major floodplain areas left in Central Europe and is exceptionally rich in biodiversity.

But the environmental processes in the National Park are at risk. The Danube east of Vienna has long been subject to river bed degradation (approx. 1 meter in the last 50 years), leading also to a lowering of water levels and the groundwater table. In addition, the river was canalised by river regulation structures along both river banks and side arms were cut off in the cause of the so-called “Big Danube Regulation” in the 19th century. This has led to a disconnection between the river and the floodplains and has resulted in the drying up of large wetland areas.

In 2002, the Austrian Federal Ministry of Transport and the Austrian Waterway company via donau initiated an integrated expert process for an "Integrated River Engineering Project on the Danube East of Vienna" (IREP). The project aimed to balance the interests of inland navigation with the environmental needs of the Danube Flood plains National Park and in particular the conservation objectives of the Natura 2000 site.

For the IREP, an integrative planning process was designed. An interdisciplinary steering group, consisting of well-known experts from the fields of ecology, inland navigation, regional economy and hydraulic engineering was established. The group analysed in detail several alternatives and identified 11 different variants for developing the Danube section east of Vienna. The preferred alternatives were discussed intensively and improved over several years.

In conjunction with these discussions, the involvement process of a wider group of stakeholders was carried out to discuss the interim results of the steering group. This process involved about 40 stakeholders representing NGOs, affected ministries, authorities, communities, the navigation sector, the national park and others. The steering group agreed to a set of measures aiming for a win-win situation for both the ecology and the navigation. An interdisciplinary planning team was responsible for translating these guidelines into a sound project.

DanubeLogistics – Green Transport for a Green Economy

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In times of declining resources of petroleum based products, bio based green resources are getting increasingly important as additional source of energy and raw material, so called renewable resources. Renewable resources are commonly defined as agriculture and forestry products as well as biogenic residues and waste materials for energy or material use. One of the main sources for renewable resources is wood which is used as construction material, as biomass for heating purposes as well as for the production of packaging material and textile fibres, etc.

Other renewable resources for material use include - besides others - starch, vegetable oils and fats, natural fibres and pulp. Energy use of renewable resources comprises the production of heat, power and fuels. Wood is the primarily renewable resource for the production of heat and power. In the field of fuels, rape and other oil-rich plants like sunflower are converted into liquid biomass and biodiesel. Starch-rich and sugar-rich plants like grain and sugar beets are suitable for the production of bioethanol.

The Danube navigation already plays an important role in the transport concepts for these products. Currently around 20% of the total transport volume on the Austrian Danube can be classified as agricultural and forestry products, like wood, wheat, vegetable oils and fats, etc. Referring to their special requirements and typical characteristics, the following advantages of Danube navigation can be highlighted for these types of products:

- Environmental friendly mode of transport
- Cost efficient transport solution, especially for bulk cargo
- High volumes of renewable resources along the Danubeaxis, huge growing areas in the vicinity of ports and terminals
- High density of Danube ports with efficient handling and storage facilities for agricultural products
- High loading capacity of Danube vessels compared to other modes of transport
- Reliable logistic partners with long-term experience and well established transport chains

The Transport Development Team of via donau carries out regular market analyses for dedicated cargo groups and their potential for Danube navigation. The last market review was published in the framework of the INWAPO project and focused on nine different branches. The outcome of this study showed the high potential of renewable resources for Danube navigation, so the topic was selected to be further investigated within a dedicated working initiative. A similar initiative was already launched before with a focus on “High & heavy transports on inland waterways”. Within its frame four expert working groups and 2 additional events were organised by via donau and partners. This first initiative was completed in autumn 2012; in addition to a final paper also a concrete transport project was initiated in cooperation with via donau. The new

working initiative “Transport of renewable resources on the Danube” will be organised according to the same pattern.

Promoting the transport of renewable resources on the Danube, via donau launched this working initiative as an information and knowledge exchange with focus on the Austrian sector through regular expert working groups. Shippers, Navigation companies, ports and terminals as well as freight forwarders and logistic service providers should discuss the possibilities of the environmental friendly transport on the Danube waterway. On the one hand the expert working groups should enable an interconnection within the sector through the information and knowledge exchange between the participants. On the other hand good practice presentations should show the experts how inland waterway transport can be integrated in their supply chains for renewable resources. Additionally the participants get detailed information on the advantages of Danube navigation by presentations prepared by via donau.

This project will be carried out from 2013 to the end of 2014 and will include several expert working groups at a national level focusing on specific topics linked to Danube logistics. In parallel to these workshops additional events and presentations with a focus on renewable resources shipped on the Danube will be organised by via donau.

Within this project good practices and presentations, also including external experts, will show examples how to include Danube navigation in the supply chains of these products. Finally, further modal shift towards inland navigation, one of the most environmental friendly modes of transport, should be achieved by triggering concrete projects together with the industry.

SMART RIVERS Conference 2013

- ABSTRACT 7 -

Building up REWWay

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Although inland navigation and railways operate at a low noise level and support environmental goals, trucks are used for the majority of freight transport. A shift to eco-friendlier means of transport is absolutely necessary, since the overall traffic volume is rising. Indeed, the anchoring of eco-friendly inland navigation is in accordance with transport and regional objectives in the EU (i.e. the Danube strategy and the European Action Program - NAIADES) and in Austria (i.e. the National Action Plan Danube Navigation – NAP).

One of the reasons for the low modal split of inland waterways is the lack of education about this topic. In fact, inland waterway transport is underrepresented in general logistics education. Education and training materials are often either missing or outdated. Consequently, new generations of logisticians are not aware of the opportunities offered by inland waterways.

For this reason, via donau and Logistikum established a cooperation to close this gap. Via donau – Österreichische Wasserstraßen-Gesellschaft mbH was established in 2005 by the Austrian Federal Ministry for Transport, Innovation and Technology and was tasked with the maintenance and development of the Danube waterway. Logistikum was established in 2006 and has become the largest Austrian research and development institution for logistics management.

The aim of the cooperation is to develop and promote a competence centre for inland navigation at the Logistikum Steyr. The main focus is to strengthen the transfer of knowledge between all relevant parties in the long term by collecting, translating and developing new learning material. As a result, REWWay generates didactically valuable materials for different stakeholders.

The demand of target groups (i.e. secondary and tertiary education institutions) must be clearly identified to develop specific materials and didactic methods. Therefore, national and international market research including workshops, focus groups and expert interviews was conducted. Accordingly, requirements for the target group i.e. concerning subjects, didactical methods etc. should be defined. Based on this, target group specific material will be generated.

The results of the market research suggest that few teaching units are used for transport in general. In fact, most units focus on railway and road transport and only few units are used for inland waterways. The reasons for this are the low economic impact of IWW and the lack of teachers' knowledge in this specific field. Typically, knowledge transfer is provided using "common" didactic methods such as school books or worksheets. Modern methods such as case studies, computer based training or business games are seldom used.

In conclusion, one way to improve the modal split of inland waterways is to boost knowledge by increasing the number of teaching units concerning this subject. The integration of all relevant stakeholders will ensure the use of the provided teaching materials. Indeed, utilization of materials is fundamental to the future developments of the Danube waterway.

SMART RIVERS Conference 2013

- ABSTRACT 8 -

Accelerated Low Water Corrosion (ALWC) - a myth or not?

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Different theories and case studies are published worldwide to announce the problem of corrosion in aquatic environments, in particular ALWC (Accelerated Low Water Corrosion). Corrosion in riverine systems (river bed and the estuary) is often unpredictable and caused by specific macro- and microfouling in marine, brackish and fresh water.

Fouling or bio fouling is known as a complex layer of (micro-) organisms growing on a substrate, including the organic and inorganic components in between, forming a biomat. The phenomena established in biomats can be different, but their corrosive consequences are similar on steel sheet piling and even stainless steel structures. A critical feature of microbial influenced corrosion (MIC) is that it is not as visible as the commonly known rusting of iron, but usually occurs as a 'hidden' process in aqueous constructions.

With the help of a dry setting installation, the research group can easily observe and sample the macro- and microorganisms that cause accelerated corrosion. This type of cofferdam allows safe and flexible access to the steel infrastructure under the water level and does not require divers to perform the observations. The mobile cofferdam, also referred to as an underwater caisson, sets a structure dry in sections, allowing researchers to progressively and statistically acceptably inspect the evolution of these phenomena. These inspections allow investigation of fouling organisms in relation to corrosion and even controlling anti-corrosion solutions.

This research and a review of the relevant literature show that stopping the corrosion of fouling organisms takes specific measures. Besides economic losses, microbial influenced corrosion causes failures that are of environmental concern or even hazardous. As the research includes aggressive accelerated forms of corrosion, thickening the steel over the full length of the sheet piling is no feasible solution and far from economic. Cathodic protection, sacrificial anodes and impressed current systems do not offer satisfying results in terms of stopping these types of corrosion. To bring a definitive stop to this corrosion, a good and durable high solids and diffusion tight coating system is much more effective and shows admirable results, without having to affect the fouling organisms and the environment. The knowledge and technology built up during the last few years enables the project team to get a closer look on what actually happens below the water level and share the current findings.

International RIS data exchange – The enabler for added value logistics services

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Besides the provision of properly maintained physical infrastructure, the provision of interoperable intelligent infrastructure is essential for safe and efficient inland navigation.
Based on this requirement, River Information Services (RIS) aims to increase safety and efficiency of inland navigation by means of creation, exchange and provision of relevant information about the fairway, as well as about the transport itself. RIS is comprised of various standardised technologies providing a series of services to all relevant stakeholders within inland navigation. Based on the RIS Framework Directive of the European Union (2005/44/EC), almost all countries with a considerable waterway network have already implemented national RIS systems and brought them into operation. Due to the fact that inland navigation operates mostly cross-border, it is necessary to exchange and provide relevant information for the transport on an international basis.

This requirement is stipulated by the various actors within the supply chain, especially when the vessel is navigating in a foreign country. Up- to-date and reliable data such as vessel position, estimated time of arrival (ETA) or the type and amount of cargo loaded on a vessel contribute to increasing the efficiency of a transport. Such information supports the shipping company in fleet management, whereas logistics services providers or port operators need a regularly updated transport status for advanced berth management. Eminently, in the field of multimodal transport, the usage of port infrastructure (e.g. cranes, wagons) for transhipping the cargo has to be planned efficiently in order to avoid waiting times for the other modes, like train or truck. In addition, the management of floating stocks comprising the tracking of cargo and the provision of estimated times of arrival can be realised. Consequently, inefficiencies in the field of inventory planning at the port get reduced.

Therefore, international RIS data exchange becomes more and more important and the awareness for its necessity has increased considerably during the past years. As interoperability and compatibility are a precondition for international RIS data exchange, the responsible RIS providers of several countries joined forces within the projects IRIS Europe I and II to specify and pilot implementation of international RIS data exchange by means of a decentralised architecture based on defined processes, interfaces and messages. Considering the important data protection regulations, the legal requirements were identified, documented and are forming the legal basis by means of signed contracts and service agreements. Within the technical and functional realisation of the international RIS data exchange, data protection is ensured by means of a strict role-based access rights mechanism in order to ensure that only authorised stakeholders are able to retrieve relevant data. The project RISING investigated specific logistics services based on international RIS data exchange aiming to increase efficiency in Inland navigation transport processes. Furthermore, within the project PLATINA, European services like the European Vessel Certification Database were implemented and brought into operation already.

Within IRIS Europe 3 (2012-2014), international RIS data exchange shall be improved based on experiences out of the test operation as well as based on feedback from logistics stakeholders and shall be brought into (pilot) operation. Once the international exchange of relevant RIS data is in operation in several countries, logistics stakeholders will be able to increase efficiency in their transportation processes based on the available reliable information. Furthermore, a series of value added services can be provided with the potential to further increase efficiency but also safety and environmental friendliness of inland navigation.

The conference contribution presents the concept and benefits of international RIS data exchange and provides an outlook to potential future developments.

RIS Navigation Support Services – Can new services make navigation safer?

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Past experience has shown that the most dangerous situations on rivers are those where the fairway is narrowed or comes closer to the riverside infrastructure, e.g. approaching river locks, passing under bridges, approaching riverside berths and navigation in dense traffic situations in port access areas. The availability of River Information Services (RIS) in many European countries provides the possibility to introduce new services that support the skippers in making informed navigation decisions in dangerous situations – Navigation Support Services.

The aim of RIS is to increase safety and efficiency in river transport through the development of innovative navigation support systems for inland waterway vessels. Considering the further evolution of RIS, a main focus is the reduction of the risk of vessel collisions and collisions with infrastructure along the rivers, channels, port and lock access. RIS Navigation Support Services support the goals according to the RIS Framework Directive of the European Union (2005/44/EC), where one focus lies on optimising the use of the infrastructure and improving safety on European waterways.

Navigation Support Services aim at providing accurate and reliable information to skippers in order to allow safer navigation and reduce human error. The navigation service shall act as visual guidance support system providing accurate distance information between the vessel's hull and the surrounding infrastructure to support navigation decisions.

Visualisation and presentation to the skipper are important key factors of a navigation support service and requires accurate data of both; the vessel and infrastructure. While information of infrastructure is mainly available from geo-referenced Inland Electronic Navigational Charts (ENCs), the position of the vessel has to be determined in real-time using Global Navigation Satellite System (GNSS) technology.

Within the project NAVWAT 2 (Future high precision navigation system for inland waterways), a precision navigation system test user terminal based on GNSS positioning and tailored to the use for barge convoys and conventional vessels in inland navigation was developed. Test results gained at an inland waterway trial will be presented. Benefits and advantages of the system are emphasised, and feedback of end users is described.

Furthermore, within the FP7 project ARIADNA (Maritime Volumetric Navigation system), an innovative navigation solution for improving traffic management and reducing human error has been developed. The new navigation support system based on Volumetric Navigation concept provides warning and manoeuvring support to the skippers for collision avoidance.

The so-called Volumetric Navigation System (VNS) defines the position of the vessel in a 3D virtual-safety-volume envelope. Every vessel is represented by a safety envelope whose geometry depends on its real shape, navigation and dynamic parameters and the surrounding environment.

The calculated, geo-referenced ‘safety volume’ uses GNSS technology to derive its position and is influenced by speed, navigation characteristics, environmental as well as risk factors. Depth and bridge information gathered from Inland ENCs completes the input assembly for a reliable navigation support system able to warn the skipper in case of an imminent collision.

Test results of the inland waterway trial of the ARIADNA solution on the Austrian Danube section as well as results from a maritime trial in Gibraltar Strait will be presented at the Conference.

SMART RIVERS Conference 2013

- ABSTRACT 11 -

Increasing need for cooperation in Vessel Traffic Management

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The nautical environment we work in changes rapidly: it's becoming more and more complex as well as competitive. This applies to the world of inland shipping too, a world which has changed strongly in the last decade. Nowadays it's a complex sector that continuously has to strive to work faster and more efficiently in a global competition. This must also be accomplished within complex networks with different modalities (like road transport, rail transport, sea shipping and air transport) and different actors (governments, harbours, agencies, stakeholders, shareholders, etc.). Networks which are becoming more and more complex.

Public organisations are stimulating, ánd stimulated, to adapt to this changing environment. For public organisations and their staff this change implies a change to new working methods, new IT and new ways of cooperation. These 'hard' changes only will succeed when the culture of these organisations, and with that values, attitudes and competences of their staff, are adapted to this new environment. This article elaborates on this need of changing culture, attitude and competences that are needed within public organisations to cope with this more and more complex and competitive environment in Vessel Traffic Management.

Firstly the article describes the change from a role-based culture to a task-based culture. A change needed to transform large hierarchical orientated bureaucratic organizations into flexible entities where results are more important than rules, power or personal needs. This leads to desired competencies of individual vessel traffic managers, such as integrity, neutrality, flexibility, context-awareness, cooperative and result orientation.

Secondly, this article shows the impact of this change at an organizational level. Complex networks ask for competencies so as to cooperate not only on an individual level, but on an organizational scale as well. This shows that organizations, to develop successful cooperation, have to be transparent and share information and knowledge. For example information about planning, cargos, capacity, etc. and such information sharing is difficult, especially in public-private and private-private interactions.Organizations also have to share resources, costs and benefits. So at this organizational level too, the most profound and therefore most sustainable solution, is to develop a culture of cooperation between organizations.

Finally, this article will conclude that cooperation orientated skills, focused on results, flexibility, transparency and trust are necessary as well on an individual vessel traffic managers-level as on an organizational scale.Given the hierarchic nature of navigation, these changes are difficult and still have a long way to go.

Recent developments in fairway information services - how to make different services work together

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As with other modes of transport (e.g. road, rail), IWT (Inland Waterway Transport) is subject to un-planned changes and limitations. For IWT stakeholders it is of outmost importance to get up-to-date information about the status of the IWT infrastructure, supported by one of the key RIS technologies NtS (Notices to Skippers). NtS were developed, standardized and implemented in various European countries to facilitate language independent, machine readable distribution of safety and voyage-related information such as water levels, shallow sections, blockages (of lock chambers) and (reduced) bridge clearance.

Usually there is more than one information source per country/region. Depending on national workflows, data is provided by the shipping police, competent authority for traffic management, port authority or lock operator. It is often coded manually in NtS messages at vessel traffic management centres (VTM) or navigation authorities. In the NtS fairway and traffic related messages, incidents are coded by means of subject – object – reason – limitation codes. To meet different national requirements, more than 30 redundant codes were included in the code list to provide flexibility. The flexibility provided by the standard combined with the fact that messages are compiled by various NtS editors working in different organizations and having different background leads to announcement of dredging requirements in different ways. Since the flexibility was identified as the main reason for ambiguous encoding of similar events, a working group of the NtS expert group was established to provide new NtS encoding guidelines and thus enabling unambiguous, harmonized provision of fairway information via NtS.

Humans are quite flexible in interpretation of text, but NtS are not, only published on websites and sent out via e-mail. The need for a harmonized NtS provision was increased by the fact that an NtS Web Service was standardized in June 2011, enabling automatic exchange of fairway information between authorities and from authorities to users, as well as integration of NtS information into third party systems such as on-board Inland ECDIS viewers (Electronic Chart Display and Information System) and voyage planning applications. NtS provides information about the status and availability of the waterways and thus is important for selection of the most effective route of a vessel as well as ETA calculation. Software algorithms need strict rules and flowcharts to deliver good results.

Furthermore, (geo-)reference data plays an important role. Location codes according to the International Ship Reporting Standard (ISRS) serve as a unique object identifier and a standardized link between different RIS services. The RIS Index serves as a directory of ISRS location codes, object names, geo coordinates and other useful information of e.g. locks, lock chambers, bridges, bridge openings, river hectometre points along fairway axis and other objects. ISRS location codes are included in NtS messages and assigned to objects included in Inland ENC (Electronic Navigational Charts). By this means, static information (e.g. lock chamber) in the Inland ENC can be enhanced with the operational status (e.g. in operation, inspection, repair) and the time period a status is expected to persist. Still those links between static and dynamic data have to be improved within the key RIS technologies and services built upon them.

The conference contribution will show lessons learned from the exchange of NtS information via web service, depict why incidents were not announced in a uniform way by different sources and deliver a solution for harmonized provision of fairway information via NtS by the authorities that can be integrated in on-shore and on-board fairway information service (FIS).

SMART RIVERS Conference 2013

- ABSTRACT 013 -

Network of Waterway Administrations – Network of RIS Providers and RIS Authorities

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The South-Eastern European area is in many respects one of the most fragmented areas in the European Union. It is characterized by historically grown economic and social disparities, cultural and ethnical diversity as well as by distinct political and administrative frameworks. The currently existing transport system in South-Eastern Europe in many aspects reflects these challenging preconditions and imbalances. It shows a high level of fragmentation due to both a long-term neglect of joint transnational and intra-regional strategies and insufficient public funding on the national level. The Danube is the most international river of the world and the second longest river in Europe. On its navigable length of 2,411 km, the Danube passes ten countries[1], which share a common border of about 1,070 km. The Danube riparian countries currently face different political, economic and social framework conditions.

With the European Commission establishment of the multi-annual action programme NAIADES[2] in 2006 and since 2010 the Danube Region Strategy of the European Union, united responses are being implemented to tackle the problems in the Danube region and to foster positive change in the awareness of inland navigation. In this new framework, two initiatives have arisen: NEWADA and IRIS Europe. The two projects behind these are here respectively to "improve comprehensive waterway management of the Danube and its tributaries" and to "implement harmonised River Information Services (RIS)".

Our attempt here is to analysethe characteristics of transnational cooperation andshowhow this can successfully contribute to the objectives of improving the accessibility of Danube navigation as a solid alternative and a reliable partner for the industry. The benefits and challenges stemming from the improvement of the Danube river as a waterway requires a high degree of transnational cooperation.Indeed, decisions taken by one of the Danube countries will havea significant impact on the fellow riparian countries. Thus we speak here about harmonization and the best approach is one of stakeholder management (e.g. within the independent RIS Expert Groups and task forces in IRIS Europe 3) and the introduction of performance indicators (within Board of Directors Meetings in NEWADA duo). The message is that the establishment of these networks, both on waterway administration level and on RIS provider/RIS authority level, must live beyond the project's lifetime and ways must be found to ensure continuity in a non-funding framework, yet keep the collaborative spirit.

[1] Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Romania, Moldova and the Ukraine

[2] NAIADES - An Integrated European Action Programme for Inland Waterway Transport, Communication of the European Commission on the promotion of inland waterway transport, 2007

The chaos with “unique” vessel data within RIS – practical experiences and proposals for improvement

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Data is the basis for all related River Information Services, therefore, sophisticated data is needed for the provision of a good service. Different RIS systems like the Hull Database (HDMI), the Automatic Identification System (AIS), the Electronic Reporting system (ERI) or applications like Lock Management (LMS) are all collecting vessel data by different means.

For sophisticated services or for the international exchange of RIS data or logistics purposes, the data from different sources has to be matched. Unfortunately, for historic reasons, different technologies have their own unique vessel identifiers.

Recent experiences in Austria have shown that vessel data (e.g. vessel dimensions) differ significantly between various sources. Worse, it turned out that even the unique identifiers are not always reliably set to the correct value. In order to provide qualitative services or simply to request vessel data from other systems or countries, unique identification is necessary. A first manual analysis of the situation showed that of the vessel data stored in the databases of the different RIS application in Austria, only about 10 to 15 per cent could be considered as completely correct and ready to be combined to a complete data set.

This result led to the creation of a software tool which is able to automatically compare the data sets from different RIS applications for each vessel and produce error reports. This will be the first steps towards a fully automatic data correction algorithm which shall ensure that in the future vessel identifiers and key data are correct and can be used internationally for the provision of high quality services.

The presentation will explain the problem giving practical examples, present the data comparison tool and show the initial findings and the potential approach to automatically correct wrong vessel data in the RIS environment.

The lessons learned might be of significance for all RIS providers in Europe in order to ensure the reliability of RIS data.

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- ABSTRACT 15 -

Capacity of Inland Water Transport systems, from a single lock model to a network model

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Considering the massive investments in the European IWT systems, it is a challenge to many network administrators to ensure that the service level in terms of capacity and commercial speed is high enough to keep transport on water competitive compared to other transport modes.

In order to assist those network managers and to be able to perform global waterway capacity assessment studies, IMDC-Waterways (Integrated Model for Design and Capacity assessment of Waterways) was developed starting from the existing IMDC-Locks model.

IMDC-Locks (Integrated Model for Design and Capacity assessment of Locks) was presented at Smart Rivers 2011 (Bayart et al., 2011). This model shows several advantages compared to other lock capacity models:

- The model does not rely on empirical relationships but on a modelling of all steps of the locking process, submitted to a real fleet of ships, each defined by an arrival time, dimensions and characteristics;
- The model is equipped with a stochastic ship traffic generator that can translate macroeconomic transport predictions (fleet distributions) into traffic input for the lock-model;
- The model can deal with a theoretically infinite amount of lock chambers, while most of other existing models are in the best case limited to two;
- The model can deal with tidal boundary conditions at one (or both) sides of the locks. The lock filling/emptying process duration can be introduced as a constant value, as a function of the water level difference between both sides of the lock, or as a time series;
- The model is fully developed in-house which allows it to provide tailor-made adaptation to specific projects or client's need.

However, several capacity problems required the expansion of the model to encompass the whole network:

- Lock complexes on a same waterway have a mutual influence on each other: traffic at a lock often comes from another lock (most of the time with the same chamber characteristics), which "pre-treats" the fleet and organises it in groups of ships that pass a series of locks together. It is necessary to take this effect into account in order to avoid underestimation of the capacity of locks. Alternatively, improving the capacity of one lock can just move the bottleneck to another complex of the waterway and only have a marginal effect on the capacity of the waterway, while important structural measures and costs can be involved;

- Lock complexes are not the only possible bottlenecks on waterways. On tidal waterways, the pilot sometimes needs to take a tide window into account depending on the ship's draught. On other parts (bridges, sharp bends) crossing of two ships can be impossible, depending on the dimension of the ships, the available fairway profile and the flow conditions;
- When saturation of locks or waterways starts to occur, the increase of waiting times on a waterway can make an alternative route (when existing) more attractive, which has a mitigating effect on the saturation issues.

In order to be able to take those phenomena into account, IMDC-Waterways was developed, incorporating IMDC-Locks' traffic generator and lock processing module.

Within the IMDC-Waterways environment, a network is defined by nodes and by the branches that connect these nodes. The purpose of the nodes is to define routes, whereby a route is defined by a succession of nodes. The purpose of the branches is to determine the transit time between two nodes depending on the interactions, on the one hand between the vessels and, on the other hand between the vessels and the infrastructure of the network.

Two types of branches are currently implemented within IMDC-Waterways:

- A lock-branch, defined by an IMDC-Locks module;
- A waterways-branch, which models the interactions (alternating navigation, overtaking and crossing) between vessels on a section of river or canal according to its profile and the prevailing hydraulic conditions (prevailing level and current velocity).

Depending on the total expected transit time for a specified route, IMDC-Waterways is also able to withdraw ships from the network (assuming that an alternative route is preferred).

The paper will detail these developments on the basis of case studies and give examples of results produced with the new software for navigation studies of the Upper Seascheldt between Ghent and Antwerp, and on the fluvial network of the Grand Port Maritime de Dunkerque.

Tidal end of the Scheldt in Gentbrugge-Melle : Restoration of navigability in the sedimented river arm and design of a new lock

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The tidal area of the Sea-Scheldt is bounded in Gentbrugge in the eastern part of the city of Ghent. Significant sediment accumulation with a total thickness of up to 4m in Gentbrugge induced tidal nature like freshwater mudflats and tidal marshes, but also jeopardizes the drainage of 3400 ha of adjacent land. Furthermore, an important part of the embankments along the trajectory still needs to be adjusted to reach the safety objectives of the Sigmaplan.

Shipping on the 8km long trajectory between Gentbrugge and Melle, at the bifurcation of the Sea-Scheldt and the Ringvaart around Ghent, faded out completely in the mid-1980s and shifted to the Ringvaart. Re-enabling navigability of the Sea-Scheldt towards Gentbrugge for recreational shipping can offer a solution for the interference of increasing commercial shipping (CEMT IV) and recreational shipping on the Ringvaart now.

Retaining the existing tidal boundary, or shifting it to the downstream end in Melle, would lead to a significant extent of the embankments to be adjusted (2 x 5km) and a large volume to be dredged ($10^6 m^3$), or to an important loss of tidal nature and buffer under storm conditions. The interaction between technical studies concerning hydrology, hydraulics, sediment transport and ecosystem functions on one hand and a widespread consultation process with all stakeholders on the other hand, lead, literally, to an intermediate solution.

A combined lock and storm barrier halfway along the trajectory leads to the highest score in the achievement of the different intended objectives. Making new connections between the river Scheldt and two adjacent areas compensates the shift of tidal nature to a non-tidal fluvial type in the upstream part on one hand, and the loss of buffer under storm conditions on the other hand.

In the design of the lock itself, three identical single leaf pivoting gates were found to be most suitable under the given boundary conditions: a relatively small lock width of 8m and an almost equal positive and negative water level difference of 3m. An intermediate gate allows adaptation of the water use to the shipping demand and takes away the need of an additional reserve gate. In combination with a latching frame to resist negative hydraulic loads, this type of gate was never used in Flanders.

The remarkable conclusion in the specific case of the Sea-Scheldt between Gentbrugge and Melle points out the scenario with a new lock as the most favourable lay-out of the waterway to achieve the multiple objectives. Starting in 2013, an Environmental Impact Assessment will be carried out. In the design, optional functions are taken into account: hydropower production, fish migration and crossings for pedestrians and cyclists.

Navigation simulations on a new CEMT VIb lock in Ampsin-Neuville on the Meuse river in Wallonia

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In the frame of priority project n°18 of the Transeuropean Network – Transport supported by European Commission, a new lock chamber with dimensions 225 m x 25 m will be constructed on the Meuse-river at the lock complex of Ampsin-Neuville. In the present situation, Ampsin-Neuville is a double chamber lock complex, with one 136 m x 16 m (Extended Rhinemax) and one 55 m x 7.5 m (Kempenaar) lock chamber. The new CEMT VIb lock will replace the old Kempenaar lock chamber. Because the lock is situated in a river bend and because vortices can appear in the upstream and downstream ports of the locks, nautical situation cannot be characterized only with standard guidelines for lock design. Therefore, a first phase of currently performed nautical study aims to validate (or adapt) the preliminary design of the lock, ports and guiding walls, as currently proposed by the administration.

This new lock will remove the last missing link for CEMT Vb and VIb units on the Walloon Meuse between Namur and the Albert Canal (and further to Antwerp, Rotterdam and the Rhine-Main-Danube link). In a second phase of the study, the focus is therefore set on the navigability of those units on the whole Walloon Meuse. The purpose is to define the maximum discharge enabling safe navigation for these units, in order to adapt the regulation policy.

Therefore, the scope for the study is then double:

- For the lock, validate the preliminary design of the ports and guiding walls and define acceptable waiting berth at the new lock (in or outside ports) for CEMT class Vb and VIb units;
- For the Walloon Meuse between Namur and the Albert Canal, identify critical sectors for class Vb and VIb units and define the maximum discharge enabling safe navigation considering both directions.

For both phases of the study (the lock and the whole Walloon Meuse), the same integrated approach is followed. That approach relies on three main steps:

- Definition and analysis of the flow characteristics determining the fluidity and the safety level for navigation within the proposed fairway (water levels, currents, blockage ratio, curvature of the navigation axe, safety distances between the ships and the boundaries of the fairway); and confrontation of those characteristics with:
  - Existing guidelines for locks and inland waterways design;
  - Characteristics and regulations on comparable waterways in Europe;
  - Expert advice.
- Simulation of trajectories with a real-time navigation simulator. Analysis of the simulations and conclusions in terms of fluidity, safety and comfort for navigation.

- Global conclusions and cost-efficiency-capacity analysis. This last point is essential in the study. It allows overlay of the nautical conclusions for individual simulations performed on the real-time simulator into global conclusions on the capacity of the lock and/or the waterway. It gives assistance to the authorities for taking the decision to validate or not the current preliminary design of the new lock complex, and to accept or restrict CEMT VIb units on the Meuse (and define and prioritize navigation improvement projects for the identified bottlenecks).

This study is performed for the Service Public de Wallonie (funded by SOFICO) by IMDC nv, situated in Antwerp (Belgium) and DST, situated in Duisburg (Germany). Both companies show a very complementary know-how: IMDC is a key player in hydrodynamic modelling and capacity studies of locks and waterways and DST is expert in navigation simulations and develops and runs its own real-time inland navigation simulator named SANDRA (Simulator for Advanced Navigation Duisburg – Research and Application).

The paper will present the developed tools for the study (data collection, hydrodynamic models, navigation simulation, capacity models) and detail main findings and conclusions.

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- ABSTRACT 18 -

Integration of inland waterway transport in the intermodal supply chain: a joint research agenda

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Policy makers at European, as well as regional levels, express the need to stimulate inland waterway transport as part of the intermodal transport chain (EU, 2011). A growing market share for intermodal transport should mean a shift towards more environmentally friendly transport modes, less congestion and better accessibility and opening-up of the seaports. Decision support models for intermodal transport are reviewed by Caris, et al. (2013). In this paper we identify research opportunities and challenges which will enable the integration of inland waterway transport in the intermodal supply chain. An overview of past research is presented and research gaps are highlighted.

The first research challenge is modelling the waterway transportation system as a whole. Multiple research efforts have already been undertaken to model isolated parts of the transportation network, such as locks, inland terminals and port operations. These components of the transportation system interact with each other. A model covering all aspects of the inland navigation network may demonstrate benefits of synchronization and enable an analysis of the entire network. Synchronization may, for example, be realized between consecutive locks or between locks and nearby terminals. Also, hinterland and port operations could be better aligned.

A second challenge is the integration of various planning systems for the operational planning in inland waterway transport. For example, lock planning systems and quay handling systems could be adjusted to achieve an efficient handling of inland vessels in the port area. Also, lock openings and priority rules of multiple locks may be tuned to another so as to create a smooth flow through the network.

A third research topic is the analysis of bundling networks for intermodal barge transport. Consolidation of freight flows may improve the efficiency of intermodal operations. Inland terminals may cooperate with the objective to create denser freight flows and achieve economies of scale. In this way, the attractiveness of intermodal barge transport could be improved (Caris et al., 2011, 2012). Questions arise concerning which type of bundling network is manageable in reality and how will benefits be allocated among the participants in the cooperation.

A fourth research topic is the collection of disaggregate time series data. The need for this type of high precision data is underlined by the fact that in the field of freight demand modelling, a shift towards an increasing behavioural realism is exhibited by the modelling of the individual commercial interactions (see e.g. Roorda 2011). This shift has increased the data needs for the development of this type of models. Moreover, in the light of the development of policy measures aimed at stimulating multi-model transport, more reliable information is needed to elevate the efficacy of these policy measures.

Design of the fourth Lock of Lanaye

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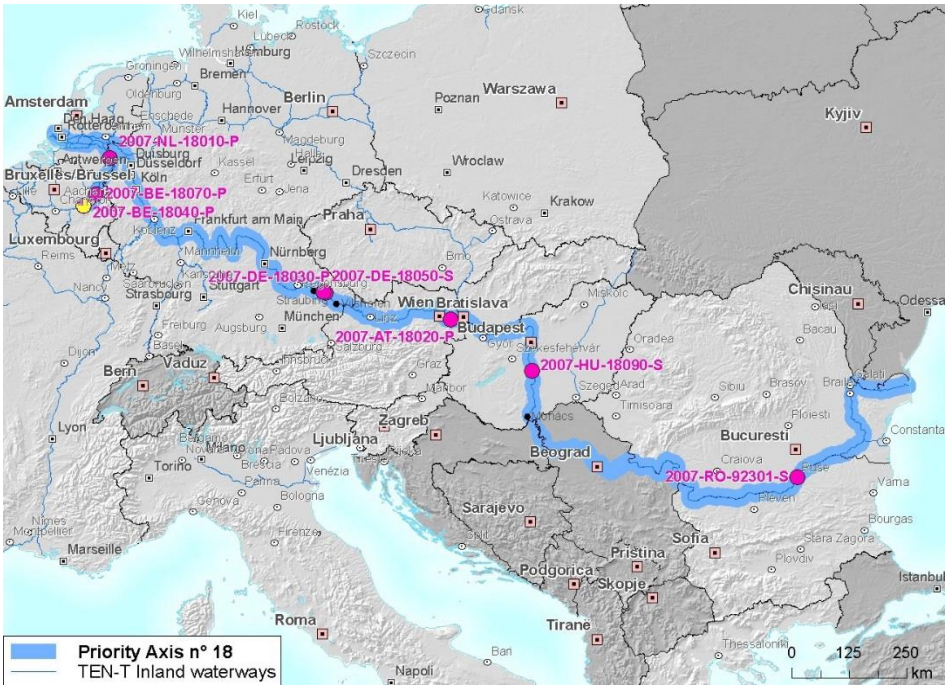
In order to promote and increase the navigation through the Meuse and the Albert Canal (4500T convoys between Namur and Maastricht), the Public Service of Wallonia decided to build a class VIb lock on the Albert Canal at Lanaye. This waterway is included in the TEN-T project n°18: Rhine/Meuse – Main – Danube.



The GREISCH office is in charge of the studies of the lock and the related buildings, equipment and surroundings, together with SNC Lavalin with regard to the electromechanical equipment.

The fourth lock of Lanaye is implanted upon the Belgian-Dutch border in a protected natural site, next to 3 locks to keep in service. The head of the lock reaches 13.6 m. It is built upon a gravel and chalky soil in an enclosure located on the right bank of the Canal. It is complemented by a hydroelectric plant / pumping station.

The new lock (effective plan dimensions 225 x 25m) is equipped with longitudinal culverts (filling and emptying system driven by circular valves), a valve gate upstream and a miter gate downstream, both operated by oleo hydraulic jacks.

Two major difficulties had to be faced during the studies:

The head of the lock (about14 m) generates significant hydraulic gradients All of the major works must be designed taking into account hydrogeological and geotechnical aspects: risks of underground flows, hydraulic pressure, watertightness,…

The environmentally sensitive context (Natura 2000 sectors, protected species, ...) leads to adopt a large number of accompanying measures, among which is the limitation of the available area (during construction as well as in the final stage).
The presentation will describe the design principles adopted and related to these constraints.

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- ABSTRACT 21 -

Location analysis for the modal shift of palletized goods to the West European inland waterways

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An important portion of transported goods are packed on pallets. The distribution of these palletized goods creates many truck movements. The negative impacts caused by this road transport affect the society, the economy and the environment.

An innovative solution to overcome these negative impacts is to bundle the transport of palletized goods over the inland waterways, and organize the last mile of distribution via a limited number of trans-shipment hubs. The truck transport distances are thereby reduced to an absolute minimum.

For the research around this solution, a location analysis model was developed for Belgium. The model calculates, on the basis of an origin-destination matrix, the most optimal number and the most optimal locations of the trans-shipment hubs.

By adding a cost structure to the model, it calculates the financial cost of the single modal transport and the intermodal transport for every origin-destination-combination. By doing so the overall potential modal shift and the potential turnover (in ton) of every hub are computed. Additionally, several scenarios, including road pricing and depot costs, are included in the model, as well as a calculation of the potential reduction in CO_2 emissions.

Initially, the analysis was limited to Belgium. However, transport, and the infrastructure which it uses, is not limited to national borders. This is especially the case in the European Union which functions as a free trade area. Therefore the model is enlarged to Western Europe (Belgium, Netherlands, Luxembourg, Germany and France).

An analysis is to be performed on the basis of internal transport data which is attributed to the NUTS 3 areas of the stated countries. The result of this analysis will be an international, most optimal, intermodal network and the calculation of the economic and ecological – in terms of CO_2 emissions – potential of the concept.

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- ABSTRACT 23 -

Smart River flows through Smart Cities : Run-off river hydroelectricity

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Urban performance currently depends not only on the city's endowment of hard infrastructure (physical capital), but also, and increasingly so, on the availability and quality of knowledge, communication and social infrastructure (intellectual and social capital). The significance of these two assets – social and environmental capital – itself contributes to distinguish smart cities from their more technology-laden counterparts. Sustainability is seen here as a major strategic component of smart cities.

The label Smart City is still a quite fuzzy concept, and for sure, the “smart city” has also been used as a marketing concept by companies and by cities! And of course EDF-Luminus had it as a duty to enter the course of this new development of the city. First of all in terms of mobility, with projects related to electric-powered transportation inside the city: firstly, fleet of electrical vehicles for the company, secondly, making electrical vehicles available to people, and thirdly, at a larger scale, the set up of battery charging terminals for electrical vehicles in the park-and-ride facilities at the edge of cities.

Another theme is the smart use of energy. After all, is it not being said that the most environmentally-friendly KWh is the one that we don’t use? But this leads us away from the Smart River.It is in the field of hydroelectricity, and more precisely in the frame of the run-off river power plants, that the past meets up with the future. Since 1949, during the building of the dams of Monsin and Ivoz-Ramet, on the river Meuse, at the borders of the City of Liège, the ancestor of our present company was involved in the development of the energetic potential of the river. Historically, when the notion of an interconnected grid was still in its very early stages, the small units were supplying the local grid. What could be more sustainable than the exploiting of an energy that crossed the city through the river? Of course, the hydro-electrical potential of our rivers is far from covering all of our needs. However, the decentralized generation of electricity, inside a district or city, meets the concept of a smart city. And it is natural enough to wish to design hydroelectric power plants so that they better fit into the landscape. Reducing the size is one of the possibilities. EDF-Luminus has contributed to the development of technologies and prototype machinery in the dams on the river Meuse, with subsequent reductions of civil works, dragging down capital investments as a consequence. Even more recently, power plants with almost no above ground infrastructure have emerged, as well as turbine, which can be integrated to, or completely replace, barrage gates. Finally, the concept of floating power stations, without any civil engineering, has been successfully set up.

The concept of sustainability is also met by the recent developments in terms of “Fish Friendly” turbine technologies, which particularly respect the aquatic life.

Finally, let us emphasize the role the hydroelectric operator has in the cleaning of the river. Each power station is equipped with thrash racks that are designed to protect the turbines. These racks have to be regularly cleaned up, and hundreds of tons of waste material are taken out of the rivers each year! All of these facts clearly demonstrate that the small-scale run-of-the-river hydroelectricity is a binding factor between the smart river and the smart city this one crosses.

Inland vessels at sea: a useful contradiction to solve missing links in waterway systems

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In general, inland vessels are not allowed to navigate at sea. For sea ports with a suitable connection to an inland waterway system, this restriction raises no problems, as the inland waterway network is directly accessible from the maritime terminals. In some harbours, however, the connection between the berths for sea-going vessels and the inland waterway system is either not adequate for large traffic flows, or even non-existent. When the connection with inland waterways involve a (limited) trajectory over sea, feeder activities can principally only be performed by ships with a maritime status, such as coasters. For a limited number of maritime ports, however, the local regulations conditionally allow a specific type of inland vessel to perform short sea voyages in favourable weather conditions to reach the inland waterway network. This type of traffic, referred to as 'estuarine' or 'fluvio-maritime' traffic, is well established in Zeebrugge, which is located at a distance of about 16 nautical miles from the mouth of the Western Scheldt estuary. Another example is the Port 2000 container terminal in Le Havre, which has no direct access to the inland waterway system, but is located a short distance from either the sea lock (north access) or the river Seine (south access). Similar practice is also applicable in Italian (Ravenna, Venice) and Chinese (Ningbo) ports. An overview of fluvio-maritime practice and the regulations was recently issued by PIANC (INCOM/MARCOM Expert Group on Direct Access to Maritime Ports by Adapted Inland Waterway Vessels).

To be allowed to perform a sea voyage in coastal areas, an inland vessel has to meet several sets of requirements, issued by both the classification society and the local authorities. These requirements need to be fulfilled to guarantee that an 'estuary' vessel is able to resist the additional loads (bending moments, shear forces, torsion moments, accelerations, ...) acting on the ship due to the more severe wave climate at sea, and to ensure that the wave induced motions will not result in undesired events such as flooding of the holds, excessive overtaking of water on the decks, slamming, ... The different sets of requirements lead to restrictions concerning the loading conditions of the vessels, expressed in (both upper and lower) limits for the draft of the ship, but also accounting for the height of the centre of gravity which influences the stability and, hence, the roll motion.

Obviously, there is no uniformity among the regulations issued by the different local authorities. As an example, the Belgian legislation requires the calculation of the response of the vessel in realistic, directional seaways, resulting in a probability of exceedingly critical levels. The French regulations, on the other hand, consider a number of severe generic wave conditions. These rather fundamental differences make it very difficult to compare the levels of safety achieved by the different regulations.

The paper intends to give an overview of and a comparison between the different regulations issued by the local authorities, with emphasis on the situation in Zeebrugge and Le Havre. The technical requirements mentioned in the Belgian and French legislations will be analysed and applied to a type of container vessel that is operational in both areas. Where possible, this analysis will be extended to other areas with fluvio-maritime transport activity. Recommendations for further research on the subject of estuarine transport will be given.

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- ABSTRACT 26 -

Technical solutions for improving the navigation conditions on the common Bulgarian-Romanian sector of the Danube

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The Lower Danube River presents problems for navigation during low water periods when the minimum required water depths of 2.5m, as recommended for the Danube Commission for at least 94% of the year, is not accomplished. Being part of the Pan European Corridor n°VII, this important navigation waterway has received the attention of the Ministry of Transports of Romania to conduct studies looking for engineering measures to improve the navigation conditions. The area of study comprises the common Bulgarian-Romanian sector from Iron Gates (rkm863) to Silistra (rkm375) and the project has had the support of the European Commission and the Bulgarian government interested in the sustainable development of this important waterway.

In order to achieve this objective, a feasibility study has been prepared looking for technical solutions to the limitation on navigation at present, but taking into account the strict environmental restrictions in such an important habitat and other stakeholder users of the water, such us electric generation plants, water for human consumption and irrigation.

The feasibility study first makes an assessment of the present situation and identifies the navigation constraints. Then, the technical solutions for improving the navigation at those critical sectors are investigated. In order to make an efficient and systematic evaluation of the technical solutions, a 2D hydrodynamic and sediment transport numerical model has been set up. The model consist of the whole river stretch of the project in one finite element grid with higher grid resolution at the critical sectors. Having only one grid for the whole model also has the advantage that the effect of a solution in one critical sector can be assessed at the other critical sectors. The model also helped to evaluate different alternative development strategies at each of the critical sectors allowing their optimization, aiming at reducing the footprint and costs of the project. Effects on water levels, water depths, flow velocities, flow distribution between river branches, maintenance dredging, water availability for other stakeholders, risk of flooding, and evolution of the river bed were assessed.

The proposed technical solutions comprise: realignment of the fairway, constriction of the river flow (i.e. chevrons, bottom sills, groins) and dredging works. During the selection of the possible solutions at a sector to evaluate different alternatives, environmental issues played an important role in the decision. For instance, the total closure of secondary branches was not allowed and the restriction of protected areas, such as Natura 2000, was avoided.

The basic design of the functional operation of the structures and its effect in the hydrodynamic and sediment transport conditions was also assessed with assistance of the model, to assure safe navigation with low current velocities and minimization of the bottom evolution to reduce the maintenance dredging. The model also allowed assessment of the performance of the structures, not only for the dry periods, when navigation is hampered, but also during average

conditions and even extreme river discharges and future estimate of climate change, to verify that that technical solutions will not increase the risk of flood.

The approach followed, when evaluating possible project development alternatives, consisted in combining the technical solutions of: an Autonomous Alternative (AA), used as reference for the present conditions, a Basic Alternative (BA), with only dredging works, and several Enhanced Engineering Alternatives (EEA), with training works. All these solutions were combined in the final Optimized Alternative (OA).

The project is at the moment in the phase of finishing the Environmental Impact Assessment Study to proceed to Public Consultation; and finally proceed to detailed design and construction.

SMART RIVERS Conference 2013

- ABSTRACT 27 -

Detailed design for inland waterways: the opportunities of real-time simulation

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Since the installation of the first full-mission manoeuvring simulator in 1986 and the Towing Tank for Manoeuvres in Shallow Water in 1992 (cooperation Flanders Hydraulics Research and Ghent University), at FHR the focus has been on manoeuvring of maritime ships in shallow and confined water. As manoeuvring in confined water is the operational condition on most inland waterways and ports, a catch-up effort has been made by FHR over the last five years combining fundamental experimental research in the towing tank and applied simulation research at the inland simulator Lara. The paper illustrates the opportunities of real-time simulation by comparing the concept design guidelines for inland waterways with the results of detailed simulation design for two cases:

- Meetings and overtaking manoeuvres of two inland vessels: For the upgrade of a canal which forms part of the Seine-Scheldt connection between France and Belgium, guidelines were set up by the responsible government agency for a two-way traffic lane on the canal for a CEMT class Vb push barge convoy (185 m long, 11.4 m wide) and a CEMT class IV motor ship (85 m long, 9.5 m wide). Due to several reasons (among others available area and economic reasons), the commonly accepted design guidelines could not be met everywhere. Therefore, the proposed design with widened bends and adjusted channel sections was evaluated with real-time manoeuvring simulations on two coupled simulators (inland simulator Lara and simulator SIM225 from FHR). Meetings between the class Vb and class IV vessels were simulated under different wind conditions. Based on the track plots of the individual vessels, an optimized design of the canal could be proposed.

- Design of infrastructure (bridge openings, lock complex) on inland waterways: Due to environmental and economic constraints, waterways cannot always be designed according to concept design dimensions. Several projects have shown that concept design can be too restrictive and that there is scope for improvement in detailed design through real-time simulation involving all parties in the design process.

As the realism of the ship behaviour will make or break the simulation results, the determination of the manoeuvring behaviour is of utmost importance and based on model tests. The knowledge of ship behaviour of inland vessels helps in defining the limits of the designed inland navigation channel and is distributed by the Knowledge Centre Manoeuvring in Shallow and Confined Water (www.shallowwater.be) through the participation in the PIANC Working Group 141 Design Guidelines for Inland Waterways.

SMART RIVERS Conference 2013

- ABSTRACT 28 -

Empty Container Management in the Benelux Waterways

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Compared with traditional cargo ships, maritime container transport allows shorter loading and unloading times and better opportunities for pre- and post-haulage. These save costs and reduce bottlenecks in seaports. This is why the degree of containerization has risen significantly in the main world sea ports. Due to congestion issues and to the scarcity and cost of available land near seaports, regional import-export businesses and liner services have been moving from seaports to their hinterlands. In these liner services, container barges follow a fixed schedule with a given order of dry ports to visit and the calling times; at the last dry port, this order is reversed to end up in the port where the tour began.

Demand and supply of empty containers at a port mainly depends on the cost of building or leasing containers and on the cost of repositioning empty containers from a surplus to a demand region. Repositioning of empty containers implies container movements between regional importers, seaports and dry port terminals, depots and export customers. Although our research focuses on the landside repositioning of empty containers, the hinterland region strongly depends on the global movement of containers.

The scientific contribution of this paper is the development of a model for empty container management in the hinterlands of the ports of Antwerp and Rotterdam. The objective of the proposed model is to minimize the total operational cost while satisfying the demand for empty containers. This goal is achieved by choosing the most efficient transportation mode between a seaport and its hinterland: road, inland waterways or intermodal transport. The objective can also be reached by making a decision on street-turn opportunities, i.e. when empty containers are moved directly from consignees to shippers. Moreover, to fit the real-life operation management as well as possible, our model also includes container substitution and container leasing options.

At the operational level, the time factor and the stochasticity inherent in the system are the key players. In such cases, where uncertainties in future predictions exist, system variables cannot be deterministically known for the future periods and can only be predicted probabilistically. To take uncertainty in empty containers demand and supply into account, a two-stage model is proposed. In stage one, all the parameters are deterministic; whereas in stage two, parameters such as supplies, demands, and ship capacities for empty containers are random variables.

- ABSTRACT 29 -

The Seine-Scheldt project in Flanders – The lock of Harelbeke

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The Seine-Scheldt project aims to connect the Seine basin in the Paris region with the Scheldt basin in the region of Antwerp-Rotterdam, for vessels up to ECMT-class Vb (4500 tons). In order to achieve this by 2016, the Belgian region of Flanders is preparing navigability enhancements of the river Lys, which currently allows vessels up to 2000 tons.

One of the main challenges for this calibration lies in the construction of a new lock in Harelbeke, to replace the insufficient existing one. Therefore, the reconstruction of the lock and its interconnected weir, and simultaneously the reassessment of the urban site with its waterfront and its two bridges, becomes an important goal for the Seine-Scheldt project.

Due to the urban environment, the project site has many conflicting goals that highly increase the complexity of the overall project. In order to achieve an integrated project that offers a best fit solution, Waterwegen en Zeekanaal NV decided to launch a “Design & Build” procedure (D&B) for the project in Harelbeke.

The call for candidates was published in December 2010. The 7 selected candidates received the contract specifications in May, 2011 and were invited to lay down their tenders by October 2011. Based on the criteria stipulated in the contract ranging from spatial quality over technical, hydraulic and nautical merit to aspects of nuisance during execution, durability of the design, planning and overall management, the candidates that submitted the best 3 tenders were invited to further detail their conceptual design. In a 2-step, procedure this lead to their best and final offer (including the overall cost for the design and the construction of the project) submitted in October 2012.

The contract demands the continuity of navigation during the execution of the works, apart from a maximum of two distinct periods of maximum 6 weeks when navigation can be shut down. Together with the restriction of the total execution time of the works to a maximum of 30 months, this proved to be quite challenging.

Since the existing weir also needs to be replaced, the aspect of water management and flood control became a very important factor in the evaluation of the different tenders. In fact, in the end, this was the decisive criterion for selecting the winning design.

To solve the problem of fish migration along the river Lys, the contract also asked for the design of a fish ladder to bypass the weir. All candidates offered designs, but only a few of these designs proved to be sufficiently attractive and passable for the specific species of fish that migrate on the river Lys.

For the design of the overall project in Harelbeke, the emphasis was laid on minimising the total Life Cycle Cost of the infrastructure. In order to do so, a hydraulic actuator was installed in all three tenders to achieve an energy neutral project. This actuator serves a double purpose: in periods of high flow the actuator generates electric energy and in dry periods the actuator can pump up the water losses of the lock so that navigation can still be guaranteed. Other important factors in Life Cycle Costing are the cost of downtime of the system and the cost of maintenance. Since the D&B contract lacks the maintenance factor as an implicit quality control, the importance of durability in design could not have been set high enough.

This paper will discuss the designs submitted during the D&B-procedure for the new lock of Harelbeke. The way the contractual goals are met in each of the tenders will be evaluated based on the criteria set in the D&B contract. To conclude, an evaluation of the D&B procedure in obtaining an integrated design for the overall project in Harelbeke will be made, together with a reflection on the lessons learned for future use of this type of procedure in similar projects.

SMART RIVERS Conference 2013

- ABSTRACT 30 -

Challenges and opportunities to creating a maritime natural gas corridor on the Upper Ohio River and in converting towing vessels to burn natural gas.

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The recent discovery of abundant supplies of natural gas close to the Upper Ohio River holds the potential for greatly reducing the transportation cost and environmental footprint of waterway transportation in the Port of Pittsburgh, and in all of the US waterways, but it also faces significant technical, logistical, environmental, regulatory and political obstacles that need to be overcome before any such investment would take place. Furthermore, the issues impact two discrete industries that make decisions independently but must depend on each other for a common outcome.

The first obstacle is the infrastructure investment required by the natural gas companies. This includes site location issues, physical infrastructure concerns, environmental permitting issues, logistical support networks, nexus and locational opportunities for servicing other modes of transportation and a top level cost analysis of all of these factors. The overall concern of the natural gas supplier companies, however, is whether there will be sufficient market demand for the product to justify such investments or “will the towing companies make the investments to use the natural gas fuel?”

The towing company concerns are even more complicated, including the projected build out of newly designed vessels. But unless a significant amount of new build vessels can come on stream quickly, it is unlikely that the suppliers will rush to build their infrastructure. Therefore, significant attention must be paid to the issue converting existing vessels as well in this chicken and egg dilemma. The methodology needed includes inventorying vessel characteristics, vessel activities and operational patterns; the available technologies to retrofit existing vessels to support natural gas as a fuel, the environmental issues in and emotionally charged environment and regulatory process and issues to be addressed with the advent of a new technology. The towing companies will also require the same type of top level cost analysis of these factors. The overall concern of the towing companies will be the supply and availability of the natural gas as a fuel.

The management of financial risk and public relation issues in this environment is critical, including what role of government can play in encouraging or discouraging this type of development. The government interest is measured by job creation, pollution and emission reduction, regulatory competition and external benefits on the one hand with potential pollution in the production process on the other. Final investment strategies may include public and private partnerships or partnerships across industry lines, possible with fuel suppliers investing in towing companies or vice-versa. The study by the Port of Pittsburgh Commission and Pittsburgh Port Technology, Inc, and its partners will accumulate the data and bring the government and the two industries together to build confidence in a mutual decision-making process. The merging of the two investment strategies, or the investment strategies of third parties, including governmental investments, may all be part of the finals solution.

SMART RIVERS Conference 2013

- ABSTRACT 31 -

Optimizing design of river training works using 3-dimensional flow simulations

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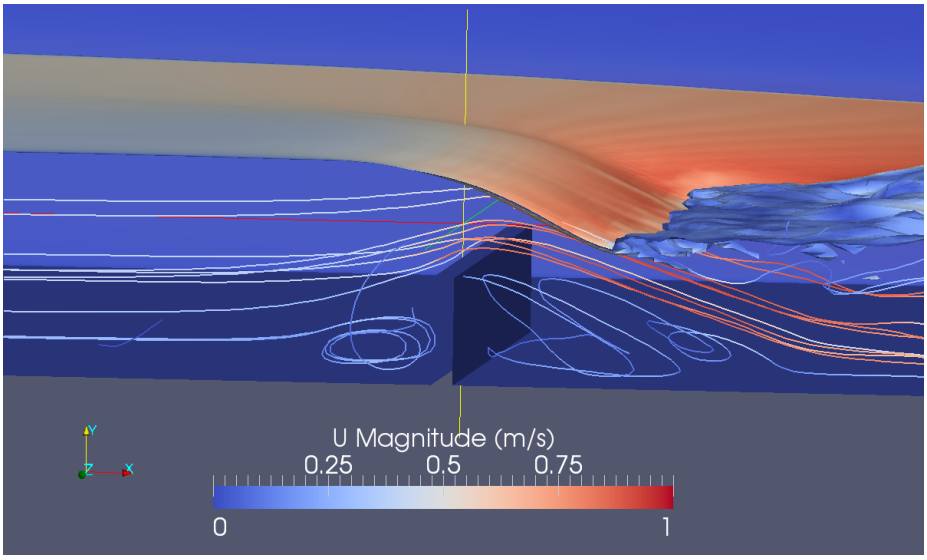
In past centuries, many rivers worldwide have been engineered to facilitate river navigation needs. The constructed river training works have regularly proven to be effective in maintaining depth and position of the navigational channel, but after years of operation some of the existing structures have become outdated and require design updates. In some cases the designs require updates because of changed conditions in the river, in other cases because of changed management objectives or because of new insights into flow-structure interactions. In the current study, we give examples of river engineering works that require design updates and demonstrate how 3-dimensional flow simulations may aid in achieving improved designs that serve navigation needs and additional river management goals.



SMART RIVERS Conference 2013

- ABSTRACT 32 -

Triangular-Shaped Front Barges in Convoys

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For Inland Navigation, convoys could be optimized through the treatment of the bow of these convoys, with benefits of less fuel consumption and greater range, and/ or more speed.

Convoys, which are composed of barges and pushers, or tugs, typically have relatively high drag as compared to other vessels. A considerable part of this drag comes from the bow of convoy, because of its box shape. This box shape is usually somehow alleviated in its lateral view, for usually there is a curve which directs the water flow under the barge.

However, when a barge is observed from the top view, clearly there is a line which is at 90° to the water flow, at the waterline region, in most of the barges. This is because barges are typically rectangular. This substantially contributes to the decrease in the velocity of the water in this area, thus by Bernoulli equation considerations, increasing water pressure in the region ahead of the frontal part of the convoy thereby establishing a net backward force in the convoy, i.e., form drag.

This form drag could not exist if the line at the frontal part of the convoy were at a more inclined angle relative to the water flow, allowing a smoother and not stagnating waterflow. In this way, there would be much less conversion of speed energy into pressure energy.

This drag at the bow of the vesselcaused by energy conversionof flowing water becoming stagnant water (speed decrease), by means of energy conservation, into backwards pressure energy (pressure increase at the bow region) is herein called stagnation drag.

This being so, the barge in front of a convoy should be of triangular shape, in order to obtain performance benefits. This would require planning for allowing these triangular barges to be always the front part of the convoy.

In this way, we would have a good strategy for decreasing drag by removing a rectangular shaped barge in the front of a convoy and replacing it with a triangular one. Typically, self-propelled ships used in inland navigation have adequate fuel consumption as compared to convoys, mainly because of theshaped format of their bows, when compared to traditional convoys.

Also triangular barges would also help decrease the drag in front of convoys with two, three or more rows of barges. All that would be desirable is that the triangular barge be put in front in a way that its centerline coincides with the convoy centerline. Again, triangle base and height relationships could be optimized to better serve convoys.

Summing up, this abstract presents proposals for the use of triangular, cargo carrying barges always in front of the convoys. Feasibility studies including stability and shape optimization could be made through the use of Computational Fluid Dynamics (CFD) and water tank tests.

Port-Hinterland Logistics Networks and Integration: The case of Brazil

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According to the World Economic Forum, Brazil is ranked 123rd in world and 13th in Latin America regarding business competitiveness, evidencing a very low position. On the other hand, recent years have witnessed a prominent economic growth in Brazil, with a booming internal market and the country playing a major role in world economy trade.

Among other factors, the inadequacy of infrastructure in part explains such paradox. Although somewhat delayed, government has addressed this issue through deep assessments which led to a substantial increase in both public and private investments. Port development is one of the key aspects and many improvements have already been accomplished. However, such development might not be complete if not accompanied by inland integration.

Despite the fact that Brazil faces a lack of infrastructure, it shall bring many opportunities to improve Brazilian Logistic Infrastructure in the coming years, bringing efficiency to the system, improving the level of service and competitiveness, and reducing logistic costs to users.

The ´Hub and Spoke´ concept, linking Deep Sea Terminals to Logistic Platforms at hinterlands is already in place in several locations (Europe, USA), where the links between Deep Sea Terminal and Inland Platforms are done, preferentially, by barge (or rail) because of longer distances and larger volumes. The final leg, linking Logistic Platform to final Customer, is done, mainly, by truck because of flexibility, shorter distances and less volume to be moved.

This present work describes main initiatives to unlock Brazilian port bottlenecks through creation of logistics platforms and the development of waterways which will lead to creation of a more balanced modal split. It also presents the reforms on the physical capacity, institutional framework and management required to the Brazilian port sector. The presentation will also verify the best practices implemented worldwide (international benchmark), making a parallel to Brazilian initiatives.

PIANC SMART Rivers Conference 2013

- ABSTRACT 34 -

Possibilities for reducing fuel consumption and greenhouse gas emissions from inland navigation

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In absolute terms, the greenhouse gas emissions due to inland navigation are very insignificant in comparison to the total amount of greenhouse gas emissions caused by transportation and even more insignificant in comparison to all anthropogenic greenhouse gas emissions. This is a result of the high energy efficiency of inland navigation and of its generally minor role in transport. However, the other modes that compete with inland navigation are making advances in reducing their greenhouse gas emissions. If inland navigation wants to retain its competitive advantage as being “environmentally friendly”, it also needs to further reduce its greenhouse gas emissions.

There are many **ways to reduce the fuel consumption and CO_2 emissions**of inland navigation vessels. By implementing several technical measures simultaneously, one could realistically envisage a reduction of between 10 and 50 % compared with vessels currently in operation. Increasing the size and capacity of vessels in particular offers substantial potential for savings. When it comes to operational measures for reducing fuel consumption and CO_2emissions there are fundamental similarities to the technical measures. There is a wide variety of possible options available which ship owners can choose from, depending on which are most economically viable for their ships and applications. By implementing several measures simultaneously, one could realistically envisage a reduction of between 10 and 40 %. However, any quantification of possible potential savings depends on many factors, which can vary significantly from one type of ship to another and, in particular, on their operating conditions. Given the developments in the fuel market, switching to **alternative fuels** and types of propulsion is a long-term possibility not only for saving CO_2, but also for ensuring future fuel supply. A mix of fuels may become established in inland navigation, consisting of liquefied natural gas (LNG) as well as liquid and gaseous biofuels.

Supporting measures for reducingfuel consumption and greenhouse gas emissionsmay includemaking relevant information easily available for the navigation industry, the introduction of indicators and management plans for improving energy efficiency, as well as environmental labels and financial incentives. Measures taken to reduce greenhouse gas emissions can be accompanied by **additional benefits**: In particular, if the reduction in greenhouse gases results from a reduction in fuel consumption, then pollutant emissions are almost always reduced as well.

Scenarios for greenhouse gas emissions from inland navigation show that extensive implementation of various existing technical and operational energy-saving measures as well as a continued increase in the average size of vessels will allow greenhouse gas emissions from inland navigation to be kept more or less constant, even with a steady increase in the total cargo volume.A significant reduction in the absolute amount of greenhouse gas emissions from inland navigation accompanied by a simultaneous increase in the total cargo volume may be possible, if low carbon fuels are used on a large scale, alongside LNG.

SMART RIVERS Conference 2013

- ABSTRACT 35 -

Water Depth on Sill and Vessels' draft Control of Three-gorges Lock

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Navigation conditions have been improved greatly since the construction of the Three-gorges Dam. The cargo volume through the Three-gorges lock has increased continuously from 18 million tons in 2004 to 100.3 million tons in 2011. The average dead weight tonnage of vessels through the lock has increased from 880 tons in 2004 to 2680 tons in 2011 at the same time.

In the design stage, the design vessel for the lock was push train composed of 4 barges of 3000 dwt. The dimensions of the train were 219×32.4×3.3 m (length×width×draft). Since the lock was put into operation, more than 95% of the vessels passing through the lock have been motor barges. There are no large push trains. In 2011 about 34% of the vessel deadweight through the lock were larger than 3000dwt with draft of more than 3.7m.

The water depth on the sill of the Three-gorges lock is influenced by the water levels of the upper stream and downstream of the dam and the operation mode of the filling and emptying system of the lock. In principle the minimum water depth on the sill varies between 5.125m and 6m.

To guarantee the safe passage of vessels through the lock and protect the top plate on the chamber floor from collision by vessels, the draft of vessels must be limited. In order to establish the controlling standard for vessels' draft, a field investigation was carried out at Three-gorges lock. The speed of vessels entering and leaving the lock was measured. The results showed that when the water depth on the sill was much deeper than the design depth, the vessels would enter and leave the lock very fast. The entering or leaving speed of smaller vessels was longer than that of bigger vessels. The speed of vessels with dead weight tonnage over 4000t and draft over 3.8m was about 1-2m/s.

24 typical vessels were chosen and the vertical movements during entering and leaving the lock were recorded. Combined with the results of previous model tests, the vertical movement (δ) of vessels entering or leaving the lock depends mainly on the cross section area (F) of the chamber beneath the water surface, the cross section area (f) of the vessel under water and the speed (v) of vessel entering or leaving the lock. Then an empirical formula was put forward to estimate the vertical movement for different water depths on the sill when vessels were entering and leaving the locks.

$$\frac{\delta}{H} = -15.026K^2 + 3.923K + 0.0267 \qquad K = \frac{v^2}{2gH} \times \left[\left(\frac{F}{F-f} \right)^2 - 1 \right]$$ (H: water depth on sill)

Based on the analysis, the following standard for controlling the vessels' draft was suggested for the operation of Three-gorges lock.

Tab. 1 Standard for controlling vessels' draft of Three-gorges lock

Water depth on sill	5 m	5.125 m	5.5 m	6.0m
Max. draft	3.9 m	4.0 m	4.3 m	4.5m
note				Dead weight tonnage should not be larger than 5000 t

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SMART RIVERS Conference 2013

- ABSTRACT 37 -

Ship-induced loading and stability of estuarine waterways structures

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Estuarine and riverine waterways structures such as groins or training walls are loaded by changing water levels, currents, ice, wind waves and ship waves. These structures are composed of rubble mounds without any interlocking elements and are often used along German estuaries and rivers for coast or bank protection. New research for German estuaries has shown that the influence of long ship waves is more important than expected and should not be neglected during the design of these structures. In addition, it was interesting to observe that especially long-period waves have caused the observed failures and damages. Therefore, a new research program was started to investigate the influence of long-period ship waves on estuarine and riverine structures.

The present paper will focus on the first results of this research program and will give an overview on the scientific background, the observed failures, the reason for research and on the first experimental investigations concerning the impact of long period ship waves on waterways structures.

Fig. 1: Ship-induced waves overtopping a groin (photo: Uliczka, 2012)

Experiments were performed in 2D in the large current flume of IWW in Aachen for different kinds of structure geometries and hydraulic conditions. In addition, wave flume tests will be performed in 2D in the wave flume of the Leichtweiß-Institute for Hydraulics in Braunschweig and in 3D in the ship basin of BAW in Hamburg. Test results will be available during the Smart Rivers conference.

The tests are focused on the understanding of the hydraulic processes due to the overflow of long-period waves and the stability of the cover layer. Therefore, a first set of tests was performed on the processes for impermeable and smooth structures. A second set of tests was performed on the hydraulic processes for impermeable and rough structures. A third set of tests was run for permeable and rough structures. The test results were compared from a hydraulic point of view and the stability of the different structures under wave attack was determined. Preliminary design formulas were derived to assess the stability of groins and training walls under ship wave attack.

SMART RIVERS Conference 2013

- ABSTRACT 38 -

Networks for nautical tourism at smart rivers

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The paper's author is a well known expert for nautical tourism and marina planning with 30 years of scientific and practical experience in the field. On this basis the paper gives practical advice on the development of nautical tourism networks for smart rivers.

Smart rivers are the basis for settlements all over the world being used for transportation, energy and fishing. Nowadays, smart rivers present other opportunities. Nautical tourism is a great possibility for business on the riverside. The process of establishing nautical tourism changes the appearance of the riverside. For touristic activities to increase it is necessary to integrate nautical tourism and leisure development of the river system.

The paper presents methods for developing nautical tourism networks, pointing out the structures and elements of nautical tourism at rivers and the development of infrastructure for boats and boaters. The key is to combine the existing touristic facilities landside with the nautical infrastructure riverside. In many cases nautical infrastructure has not yet been developed.

A very important aspect for the network development is the distance between the hubs in the network. Since nautical tourism is a form of urban tourism, nautical infrastructure must be located in communities along the river. The distance between two such communities must be manageable in a day journey. For a nautical network to work, the two aspects that must be congruent are the landside facilities and the network's hubs.

The paper shows how this kind of nautical network can be developed and planed. Nautical tourism benefits all parties concerned including the cities along the river where business will increase allowing the cities to flourish.

The first step to establishing a nautical network is to appoint a development coordinator who will integrate all the concerned parties and coordinate their various interests. Furthermore, the local administration and government must be willing to develop nautical tourism and finally the local touristic companies must be interested in this development.

The next step in the development of nautical tourism is to cover the financing. Thus, the coordinator must identify the necessary costs and find possibilities for financing including public funds.

Finally, the cooperation of the communities along the river is essential for the network to function, including joint marketing and a guide system. The paper shows how to develop nautical tourism on a local scale presenting methods and examples of development. Further information will be part of the oral presentation.

- ABSTRACT 40 -

The Ports of Bremen/ Bremerhaven Hinterland Traffic/Inland Shipping

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Ports and foreign trade established the economic base of the Free Hanseatic City of Bremen since the 9th century. The constitution of the State of Bremen therefore includes provisions prescribing the construction and maintenance of modern ports and the pursuit and ongoing development of shipping and trade, for the benefit of Bremen, Germany and Europe.

The Port of Bremen nowadays consists of two port complexes located on the River Weser, the city-port of Bremen and the port of Bremerhaven with both forming one centre of maritime excellence. As a location for port and logistics operations, it has successfully positioned itself among Europe's leading centres of commerce and freight transhipment. The key feature of the twin ports is their universal function and their distinctive division of labour. While Bremerhaven, located only 32 nautical miles from the open sea, is specialised in handling container vessels, car carriers and fruit reefer ships, the terminals in Bremen, located 60 kilometres further to the south, concentrate on general and heavy-lift cargo and on handling bulk commodities.

The support of ports and logistics are of paramount importance for the economic strength of the Free Hanseatic City of Bremen. During the past years the ports of Bremen and Bremerhavenrecorded a strong dynamic increase in cargo handling. Already in 2011 the volume of waterside transshipment surpassed the level of goods handled before the economic and financial crisis of 2008/09. The figures even exceeded all prior outlooks. In the year of 2012 85 million tons of trans-shipment were handled. This constitutes a growth of 5 percent in comparison with the year before. Therefore, the ports of Bremen defied the generally difficult development of economy within the European Union as shown by the declining figures of trans-shipment of ports in Europe and overseas.

The capacity and quality of their hinterland connections are of crucial importance for the competitiveness of the ports in Bremen and Bremerhaven. Therefore Bremen presented a masterplan aimed at enhancing the role of inland shipping in hinterland traffic. The masterplan describes the development potential of this eco-friendly transport mode.

In Bremen and Bremerhaven, inland waterway shipping is linked to the German waterways network in two directions – to the west via the Lower Weser, the River Hunte, the CoastalCanal and the Dortmund-EmsCanal to the Rhine, and to the south via the Middle Weser and the MidlandCanal to the destinations such as Minden, Hanover and Braunschweig. The Middle Weser can only be navigated at present by barges up to 85 metres in length and with a maximum loaded draught of 2.20 metres.

The transhipment of inland waterway transportation accounts for just under a tenth of seaborne cargo handled in the twin ports of Bremen. Of more than 300 public and private sector inland harbours in Germany, Bremen is ranked 8th, with 6.3 million tonnes (2011). Although inland

shipping is traditionally a transport mode for bulk commodities, it is also benefitting from container transhipments to an increasing degree.

SMART RIVERS Conference 2013

- ABSTRACT 41 -

Inflatable Structures in Hydraulic Engineering

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An inflatable dam is a relatively new gate type, which enables savings to be made on the capital spending and maintenance costs. It consists of a multi-ply rubber membrane filled with air or water and clamped to the weir body with one or two fixing bars. Inflatable dams have a number of advantages when compared with steel gates. Inflatable dams are mainly used at movable weirs enabling navigation and hydropower generation, but also at storm surge barriers. Related applications are bulkheads, cofferdams and temporary gates as well as combinations with flap gates, i.e. Obermeyer gates. In the USA, Japan and other countries, inflatable dams have been used for more than 50 years in conjunction with movable weirs. The first inflatable dam in the German water and shipping administration was installed after intensive investigations in 2006. Due to the positive experiences and the great economy, a rapid increase of planned inflatable dams can be observed. Also in the French water and shipping administration, a number of inflatable structures, a combination of flap gate and inflatable dam, have been installed in the last five years.

The intent of the new InCom Working Group 166 “Inflatable Structures in Hydraulic Engineering” is to share these experiences, techniques and methods worldwide and provide a comprehensive summary of best practices that can be incorporated into future design of inflatable structures. Furthermore, a compilation of designs should be created for inflatable structures in conjunction with movable weirs, storm surge barriers and bulkheads. The Working Group will also aim to gather expert analysis on relevant problems in some countries during the implementation of such inflatable structures. Finally, the group will analyze the possible contribution of the use of these structures with climate change.

On the basis of case studies or existing compendiums, in particular in Japan, a design approach shall be developed considering other standardization efforts, such as “Voies Navigables de France/Centre d’études techniques maritimes et fluviales”, Federal Waterways Engineering and Research Institute/Waterways and Shipping Administration.

Some of the issues to be investigated include:

a. Design of the membrane and the anchoring system: Providing methods to estimate the membrane forces, defining loads, stress concentration and safety factors
b. Material requirements for the rubber and the fabric inlay
c. Defining application limits, recommendations for filling media
d. Hydraulic design of the weir sill and the inflatable dam, energy dissipation and countermeasures against vibrations
e. Use categories recommended for these inflatables structures and precautions for their implementation

The contribution describes the objectives of the Working Group, covers some results of recent investigations and gives an outline of the first experiences with design, construction and operation, in particular in Germany.

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- ABSTRACT 42 -

Towards the CFD-modelling of multiscale-multiphase flow phenomena in a navigation lock

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When designing navigation locks with big lifting heights, a compromise between a short operational time, small hawser forces and reasonable construction costs has to be found. With the recently proposed filling-emptying system by Thorenz (2012), a promising solution was presented, which significantly reduces the construction effort through avoiding side channels at the upstream and downstream heads. The suggested system fills the lock through a pressure chamber beneath the lock chamber. About 60 % of the filling water is introduced through saving basins. For the remaining 40 % a direct connection shaft from the upstream water into the pressure chamber is used. In case of a complete filling through the upstream water, without using the saving basins, air entrainment due to the large falling height of the water into the connection shaft is expected. Entrained air could cause severe disturbances in the lock chamber during the filling process and thereby increase the impact of the forces on the vessels in the lock. Since the forces on the vessels are the basis for the safety risk during the locking process, it is essential to investigate all influencing phenomena.

In this study a Computational Fluid Dynamic (CFD) approach is being developed to model the flow regimes in the navigation lock. Specific focus is put on the modelling of multiphase flow phenomena of various scale ranges. In particular, an attempt is made to reproduce the air entrainment process at the plunging jet and the further movement of the bubbles through the filling shaft into the pressure chamber. Aiming at an approach that can transport the information about the bubble formation at the plunging of the jet, the bubble transport, the bubble breakup and coalescence throughout the domain, existing approaches are combined, modified and applied.

For the three-dimensional computational modelling the open source CFD library OpenFOAM was chosen since the availability of the complete source codes as well as the well-constructed structure of the C++ library forms a good basis for the modification. As a starting point various multiphase approaches are available. When the water flow through hydraulic structures is to be simulated the Volume of Fluid approach is mostly used. This approach solves one set of equations and reconstructs the interface between the two phases through a scalar indicator function. Structures like bubbles or drops can only be resolved, when the grid size is much smaller than the structure diameter. For the investigation of problems where the exact modeling of bubbles is crucial, the so called Euler-Euler approach is usually applied. In this approach one set of equations is solved for every phase, which allows different phase velocities or even the introduction of additional equations for taking phenomena like bubble coalescence, drag, lift etc. for one phase into account. In the current version, OpenFOAM provides one solver (called “twoPhaseEulerFoam”) which works perfectly for the simulation of bubble columns – a widely investigated application in the field of chemical and nuclear engineering. For its applicability to those models where not only the bubble modelling but also the interface modelling plays a role, these approaches still show big deficits. It is the aim of this study to find a way of combining the advantages of both approaches to provide a solution for the modeling of the navigation lock filling process. Received results will then be validated against a physical scale model of the lock.

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- ABSTRACT 43 -

TECHNICAL INSTALLATION FOR CONTROLLING LOCKS AND BRIDGES ON THE RIVER MEUSE

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The Dutch public waterway authority Rijkswaterstaat has commissioned the design and construction of a new control centre called “regiocentrale Maasbracht”. This control centre will organise the communication, control and management of fluvial navigation traffic and water management between all hydraulic civil structures on the river Meuse between Maastricht and Venlo. The centre should provide guidance to navigation, control and operate centrally all locks and bridges. It will also serve as nautical centre by:

- Connecting all local systems to the IP network of Rijkswaterstaat
- Organising a central location (“building regiocentrale Maasbracht”) which on a IP basis can communicate with these local objects
- Training of personnel

The most challenging part of the design consists of the integration of several subsystems: audio, CCTV, radar, operation and control, IP network, building automation and access system, into one uniform, easy accessible and manageable control unit with high reliability. The human factor was identified as being one of the keys of success in a highly demanding environment asking for 24h/7d safe operation in which safety for users and stakeholders as well as shipping delays are the key performance indicators.

The goals of safe and reliable operations to be performed in an environment aimed at optimal human performance and physical and mental exertion reduced to the minimum, lead to the development of a uniform and ergonomic workplace, easy and logical man-machine interface, focussing on the relevant decision presented in an optimized overview.
The high level of process and technology has been expressed in the building architecture through a simple and pure design developed by architect Wiel Arets, who created an ambitious architectural design in answer to the client’s wish to establish a landmark in the environment close to the recently widened lock in Maasbracht.

The building consists of a mushroom structure: a narrow base structure where the technical units for the building itself are installed and a large open upper structure where the operators are seated. Besides that, the upper structure is open ensuring a good interaction between the several operators. It also has a large glass façade. The combination glass façade and higher position (second floor) of the operating room with sights on the river Meuse and the lock of Maasbracht creates for the operator an extra control mechanism.

This ambitious architectural design created civil engineering challenges in construction design and construction methods:

- A cantilever upper structure (more than 7m cantilever) with a large glass façade,
- A Glass façade with isolated glass panels of more than 4,5m high with curved edges provided with an exceptional print, a special patent anchorage system and an innovative sunblind coating.

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- ABSTRACT 44 -

On the longitudinal dynamics of ship entry and exit at locks

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The passage of a ship through a navigation lock includes the ship's entrance, gate manoeuvring, filling or emptying of the chamber and the ship's exit. The aim of the hydraulic design of navigation locks regarding lock operation is twofold: to ensure both short and safe passages of ships. In order to achieve this, the design of the filling and emptying system of new locks is often accompanied by laboratory tests at the beginning of the design process and by field tests to optimize valve opening during operation, and consequently a large number of literature on this subject is available. On the other hand, concerning the question of the influence of lock and lock approach design on safe and easy ship entry and exit, the amount of literature is quite limited, although the time requirements and hazard risks can by far not be regarded as negligible for these processes.

The analysis of theoretical, experimental and field studies show that the hydrodynamic phenomena in lock chambers during a vessel's lock entry and exit are similar to the motion of vessels in narrow channels and may be described by one-dimensional model assumptions. But the process is significantly affected by the instantaneous change of cross-sectional area and return current around the vessel as well as propagation and reflection of translatory waves. Basic analytical approaches and fundamental numerical equations for the movement of the water and the ship are presented and discussed.

Theoretical methods for the solution of water and ship dynamics at locks require the consideration of a large number of factors that influence the accuracy of the method and contain model assumptions. So there is a need for model calibration and verification by physical model or field tests. Empirical investigations concerning ship's entry and exit show the impact of cross-section conditions on criteria affecting safety and ease of navigation. The attention of former field and model tests was mainly focused on the lower harbour of locks because of the more restricted water that extends the passage time and enlarges the danger of grounding in the chamber for exiting ships. In this context, ship squat and under-keel clearance during lock exit, the travel time for lock entry and risk-free lock approach speed are considered. In order to allow simple estimation of these parameters, graphs produced on the basis of regression analyses of model and field test results are presented and discussed. Squat analyses show that for exiting ships sailing with the limiting speed (e.g. the critical speed), the maximum squat for a given chamber water depth and ship draught occurs at a specific blockage factor. That means that the risk of grounding for a high draught to water depth ratio is usually not higher for a broader ship, because the smaller ship can sail with a higher speed.

The paper concludes with an overview of recent and actual investigations on ship dynamics in the BAW. This involves field investigations in order to evaluate whether a reasonable reduction of exit time could be obtained for ships travelling downstream with high blockage ratios during low-water periods at the locks of the Main River, which have a usable chamber length of approx. 300 meters. Furthermore, field tests were carried out at the two locks of the Datteln-Hamm

Canal with commercial shipping in both upstream and downstream navigation to find out whether the two locks with lock dimensions of 86.0 x 9.9 meters and 93.0 x 11.5 meters and limited sill depths are navigable for the standardized European barges with maximum draughts of 2.5 and 2.8 meters. The preliminary test results show that the narrow entrance and low sill depths at the upstream head have a large influence on the creation of translatory waves and hindrance for the vessels and result in an increase of entry time, as well as in the case for ships entering from the lower lock approach with generally low water depth in the whole lock chamber.

To get a better insight into the influence of lock design (lock dimensions, chamber and sill depths), as well as into the design of lock approaches (layout of guide and guard walls), on transit time depending on ship dimensions and ship draughts, data submitted by the Federal Waterways and Shipping Administration on the locking processes of ships are currently evaluated. The results are used for calibration and improving the existing one-dimensional numerical model to simulate lock entry and lock exit processes. In a joint research project, BAW and the Institute of Ship Technology, Ocean Engineering and Transport Systems (ISMT) of the University Duisburg-Essen are concerned with the simulation of ship manoeuvring in restricted waters. The influence of the lock entry geometry on the dynamics of the approaching ship is planned to be explored by conducting physical model tests at the Development Centre for Ship Technology (DST) in Duisburg. Moreover, these tests will be replicated in a numerical towing tank. Finally, the findings of these studies shall be incorporated into a manoeuvring model of a ship handling simulator in the BAW to enable real-time simulations of lock entries.

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- ABSTRACT 045 -

Evaluation of ship forces for a through-the-gate filling system

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The Kiel-Canal (the artificial waterway with the highest number of passing vessels per year in the world) in its current state was finished in 1914 and most of its locks still exist in their original form. The locks considered here have longitudinal culverts for filling, though the lift height is rather small (up to 1.5 m). Due to their age, several of the locks have to be renovated or replaced. For some of the locks it is now planned to replace the existing rolling gates with new gates. Due to the effort required to maintain the valves and culverts of the longitudinal system it was decided to give up this filling system and to replace it by a simple through-the-gates system. I.e. the new gates are to be equipped with valves for filling and emptying the chamber and the old filling system will be filled with concrete. The Waterways Engineering and Research Institute (BAW) was commissioned to evaluate the impact of this change on the filling/emptying time of the locks and the safety of the transit. Therefore, first the performance of the existing system was evaluated and the new system was checked against this with a combination of numerical and physical models. This combination was chosen because the numerical models are able to estimate quickly whether the proposed fundamental change of the filling system would still result in an acceptable performance of the lock. After this initial phase, which clarified the general feasibility, a physical model was built to perform a large number of additional tests for the valve schedules under different operating scenarios.

For the numerical tests the 3D fluid dynamics solver StarCCM+ was used. For these tests, additional to the flow field in the chamber, the movement of the ship should also be considered. In order to check the quality of the results, one of the scenarios was tested by both the BAW and the software vendor CD-Adapco following different modelling strategies. While the BAW worked with an approach where the computational mesh is morphed (e.g. deformed) according to the movement of the ship, CD-Adapco chose an approach with two overlapping meshes (called “overset meshes”, “overlapping meshes” or “Chimera meshes” depending on the software used), one for the lock chamber (fixed) and one attached to the surface of the ship (moving). Both approaches showed an encouraging degree of agreement. The numerical studies have shown a significant impact of the valve schedules on the forces acting on the vessel. From theoretical considerations it can be derived that the changes, and the maximum flowrate are governing the forces on the vessel. The simulations showed the validity of these considerations, and that these influences can clearly be separated. The change of flowrates introduces an oscillatory movement while the maximum results in a plateau of the force which pushes the ship towards the gate. It was attempted to derive optimized valve schedules that cancel long waves in the chamber by superpositioning. An early comparison showed that the general behaviour of both physical and numerical model are comparable. But it is obvious, that the physical models reacts less direct than the numerical model, i.e. the observed initial peak of the forces is significantly smaller. It is assumed this is due to the fact, that in a numerical model all valves open at exactly the same time, while in a physical model small variances in the timing for the opening schedules are always observed.

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- ABSTRACT 46 -

Waterways as basins for pumped-storage hydroelectricity

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In 2020, the shares of renewable energy sources has to rise to 35% of the power supply in Germany. The operation of pumped hydroelectric storage (PHS), in combination with waterways, is considered as one solution to provide storage capacity for the integration of renewable energy. A number of potential sites are currently being investigated.
A PHS is generally equipped with pumps and generators connecting an upper and a lower basin with a large height difference. In case of need, electrical energy is stored in the form of potential energy of water or converted back into electrical energy with an efficiency of over 80%. The storable amount of energy depends on geographical and topographical factors, flow conditions and the capacity of the upper basin. Further on, the location of a PHS must lie close to power lines or power-supply centres. Waterways as (lower) basins for PHS must fulfil these general characteristics regarding safety and ease of navigation.
Different constellations of PHS in conjunction with waterways were examined. In a free-flowing river, the response to changes in runoff are unfiltered. Thus, PHS with the lower basin in this waterway is only appropriate if water level changes may not be subject to excessive fluctuations. Minimizing surge and sunk induced by PHS can only be achieved through significant changes in the cross sections located below. Besides the direct inflow, the arrangement of a lateral basin close to the waterway is possible.
The water level in an impounded waterway is controlled within a tolerance band by a movable weir or a hydroelectric power plant. The inflow and discharge structure of the PHS should be placed in the headwater of a barrage close to the control structures since water level is highest and channel width is increased due to the lock's exit basin. A coordinated joint control for a coupled mode between PHS and the automated operation of barrages must be established to reduce and balance the fluctuations of PHS so that safety and efficiency of vessel traffic is not affected. The situation is different when a PHS is connected to a chain of impoundments considering the flow time of water during PHS. The water level concession of the control structures has to be reduced to obtain a usable storage capacity. Every impoundment storage capacity is limited by curves which vary with the inflow. For determining water level and wave propagation over the entire cross-section, hydrodynamic numerical models must be used regarding a vessel’s loaded draught or bridge clearance.
Shipping channels are primarily designed for transport and have little or no natural water inflow. The usable storage capacity for PSH in channels is limited to little difference in lower and upper operating level. During PSH in channels, the discharge amount of the Turbine is the criterion for velocity in the channel which affects the navigation conditions. Surge and sunk spread in channels over the entire length and will be reflected by transverse structures. It is only reducible by operating activities, since there is little space for obstructions in channels. By the lack of inflow and due to low flow velocities, flow changes have sustainable impact on the water level and thus to the waterway transport.
The contribution discusses several options of connecting PSH and federal waterways. Solutions for minimizing the influence on waterways by combining automated discharge and water level control for PSH, hydroelectric power plant and moveable weir are reflected.

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- ABSTRACT 47 -

Semi probabilistic design of hydraulic inland structures

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PIANC Working Group 140 was set up in 2010 so as to care about the semi probabilistic design for hydraulic inland structures. To better understand and mitigate the reliability in their design, engineers are using semi-probabilistic methods for their designs of hydraulic structures. To date some engineering codes such as the American Load and Resistance Factor Design (LRFD) and various design Eurocodes have progressed from a deterministic approach to a semi-probabilistic approach. The advantages of this switch are more efficient designs that better account for the reliability into the designs of these structures. These designs should have uniform safety levels with better performance and durability since the uncertainties found in design and construction are better defined.

The deterministic approach has been replaced by the semi-probabilistic approach (as considered i.e. by the EUROCODES, LRFD, é) for which partial safety factors are applied on the loads (amplification factors) and on the strength (reduction factors). The background of the semi-probabilistic approach is that each realization of the loads and the strength properties are stochastic or probabilistic in behavior. These partial safety factors are initially calibrated on empirical knowledge and more and more on the results of Level II probabilistic models to represent uncertainty in loads and strengths and differ according to the considered limit state (performance requirement of the structure), the type of loads and the failure modes being examined.

Return periods can be developed from the semi-probabilistic code to design structures to maintain a certain level of structural performance requirement. For this method, loads to which a structure will be subjected to during its service life, (i.e., water level, wind and snow actions, seismic or vessel impact events) are defined using return periods or an annual probability. These return periods for loads are applied to the structure to minimize the probability of failure for the structure. Return periods depend on the Limit State under analysis (Ultimate Limit State, Serviceability Limit State, etc.)

Some results of the work of PIANC Working Group 140, ñSemi Probabilistic Design of Hydraulic Inland Structuresò are presented. The Working Group investigated different semi probabilistic design methods and described the basics. Differences are shown and analyzed. By a questionnaire typical elements of the semi probabilistic design procedures have been investigated for ultimate and serviceability limit states. These are i.e. the determination of characteristic load or resistance values, typically used actions for hydraulic structures, partial safety factors for actions and resistances, model factors, combination factors, configurations of limit state functions, existence and number of consequence classes, target reliability indices and robustness criteria. As much as possible the findings had been compared and evaluated.

Only a few countries have special additional regulations for hydraulic structures although the basic codes are preferentially developed for buildings. Service lifetimes and target safety levels,

i.e. a ϐ of 3.8 for the lifetime, are nearly similar for all investigated design methods considering different structures. Whereas the EUROCODES have nearly balanced partial safety factors on the action and resistance side, ranging from 1.15 to 1.5, LRFD has much more bigger factors on the action side, up to 2.2, as against the resistance side, not more than 1.18. Typical actions for hydraulic structures have been defined and analyzed as well distributions are given to derive actions, resistances and partial safety factors. A focus had been set to water pressure as a key action for hydraulic structures. Typical examples for hydraulic structures such as a concrete lock section, a lifting steel gate girder and a quay wall section have been worked out according different semi probabilistic codes. Recommendations out of the work are given.

The Role of Inland Waterway Transport in Customer Oriented Transport Chain

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The Finnish Transport Agency is carrying out a multi-year study on customer orientated travel and transport service levels. The aim of this study is to improve the knowledge in the required level of service of our customers, to ensure the most efficient allocation of our resources and to create new planning tools for the design of roads, railroads and waterways based on the required service level rather than on defined technical level of the transport network. This study includes extensive survey on customer needs in different types of cargo and in different transport chains.

In this survey transports were divided into five main categories being bulk goods, mass product articles, consumer, valuable and investment goods, perishable goods and dangerous goods. The factors affecting the level of service during the whole chain of transport were defined in these categories. These factors can then be taken into consideration in the creation of planning tools and service level indicators in the latter stage of the study. The results of the study will be independent of the mode of transport, but by studying further the main causes of insufficient service level, they can be transferred to certain needed measures in a certain mode of transport.

Inland waterway transport (IWT) is nearly always just a part of a larger chain of transport. The on-going study enables the creation of tools to find out the most efficient ways to improve the competitiveness of IWT, though the measures can be on dry land instead of canals and rivers. On the basis of the factors of influencing the service level, the weak points of the service level of IWT can also be discovered and measures can be taken.

The presentation will give an overall view of the study, but it will focus on factors affecting the service level and on how IWT can meet the challenges of these factors. For instance: IWT is cost-effective, but this proved to be the most important factor only in transport of bulk goods, where IWT has traditionally had its main market. In transport of mass products (typically products of heavy industry) the most important factor is punctuality instead of cost-effectiveness. In the case of these products, it is important to find the most efficient ways to improve the punctuality of the transport chain, where IWT is part of the chain, without losing the benefit of cost-effectiveness that IWT has. This will be discussed further in the presentation in all five transport categories with some examples and ideas to insure and improve the competitiveness of IWT in the future.

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- ABSTRACT 53 -

Rapid assessment tool for designing the optimal river navigation channel route and dimensions

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The pressure on transportation networks is increasing, especially in developing countries that experience economical growth. Inland navigation may be considered the most sustainable and cost-effective mode of transport. Expansion and improving existing inland navigation routes and introducing new routes is therefore often desired. However, it may require large capital investment and maintenance. When designing the most cost-effective channel, both economic and hydro-morphological aspects need to be considered. The economic analysis can provide an estimate of the expected benefit of a navigation channel with certain dimensions. Generally, larger channel dimensions yield higher benefits, but simultaneously also higher initial investment and running maintenance costs. Based on the river's planform, the hydrodynamic and morphological conditions, these costs can be estimated.

To asses the costs of a range of different channel dimensions, it is desired to have a tool that enables a quick and preferably automated assessment of navigation channel dimensions and expected dredging volume. Currently, we are developing a rapid assessment tool, which is expected to be very useful in the planning and prefeasibility stages of inland water transport studies.

Especially in less developed or remote areas, data on rivers is lacking. In cases where data is scarce or no data is available, the first step is to make a rough estimate of the riverbed topography, based on river dimensions and planform, which can be retrieved from Google-Earth™, the discharge and some basic morphodynamic expressions for the relation between bed-topography and river flow. Verification of this tool will be done by comparing it to existing cases and to output of morphological model studies performed by numerical models (e.g. Delft3D).

Based on the estimated or – if existent – measured bed-topography, the second part of the tool will compute the optimized channel route in terms of least engineering interventions and maintenance dredging costs. Rules for navigability, for example, the minimum acceptable radius of curvature, the minimum allowed distance to the river banks, and other rules, are considered boundary conditions in determining the channel route and dimensions. In order to efficiently determine the optimized route, Constraint Programming (CP) is used. The efficiency of this technique results from the active use, during execution, of the constraints to limit the search space for the decision problem, i.e. the assessment of the trajectories building the best channel route *overall*.

With the rapid assessment tool it will be possible to make a first quick estimate of the building and maintenance costs for a range of different channel dimensions. Upon combining this information with the expected benefit, the optimal solution can be determined.

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- ABSTRACT 54 -

Optimum width of a navigation canal bridge taking into account ship maneuverability and side wind effects

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Description of the Seine - Nord Europe canal, challenges and objectives of the study

The Seine-Nord Europe Canal is a high-capacity link between the River Seine basin and the 20,000 km of high-capacity inland waterways network in Europe. It develops a new transport system ensuring the regional development and the connections with the other inland transport modes.

This 106 km long canal is situated in the Picardy and Nord-Pas-de-Calais Regions. It crosses the River Somme by a 1,300m long aqueduct. This aqueduct will be operated with single-way alternate working without navigation restriction up to a wind force of Beaufort 4.

The Development Centre for Ship Technology and Transport Systems (DST) simulated the navigation of the class Va vessels and the class Vb convoy with a length of 185 m on the aqueduct with the objective to determine the width of the aqueduct channel. The width has to permit easy navigation, and to avoid the risks of collision, also in difficult service conditions at night and with fog.

VNF considered that the tests were successful with a 32.80m width and a wind force Beaufort 1. This width has to be compared to that used for the design of the Magdeburg aqueduct on the River Elbe in Germany (34m).

Methodology

The navigation tests were performed on the inland waterways simulator of the DST. The software is based on a marine simulator for seagoing ships. Specific enhancements allow it to process simulations in the field of inland navigation. The software uses hydrodynamic coefficients determined for self-propelled vessels and convoys in a towing tank (scale 1: 16), taking into account the navigation in a confined environment. With regard to the navigation within an aqueduct, the side walls have a very important influence on a vessel sailing with an angle of drift in a narrow section.

The heart of the simulator is a fully equipped ship's bridge plus steering system. The high-resolution, 210° visual system is supplemented by a full size operating console with original radar screens.

Most of the tests were made with a width of 32.80m and with wind forces between Beaufort 0 and Beaufort 4.

The reference vessel selected for the simulations is the class Vb convoy, in the dimensions of 185m in length and 11.40m in width. The average draught of the unloaded vessel is 1.50m (2.0 m at the stern and 1.0m to the bow). It is 2.80m for a loaded vessel with three layers of containers.

Definition of the validation rules of the width of the aqueduct

In order to validate the success of a crossing, criteria have been defined on the basis of the following reasoning.

It was considered that for the class Vb reference vessel, it was necessary to maintain a distance of 4 meters between the bow of the vessel and the wall of the aqueduct and 2 meters between the stern of the vessel and the wall of the aqueduct. The distance of 2 meters is an open section of about 9 square meters which must be maintained in order to avoid hydraulic depressions and collision of the vessel with the wall of the aqueduct which could occur. Considering the results of the tests, this distance is increased empirically by 2 meters to maintain the conditions of maneuverability. When the bow of the vessel is subject to the impact of the wind that pushes it away from the wall, it is not necessary to apply the increase of 2 meters.

Key results and conclusions

Up to a wind force Beaufort 1, the navigation of the class Vb vessels on the aqueduct is carried out without particular difficulty. As the wind force becomes greater, the success rate decreases for navigation at night with or without fog. The increase of the width of the aqueduct does not significantly improve navigation for Beaufort 4 or 6 conditions. The navigation of the class Va vessels does not present particular difficulty except at night by wind forces of Beaufort 3 or 4.

The 32.80 meters width is thus a reference for the design of the aqueduct. To ensure the safety of navigation, the utilization of a bow thruster is recommended and the influence of the wind should be reduced by the provision of protective windshields.

The "Rhone model" or what evolution of the multipurpose development of the Rhone river, 80 years after its starting ?

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In 2001, in the framework of energy market deregulation, CNR, France's second largest electricity producer, took back ownership of its production. This was the beginning of its transformation into an independent integrated producer. Acquiring this new identity enabled it to market its electricity as it chose and thus free up necessary financial resources. The Compagnie Nationale du Rhône committed itself to appending the general specification of the concession a master plan for public interest missions, including inter alia the development of a voluntary environmental conservation and rehabilitation policy in the Rhone Valley.

Thus CNR improved its original corporate model, allowing it to get a new lease on life to the multipurpose development of the Rhone river. This model is based on a simple idea: a part of the receipts generated from the sale of electricity produced by assets located on a territory is invested for the benefits of the community of the same territory, in this case the Rhone valley.
Since 2004, the public interest missions have been drawn up in 5 year action plans involving 4 main areas with sustainable development as main line: navigation and developing the navigable waterway, hydropower production, the environment and local ties.

The actions included in these 5 year plans correspond to CNR's own commitments on one hand, and to operations jointly financed by several partners such as French government, state-owned enterprises or local authorities of the Rhone valley, on the other hand.

In the framework of a voluntary step, CNR incorporated its public interest missions in the Projects Contracts of the Interregional Rhone Plan, a far-reaching sustainable development program of the Rhone River and its valley, a result of the partnership among the French government, the Regional Authorities, the Rhone – Mediterranean and Corsica water agency and CNR (the main private contributor).

The paper presents the main innovations in the fields of institutional organization and project management, which allowed settling this ambitious program in accordance with the French government and in close cooperation with the neighbouring populations. Then it describes some of the outstanding actions in the field of navigation, achieved or in progress: construction of new locks for pleasure boats to restore partial navigability to the Upper Rhone upstream of Lyon, creation of a new container terminal in Port de Lyon Edouard Herriot, improvement of navigation safety, better information services to skippers, promotion of river transport, and development of tourism and leisure infrastructure along the Rhone river.

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- Abstract 56 –

Waterways improvement of the Red River Delta (Vietnam): The Northern Delta Transport Development Project

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The Government of Vietnam has undertaken a large program of development and modernization of the Vietnamese waterways in the Red River Delta financed by the World Bank. The PMU NIW is in charge of the waterway side of The Northern Delta Transport Development Project (NDTDP). This project covers two of the three main waterway corridors in the Northern Delta Region:

- Corridor 1:
  Viet Tri – Hanoi - Pha Lai – Hai Phong – Quang Ninh;

- Corridor 2 (out of the current project):
  Quang Ninh – Hai Phong – Ninh Binh;

- Corridor 3:
  Hanoi – Lach Giang Estuary.

More than 350 km of waterways are affected by these modernizations.
The future waterways will be sized for 4X400T, 2X600T barges and 1000T sea-river vessels between Hanoi and the East Sea and for 3000T sea-river units downstream.

The improvement of the access of the Ninh Phuc port for the sea river vessels will require the construction of a 1km canal between 2 rivers. In order to limit the impact, a lock 175m X 17m is being designed and a mobile bridge over the lock at the height of 8m was preferred to allow the transit of small units, with a limited impact on the road traffic.

Due to the difficulties of maintaining the unstable channel at the mouth of Lach Giang, the project recommends the construction of a bypass channel protected on both sides by two breakwaters to ensure the access of sea-river units.

The consortium CNR-Tractebel France – IMDC, with its local subconsultant VIPO, is in charge of the construction supervision of the channel improvements of the Corridor 1 designed by Egis and of the Corridor 3 designed by the consortium itself.

The total cost of the works is estimated at 70 milion USD for the Corridor 1 and up to 160 million USD for Corridor 3, invested in a period of 3 to 4 years.

The construction of the Corridor 1 started in 2012. The work on the Corridor 3 starts in 2013 with the improvement of the ports of Viet Tri and Ninh Phuc

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- ABSTRACT 57 -

Electronic height Control System to avoid Bridge Collisions on Inland Waterways

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Research into ship accidents on inland waterways in the past four years has shown a quite significant number of bridge collisions. Nearly 20-30 collisions occur annually, mostly on channels and lock regulated inland waterways. Many inland waterways are crossed by bridges which have a vertical clearance of 5.25 m or even lower. Although such inland waterways allow for two-layer container transport vessels, the skipper has to lower the wheel house to be able to pass the bridge. A collision with a bridge construction can result in heavy physical damages of the bridge and the ship and injuries to persons onboard the vessel. Furthermore such a collision can severely damage light bridge constructions (e.g. pedestrian bridges across the Main-Danube-Channel). In addition such accidents could also have an impact on the traffic flow of inland vessels traffic due to a ban on shipping along the river for a longer period.

Roughly 50% of such collisions are caused by carelessness and wrong navigational estimates. Such accidents could be avoided if the skipper could be informed about a possible collision by an electronic collision warning system ahead of time before passing a bridge.

As a consequence the German Waterways and Shipping Administration has started a research project to identify and assess possible technical solutions to inform and warn the skipper ahead of time before reaching the upcoming bridge.

The ongoing project is divided into two parts:

- A feasibility study to investigate and assess a variety of technical methods. Such methods could be land based (e.g. using optical sensors), ship based (e.g. integration of ship borne sensors with present and future GNSS technologies) or a combination of both.
- A subsequent pilot test to validate the proper function and reliability of the most promising methods in a demonstrator area

The feasibility study started in January 2013 and will provide the first results in summer 2013.

The intended feasibility study is further based on the following basic considerations and requirements:

- Reliable and accurate estimation of a safety clearance between the highest point of the ship and lowest point of the bridge, taking into account the ship construction, dimensions and load.
- Accurately timed warnings before a possible bridge collision
- Consideration concerning the dynamic ship movements
- Consideration of water level changes caused by release and intake of water by chambers of adjoining locks or by surrounding traffic.
- Consideration of adverse environmental conditions (weather, visibility, wind, etc.)
- Consideration of economical aspects with respect to required technical equipment on ship and ashore

The full paper and presentation is mainly based on the outcomes of the previously mentioned feasibility study about an electronic height control system to avoid bridge collisions on inland waterways. The paper includes a brief report about the technical solutions which are included in the study and a detailed description of the most promising technical solutions and methods. Furthermore the paper will include a summary of the assessment of the investigated methods used. In addition an outlook will be given about the planned subsequent installation of a test installation to demonstrate the reliable usage of some selected methods.

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- ABSTRACT 58 -

Architectural Design of a Traffic Centre

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Operators nowadays deal with many different information systems, which they need to integrate into one mental model themselves. To support this integration within the “Vessel Traffic Management Centers of the future” (VTMC) project, Rijkswaterstaat introduces an ICT-architecture that enables the integration of a wide variety of systems. This includes lock management systems, VTS systems, video systems, audio and VHF systems, AIS-systems and traffic management systems supporting RIS functions such as fairway information, traffic management and information, logistic information and calamity abatement.

The various roles and tasks to be performed in a Traffic Management Centre calls for a new approach on the Man-Machine Interface (MMI) that can be configured individually for a specific combination of tasks. The graphical user interface (GUI) design is based on a far-reaching integration of the information in the various main areas of GUI and clustering of information. Information about a single process or one object is presented in one general MMI. Also task-related systems such as audio (VHF) and video will be operated from this GUI. This means that information from different underlying systems are presented together and act as an integrated MMI in such a way that the operator is not aware of the underlying systems. An operator no longer needs to merge this information mentally. To enable this, a standard ICT-infrastructure of the MMI is designed that can be used in any combination of roles and tasks.

The size of the area managed and scope of the tasks to be performed in a Traffic Management Centre introduces the need to manage the workload of the operators. The introduction of task management creates the ability to distribute the specific MMI-support of the roles and tasks to be performed to any MMI. A task management system is introduced to support the distribution of tasks dynamically. The task management system will also manage the authorization of an operator to ensure that the operator can only execute authorized tasks.

The dependence of the operators to complex ICT-systems to perform their tasks in a Traffic Management Centre requires specific attention to the availability and reliability of the underling systems and their cooperation. The complexity is enhanced by the fact that the life cycle of a system is much longer than the technology generations in ICT. This means that the architecture has to support the interoperability of older technology systems and newer technology systems.

As the introduction and implementation of the Traffic Management Centers will take at least 10 to 15 years, new systems will be developed replacing older systems, new functionality will be implemented in existing systems and new technology generations will be introduced. To manage these developments, the concept of “guiding principles” for the system and ICT-architecture is introduced. These “guiding principles” will be used during the modification of existing systems and the introduction of new systems to ensure availability, reliability and interoperability. In this way the Traffic Management Centers can be introduced gradually and lessons learned can be implemented. Also, the financing can be synchronized with the normal life cycle maintenance of systems.

Organisation of Vessel Traffic Management Centres of the future: from local services to an integrated traffic management approach.

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Skippers on inland waterways need information about passage times at locks, bridges and any restrictions on their journey ahead. Good information, which is delivered on time, gives the skippers the opportunity to plan their voyage in a better way while saving time on their trip to their destination. Operators in vessel traffic management centers are responsible for the safe and efficient handling of traffic. Through the project “Vessel Traffic Management Centres of the future” (VTMC) Rijkswaterstaat will offer these services by means of an integrated traffic management approach on the entire journey instead of local services along parts of that journey. This requires a new way of organizing the RIS traffic planning services supplied by the operators of Rijkswaterstaat.

The focus shifts through the VTMC approach from regional and local measures to services on a corridor level and as such opening the door for European wide corridor management. Traffic management on a transport corridor requires an integrated network-approach where the information services to the users are an interactive part of voyage planning and traffic planning processes. As defined in the VTMC project and as stated in the PIANC guidelines edition 4 traffic planning is becoming more and more an essential and explicit part of Traffic Management.

Organisation of Vessel Traffic Management Centres (VTM-Centre) of the future
The services delivered by a future VTM-centre are in general the existing basic RIS services of lock and bridge operations and Vessel Traffic Services (VTS) and the new traffic organizations and traffic planning services in VTMC terms called Operational Network Management.

All tasks performed in a VTM-Centre are written down as a set of 400 activities. For each activity is defined which information from which system is needed to fulfil the tasks

The Vessel Traffic Services and the lock and bridge control will in future be delivered remotely in a joint VTM-centre. These services are reduced to their essentials. Other tasks, such as planning of lock and bridge openings, and updating voyage information, will be performed by the object planner. An Operational Network Manager will control all events and incidents in an entire region or corridor and safeguards the fluency of the traffic flow on the network.

Object Planner – a new role
It is foreseen that voyage plans can be executed by the skipper. In the near future VTMC will introduce unique voyage planning applications on board vessels and will deduce voyage plans from electronic reports provided by vessels sailing on Dutch waterways. The object planner monitors this automated planning of ships at a regional level for several locks and bridges.

The lock operator will receive automatically generated lockage schedules and, if necessary, will adjust this schedule to the actual situation at the lock. He, for instance, plans the lockage of ships without a voyage plan, such as yachts.

Operational Network Manager – another new role

The operational network manager (ONM) is responsible for a fluent flow of traffic. If incidents or other obstructions occur, the ONM alarms the persons and authorities responsible for calamity abatement and takes the correct steps, such as activating a patrol vessel of Rijkswaterstaat. Once arrived at the incident the VTS-operator on board stays in contact with the ONM-operator in the VTM-centre.

Human Resource Management

Every operator in the VTM-Centre is by education qualified for certain VTS-sectors, locks and bridges and parts of the whole network. For the new roles, objectplanner and operational network manager, new training modules will be developed..

In the training of the VTMC operators two new competences will be introduced being analysis of information and performance motivation. In a VTM-Centre a large amount of data will come together, so the operators should be able to pick out the most essential information in its context. Every operator in a VTM-Centre is part of a team. They have to work together to supply better services to the users of the VTM services. It's important for the operators to be aware of this and to be motivated to do one's tasks at a high level.

By this new and clear division of tasks and an excellent co-operation between all operators, together with the right information to the waterway users, Rijkswaterstaat will be able to support the fairway user better on his journey from A to Z.

Designing the Vessel Traffic Management Centres of the Future

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The project "Vessel Traffic Management Centres of the future" (VTMC) aims at defining a new generation of traffic management centres in the Netherlands. The new generation of traffic management centres will integrate the bridge and lock management services with Vessel Traffic Services under the umbrella of corridor oriented network management. The main objectives of the project are:

- Develop a comprehensive Vessel Traffic Management (VTM) system aiming at improving VTM processes and services for internal and external stakeholders. This will lead to a reference design for an integral VTM approach;
- Testing and evaluating the design in an operational environment (pilot centre);
- Transition plan for the gradual implementation of the VTM centres in the Netherlands.

The VTMC project integrates the RIS services as supported by the RIS key technologies implemented in the Netherlands in previous years - such as the European standardized technology inland Automatic Identification System (AIS), Electronic Reporting International (ERI), Notices to Skippers (NtS), inland Electronic Chart Display and Information System (ECDIS).

The project defines the following aspects of the Vessel Traffic Management concept:

1. **Service model**; definition of VTM services that will be provided in the future. The service model is the basis for all developments in the VTMC project. In scoping this activity,apart from existing VTS services and lock and bridge management, a new service is introduced "operational network management", aimed at aligning the other VTM services to ensure an optimal usage of the nautical network. In the PIANC guidelines edition 4 this service is defined as Traffic Planning;
2. **Organizational model**: definition of the general working processes and operator roles that are needed to deliver the defined VTM services, including the way the roles and different VTM centres interact with each other;
3. **Human resource model**: definition of the different operator functions (combination of roles) in the VTM centre, including requirements for training and education;
4. **Control room facilities**: definition of operator desks, control room setting and every Human Machine Interface (HMI) and Graphical User Interface (GUI needed for the different roles in the VTM centre) - the HMI and GUI are defined with operators by prototyping the different GUI's and the process management in the control room;
5. **Specification of the system and applications (on functional level)**: The functional specification include the systems and equipment to be used for the lock and bridgemanagement, VTS and Operational Network Management (ONM). The systems are specified on a functional level and aimed at a more uniform configuration of VTM centres.

The expected outcomes of the new design are the reduction of waiting times of vessels at locks and bridges, improved efficiency of the traffic management operations and improved operational efficiency of Lock and Bridge management. It is also expected that the new design will enhance information services for reliable voyage planning to improve the operation of skippers, terminal and port operators. Additionally, the new design will improve traffic management services and the whole logistic chain by integrating VTS, lock and bridge operation and regional traffic management services in one VTM centre.

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- ABSTRACT 61-

Holistic Man Machine Interface and effects on task performance – from information systems to an informing interface

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Operators in traffic management centers are responsible for a safe and efficient handling of traffic flows. The increasing quantity and complexity of traffic and resulting higher mental workload of operators endangers the effectiveness of traffic control. Besides, Rijkswaterstaat is investigating the possibilities to shift from local traffic management to corridor traffic management to better inform skippers. This asks for a broader situation awareness of operators, new traffic management roles and better cooperation between the different traffic management roles. Within the Traffic Management Centre of the future project, Rijkswaterstaat introduces the 'operational network manager role' who will control all events and incidents in an entire region and an 'object planner role' who will plan all actions in an entire corridor. A new Man-Machine Interface (MMI) design is needed in order to support the changes mentioned above.

Situation awareness

The tasks of an operational network manager, as defined within the VCM project, includes 'assessing traffic situations', 'determining scope and nature of restrictions', 'assessing the need for traffic measures', ' determining impact traffic restrictions' and 'forecasting traffic image'. This means that, according to the task description, an operational network manager needs a good situation awareness and the MMI needs to support the operator in gathering this. Situation awareness in nautical traffic management centres is being aware of all information related to the goal of safe and efficient handling of traffic, related to the operators' task. Situation awareness can be divided in three hierarchical levels, which all are relevant to traffic management operators (Endsley 1995):

Level 1: the perception of task relevant elements in the environment
Level 2: the comprehension of their meaning in relation to task goals
Level 3: the projection of their future states

Since situation awareness is of main importance for correct performance of traffic management tasks, the enhancement of operators' situation awareness is a major design goal for developing operator interfaces.

Informing Interface

In order to deal with the increased demands in situation awareness, Rijkswaterstaat is investigating the possibility to improve the Man Machine Interface design of current VTS operators and operators of bridges and sluices. At the same time, the MMI of operational network managers and object planners is being designed as well. In traffic management centers, operators nowadays deal with many different information systems, which they need to integrate into one mental model themselves. Our hypothesis is that an informing interface, in which all

relevant information has been thoroughly integrated into the operators' workstation, will better support situation awareness then separate information systems.

Holistic MMI means that the MMI is not constructed from loose MMI's of underlying systems, but that the MMI is designed as a coherent whole. The graphical user interface (GUI) design is based on a far-reaching integration of the information in the various main areas of GUI and the clustering of information. Information about a single process or one object is presented in one location. This means that information from different underlying systems are presented together. An operator no longer needs to merge this information mentally. Within the VCM interface design, there is a connection between the different information windows and information displayed in a geographic information system (GIS). The different GUI areas can all contain a different view of the same information.

This presentation will give insight in the conceptual design of the holistic informing Man Machine Interface, as designed within the VCM project. This design is created together with a broad range of Rijkswaterstaat experts and key users. The next step is to verify the hypothesis that an informing interface will better support situation awareness then separate information systems.

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- ABSTRACT 62 -

Room for the River, Cross-currents and Inland navigation

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In order to accommodate the increasing discharges of the River Rhine, the Dutch government (through Rijkswaterstaat) started the “Room for the River” project (RvR). The extra discharge capacity will mainly be realised by increasing the number and the dimensions of the high-water channels in the floodplain area. The increased capacity of the high-water channels in the floodplains significantly increases the exchange of water between the main channel and the floodplains. Depending on the water level and the design of the in- and outlets, the increased exchange of water results in stronger cross-currents in the navigation channels in the branches of the river Rhine.

Cross-currents in navigation channel

Cross-currents in the navigation channel affect the path-width of the vessels and may, as such, result in a reduction of the safety and even in a reduction of the capacity of the navigation channel. The Waal, Neder-Rijn/Lek and IJssel branches of the river Rhine are extremely important transport routes. The Waal is the main transport corridor and the busiest inland waterway with a transport of between 150-200 million tons per year (some 50% of the cargo handling of the Port of Rotterdam). As such, one of the starting points for “Room for the River” was that the project must be designed in such a way that negative effects on the inland waterway transport are avoided.

Criteria for cross-current

The discharges through the new high-water channels range from a few hundred to a few thousand m^3/s over lengths of a few hundred meters to a few kilometres. Existing waterway guidelines in the Netherlands (WG, 2011) provide only criteria for discharges up to 50 m^3/s for cross currents in relation to the width of the in- and outlets. However, for complex situations and higher discharges, additional investigations are recommended. Also, recent published work by Söhngen (2012) focussed on situations with discharges of 40 m^3/s.

In order to be able to assess quickly the high number of RvR-projects, a new and simple criterion was required. The new criterion has been based on the drift angle compensation in a uniform cross-current field and a maximum allowable increase of path width of 0.5 B (Beam of the vessel). This resulted in a recommended maximum cross-current of: $v_c < 0.15$ m/s, whereas for higher cross-current velocities, again additional investigations were recommended. This approach will also be adopted in the revised Version 3.0 of the Rivierkundig Beoordelingskader (RBK version 2.0, 2009) that presents the framework for the assessment by Rijkswaterstaat of interventions in the large rivers and their floodplains in the Netherlands.

Approach for situations with higher discharges

For most of the RvR-projects and other initiatives, the new criterion worked fine and encouraged the developers to optimise the design of their project in this respect. However, in some specific

situations, it appeared impossible to reduce the cross-currents below the new criterion, and as a result, for these projects Rijkswaterstaat required further investigations to assess the impact of the cross-current on the navigation.

The applied methodology comprised manoeuvring simulations applying the Alkyon/Arcadis SHIP-Navigator. Initially, the effect of the cross-current was investigated in real-time manoeuvring simulations with licenced and active inland shippers. Since real-time simulations include the effect of the human factor, an exact reproduction is impossible. Therefore, for the subsequent simulations, the track-keeping auto-pilot modus of SHIP-Navigator has been applied. This excludes the human factor and does allow the exact reproduction of the simulations. The auto-pilot enables as such a systematic approach to the effect of a modified situation and the related (increased) cross-current on the path width of the passing vessels.

Simulation programme

The manoeuvring simulation programmes carried out for Rijkswaterstaat comprise manoeuvring simulations for the existing situation and the proposed situation with modified flow field and cross-current. Each investigation covers a series of water-level discharge combinations, vessel dimensions (CEMT Class II, Va, Vb, VIb), and sailing up- and downstream at fixed distances parallel to the river bank or beacon line. The results of the simulations were reported in terms of (additional) path-width, the use of the rudder and the maximum rudder angle. So far, 5 river sections with high cross-currents at the river bank have been investigated to assess the proposed modifications on the cross-current and the path-width.

Evaluation of the criterion for cross-current

The present criterion for cross-current (RBK, 2009) has been derived for an analytical situation with uniform cross-current. In real situation, the cross-current is usually not uniform, and occurs in river sections of limited length. The available number of simulations will be used to compare the effect of a uniform cross-current and a real cross-current on the behaviour of the passing vessels. The objective of the present research is to evaluate the applicability of the present “rule of thumb” criterion for practical situation. The result of the evaluation will be presented.

Preliminary results from the investigated river sections indicate that where the cross-current is below the criterion of: $v_c < 0.15$ m/s, the cross-current induces extra path width of the vessel XXX also remains less than 0.5 B (B=beam of the vessel). As such, the new criterion is very useful to ensure that the swept path of the vessel remains in its own 2 B wide navigation lane and that the vessel does not enter into the navigation lane of vessels sailing in the opposite direction only because of strong cross-currents.

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- ABSTRACT 63 -

Prediction of water depth, velocity and clearance for optimizing inland water transport using a system of hydrodynamic and morphological models

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The growth of the import and export of containers will continue, and a shift is necessary from transport by road to transport over water to be able to deal with this growth. The use of existing inland waterways can be optimized if the available water depth and clearance below bridges are known accurately allowing a maximum laden draught and number of layers of containers, respectively. By correctly forecasting these, the capacity of the vessels and the waterway can be utilized in an optimal way. Furthermore, fuel consumption can be minimized by following the optimal track based on the flow velocity and using the optimal ship speed in relation to the water depth and the desired time of arrival.

This optimization is only possible by the use of a system of accurate hydrodynamic and morphological models that are able to predict in two dimensions the water depth, flow velocity and clearance. The results can then be used to set up a trip advisor, which gives the maximum laden draught or container height for which it is possible to pass the critical points on the route in addition to the optimal track and ship speed. The system consists of three models: predicting water depths, flow velocities and clearance below bridges for the coming days.

The water depth is defined as the water level minus the bed level at a certain time and place. In rivers, both the water level and bed level are dynamic and therefore changing in time. Morphological models are capable of predicting bed levels and for this purpose calibrated two-dimensional Delft3D models are applied. Two-dimensional hydrodynamic WAQUA models are applied for predicting water levels. The bed level of the WAQUA models will be updated according to the output of the Delft3D models. In the future, real-time measurements of water depths by commercial vessels will be used to improve the predictions. Next to water depth, also flow velocities are computed by the WAQUA models. The advantage of using a two-dimensional model is that the variability in flow velocity and water depth along a cross section of the river is computed. This makes it possible to define the optimal track based both on water depth and flow velocity. The clearance model is based on water levels computed by a one-dimensional SOBEK model combined with a database of bridge heights. The used SOBEK model contains all main waterways in the Netherlands. This model can be used to determine the number of layers of containers that can be piled on the vessel on a certain route without colliding into a bridge.

All the three models are imbedded in a so-called operational FEWS-system, which automatically runs the models and generates files with water depths, flow velocities and clearance that can be used by the trip advisor. A prototype version of the FEWS-system, together with the trip advisor for the river Waal in the Netherlands, has been tested successfully.

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- ABSTRACT 64 -

New sea lock IJmuiden – Wide navigation lock under narrow space conditions

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As regards the Netherlands' "wet" infrastructure, the new IJmuiden sea lock will certainly be the largest construction project of the forthcoming years. This paper presents the objectives and local conditions of this project, followed by the conclusions of feasibility studies for various structural solutions. The engineers' main challenge is to give the lock a very wide (65 – 70 m) chamber within a narrow available space between the two existing locks. An issue of prior concern is the selection of the best suitable lock gates. The nautical conditions for the passing vessels and the safety of all guiding structures are also main concerns. Additionally, all construction activities must be carried out with no hindrance to the intensive navigation in the operating locks.

Nearly all operating locks of this size employ so-called rolling or sliding gates. The technology of such gates allows for a relatively short closing and opening time in wide chambers, with no limits to the overhead space and at the cost of moderate loads to the surrounding civil structures. An important disadvantage is, however, the space that is required for gate recesses. Along with the efforts to provide that space, a number of lock layouts with other types of gates have therefore been considered. These considerations were interdisciplinary, covering the gates, their drives, the affected civil structures and their foundations. The structural studies and assessments in this field are the main subject of the presentation. Other investigations, e.g. nautical, hydrological, planning, have also been performed but are not discussed in details due to the lack of space.

All assessments were performed with respect to the multiple criteria for this complex project. Most of these criteria reflect the main functions of the desired lock, which are:

- Navigation (prior objective of the project);
- Land protection (lock forms part of the storm flood defence system);
- Traffic passage (of local significance, nonetheless unavoidable);
- Ecological linkage (between the North Sea and fresh inland waters).

The criteria that were derived from these functions covered: construction costs, technological feasibility, maintenance, availability for navigation, other nautical aspects, construction time, sustainability and risks. Three optional gate types – in various arrangements and sizes – were considered suitable for the new lock: rolling (or sliding) gates, mitre gates and sector gates.

Subsequently, the lock layouts with these gates were proposed, which allowed the determining of the scope of other works, like the civil structures in lock crowns, the chamber, approach walls, foundations and bottom reinforcements. All these works have only been investigated in quite general terms, considering the early stage of the project.

The collected results made it possible to enter the next stage that will finally allow putting the project for tender in 2015. It is the intention of all parties involved to have the new sea lock constructed in 2019. The authors of this presentation have been directly involved in solving the challenges mentioned above. They represent the Netherlands' public waterway administration (Rijkswaterstaat) and two infrastructure design companies that have performed the Proof of Concept and the global preliminary designs.

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- ABSTRACT 66 -

The idea of the expansion of the urban public transport system based on “water bus”

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In the development of urbanization, urban road traffic congestion problems plague most countries. In addition to the conventional urban public transport system: railway, subway, bus, taxi, etc. there is a certain proportion of private car travel.

In Shanghai, China, for example, in order to meet the expansion needs of ground transportation, a series of intensive infrastructure constructions have been carried out in recent years. In 2011, throughout the year the city's public transportation passenger volume was 6.09 billion, but infrastructure construction could not keep up with city expansion, so there was still traffic congestion on the ground. At its peak, the public transit system's average speed is about 16 to 20 km/h.

In view of this, many of China's large cities with rapid development, such as Shanghai, Guangzhou, Tianjin, Hangzhou, Nanjing, Wenzhou, are thinking about how to take advantage of the city's rich resources of inland river or waterway, to build a public transport network system with "water bus", as an extension or a supplement for the ground traffic system. During a survey about the waterbus program in Wenzhou China, 94 of 100 respondents endorsed it. 44% take waterbus for leisure and tourism, 27% used it for going to work or school, 62% choose to take it 1-5 times a week, and the choice of 21% of them weekly take 10-14 trips. In the survey, 67% of the respondents believe that the biggest advantage of "water bus" is that it is not congested.

This article will focus on the analysis of the status, development trends and their pros and cons of "water bus", combined with relevant Chinese city planning and construction of the "water bus", proposed ideas for inland transportation resources development and "water bus" public transport system built in cities with rich river or inland waterway resources, analysis of its necessity, reasonableness, and put forward their problems and suggestions. Finally, the article will provide the selective solution ideas to the cities that face stressful ground transportation and have rich inland river resources. Finally, this article will call for the effective use of inland water resources, rich traditional public transport system, and upgrading the value or the quality of the city's ecological environment.

Discussion on inland waterways network and the port area layout planning in Shanghai from inland waterway transport development requirements

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Inland water transport is an important part of an integrated transport system. It is an important strategic resource to achieve sustainable economic and social development. This article will discuss the Shanghai inland waterway “One ring and Ten radial line” planning and construction and the river port layout planning, combined with the planning and construction of a high-grade waterway network in the Yangtze River Delta region from the inland water transport development requirements to analysis of the reasonable economic development of an inland navigation system and river ports in Shanghai and the Yangtze River Delta region.

Shanghai’s inland waterway network “One ring and Ten radial line” is composed of 14 inland waterways. Its length is 404km and planning fairway grade level is 1000t. The waterway network combines with neighbouring provinces and cities’ waterway networks and convergence to the high-grade channel network of the Yangtze River Delta. The waterway network extends in all directions and has played an active role in the joint development of Yangtze River Delta economics. In recent years, Shanghai has invested ten billions of Yuan to construct the high-grade inland waterway.

Despite carrying out the planning and construction of the high-grade waterway network, Shanghai has also carried out inland port layout planning. The inland port layout planning combined Shanghai’s urban industrial and inland waterway network planning and set 10 municipal ports. 3 of them are the municipal main ports, 2 of them are inland container port areas to meet the requirements of Shanghai’s Yangshan Deepwater Port (Outer Harbour) and Shanghai Waigaoqiao Harbour (Outer Harbour), the other seven ports are city level important ports to provide shipping services for Shanghai. The natures of the port are dry bulk cargo, containers, Ro-Ro, and chemical industrial products (including dangerous goods). 10 municipal ports of Shanghai provide multi-currency collection and distribution services for the Yangtze River Delta region.

Currently in China, planning and construction of a high-grade inland waterway network and development of the inland container transport is one of the important measures to achieve low-carbon and environmental protection.

In addition, this article will also combine with the status of Shanghai’s inland container transport’s current problems to analyze the main reason for its existence and make relevant recommendations for the construction and development of inland shipping in order to give more reasonable ideas or solutions for reference.

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- ABSTRACT 70 -

Lessons Learned on the Design-Build Process for Mega-Navigation Projects – Lake Borgne Hurricane Barrier

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The U.S. Army Corps of Engineers committed to reducing risk to the Greater New Orleans area from a 100-year storm surge event through the Hurricane and Storm Damage Risk Reduction System (HSDRRS). The purpose of the HSDRRS is to upgrade existing flood risk reduction features (e.g., levees and floodwalls) and introduce new features authorized by Congress and deemed necessary to complete the system.

The Inner Harbor Navigation Canal (IHNC) Lake Borgne Surge Barrier is a key link in the Overall Integrated System of Projects developed by the U.S. Army Corps of Engineers to reduce risk in the area from storm surge coming from Lake Borgne and/or the Gulf of Mexico. This fast-track project has accelerated what would normally be a 15-year Civil Works project into less than 4 years from start of design to completion of construction. The project required maintaining a very aggressive schedule with tight budget constraints and required coordination and integration with the other projects that composed the complete HSDRRS.

In April 2008, the U.S. Army Corps of Engineers awarded the construction contract for the largest design-build civil works project in Corps history to The Shaw Group (Now CB&I). The 1.8-mile surge barrier was constructed near the union of the Gulf Intracoastal Waterway (GIWW) and the Mississippi River Gulf Outlet (MRGO). The $1.3 billion project contains three flood control gates, a braced concrete barrier wall across the MRGO and the Golden Triangle Marsh, and floodwalls on the north and south ends that tie into the risk reduction system in Orleans Parish and St. Bernard Parish.

Construction of the barrier floodwall began on May 9, 2009. The GIWW gate system includes a 150-foot wide buoyant sector gate and a 150-foot wide concrete barge swing gate. The third gate, a 56-foot wide vertical lift gate with vehicular bridge, is located at Bayou Bienvenue. The project was substantially completed in advance of the 2012 Hurricane Season and served well for Hurricane Isaac.

This presentation will focus on the lessons learned in this fast-track design-build project and the close coordination and interaction required between:

- System Program Manager and Project Owner– the U. S. Army Corps of Engineers
- Prime Design-Build Contractor – The Shaw Group (now CB&I),
- Integrated Design Team - Tetra Tech
- The State of Louisiana - End-user.

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- ABSTRACT 71 -

Status of River Information Services Deployment in the United States

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The implementation of River Information Services (RIS) is a non-structural method of improving inland waterway reliability, efficiency, and safety. RIS provides critical information about the waterway to vessel operators, shipping companies, governmental agencies and many other stakeholders resulting in cost savings and reduced down time. RIS in the United States is progressing through several coordinated efforts, and in line with the US e-Navigation Strategy, PIANC RIS Guidelines, and the international e-Navigation implementation effort.

RIS can be seen as a subset of e-Navigation focused on the inland waterways. More specifically, RIS supports the exchange of information making inland waterway transport safe, secure and reliable. The opportunities created by RIS also yield major benefits in terms of sustainable logistics, because RIS enables supply chain stakeholders to participate in intelligent information routing and optimizing resource allocation, such as how traffic information for logistics purposes can lead to useful solutions and services providing benefits for intermodal transport chains involving inland waterway transport.

In the US, there are many “RIS-like” capabilities, but these are not well-coordinated and some are still in development. In partnership with other government agencies and the navigation industry, the US Army Corps of Engineers is working to harmonize these potential RIS capabilities and establish a RIS Center. The RIS Center will become the focal point for the efforts of public and private inland waterway stakeholders in order to coordinate them and create a single distributed capability rather than a number of parallel systems. The RIS Center will be a Government – Industry partnership to maximize RIS capabilities and minimize costs.

This presentation will cover:

- The development of US RIS efforts
- Public-private partnership efforts to implement RIS:
  - Port of Pittsburgh Commission “wireless waterways” effort
  - Columbia River “Vessel Traffic Management Information Service” effort
- Specific RIS capabilities being implemented:
  - Industry reporting “portal”
  - Common information standards (RIS Index)
  - RIS web services development
  - Dissemination of navigation information via AIS
  - Enhancements to inland electronic navigation charts (IENCs)
- Opportunities and challenges
  - Technical issues
  - Policy issues:

    Information security, ability to exchange information between various government agencies and with industry; maintenance of system security and protection of proprietary information

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- ABSTRACT 72 -

Coping with Drought on the Inland Waterway System in the United States

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In August of 2012, the Drought Monitor map showed 52% of the United States in moderate drought or worse, 38% in severe drought or worse, and 20% in extreme drought or worse. This extensive drought had widespread impacts on the entire Nation. The scarcity of water rippled through all water users, including agriculture, municipal and industrial water supply, hydropower, recreation, fisheries and the aquatic ecosystem, and inland navigation.

However, this paper will focus on how the drought affected inland waterway transport, and Mississippi River barge transport in particular. Inland waterway transport is entirely dependent on sufficient flows of water to maintain depth in the rivers and channels. In 2012, barge transport was slowed, and sometimes even stopped due to low water. The drought continued into the fall months, and at one time in November, 97 barges were stranded or grounded. The impact to the navigation industry of losing even a few inches of water can be significant, considering that with every one-inch loss of water depth, each barge is able to move 17 tons less cargo.

There are measures which can be taken by both the industry and water management agencies to cope with drought and the consequent low water levels. Dredging is one option often taken to mitigate low water impacts to navigation and critical infrastructure. The U.S. Army Corps of Engineers can also release flows from storage reservoirs, within existing authorities and approved operating plans, to augment natural flows in the Ohio and Mississippi Rivers. This paper will explore the above options as well as others for improved drought management and also what can be done to prepare for future extremely dry periods which may be exacerbated by climate change.

Updating of US Army Corps Barge Impact Guidance Using Dynamic Finite Element Modelling of Approach Walls at USACE Navigation Projects

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This technical paper will discuss the ongoing efforts by the US Army Corps of Engineers (USACE) to update their existing barge impact guidance, Engineering Technical Letter 1110-2-563, for the design and analysis of USACE inland navigation structures.

The updating process will be utilizing non-linear dynamic finite element modelling (DFEM) of a multiple degree-of-freedom (MDOF) system for the barge flotilla and navigation structures. The DFEM models for the were calibrated to the existing full-scale barge impact experiments conducted at two USACE inland navigation projects, Gallipolis Lock and Dam and Winfield Lock and Dam.

The modelling has been focused on four different types of lock approach walls and six different types of bullnose protection structures found at USACE projects. An impact matrix of flotilla mass, velocity and impact angle was developed for each structure to envelope the design consideration at USACE navigation structures. From these series of analyses, a unified impact model will be developed for use in the design and analysis of USACE approach walls for barge impact loads.

In addition, this unified impact model will be developed into a probabilistic barge impact analysis simulation program using Monte Carlo Simulation to assist in LRFD design of the walls and protection structures.

The final guidance document and computer program will better assist USACE engineers in the design of inland navigation structures for vessel impact.

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- ABSTRACT 74 -

New PIANC Report on Waterway Infrastructure Asset Maintenance Management

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Waterway infrastructure is complex and consists of many different types of structures, such as navigation locks, quay walls, weirs, etc. with both static and movable parts controlled by mechanical and electrical components. It is also very extensive, some covering thousands of kilometers and may cross the borders of different municipalities, provinces or even countries. Most of the infrastructure is unique and was designed and built in different periods, many of which have a very long lifespan. Because of that, they can sometimes stay in service for many years even without much inspection and maintenance. As such, Asset Management may be overlooked by organizations until the infrastructure reaches an advanced state of deterioration.

There is currently no generally accepted or standardized Asset Management System for waterway infrastructure. Navigation infrastructure owners have a variety of reference documents relating to the management of assets but most of these are generic, or highly specific, and few relate directly to navigational or hydraulic assets. Different owners have approached this issue in a variety of ways and good practice has often developed independently.

The objective of this PIANC report is to compare national standards and other guidelines of:

- Asset condition grades (and other grades that may be used in decision making tools);
- Typical damage classes, and models of their development based on specific waterway assets;
- Different strategies for enabling decisions on maintaining, repairing or replacing the assets;

and make recommendations for common standards, where these would be helpful.

The report concluded that while asset management systems in different countries, whether in use for many years or just recently under construction, often originate from completely different backgrounds and needs, they all share some common features. They include:

a) Systematic organization of asset data, usually in a hierarchical format
b) Standardized inspection and assessment procedures to determine the condition of the assets
c) Deterioration models (physical / mathematical, deterministic / probabilistic) to predict the future behavior and/or remediation costs
d) Budget planning and/or allocation based on asset conditions or risks.

This paper will give an overview of the recommended practices that should be considered when implementing or improving an Asset Management System. It provides an overall framework for asset management system for inland waterways and description of the different components of such system that begins with the overall organizational goals with respect to the infrastructure system and with respect to the asset management process. The asset management process can be considered as a virtuous circle of activities and decision making, as shown in the simplified model below. It is based on standardized inspection and assessment processes that

determine the damage and condition grades, and a decision-making structure that is well integrated with risk management to determine the priority of remedial work and the optimal time for intervention.

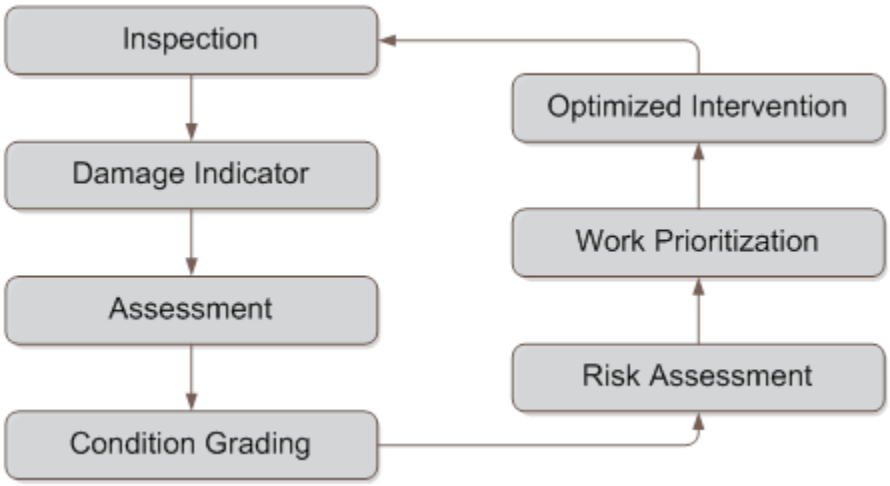

Figure1 - Simplified Asset Management Process

Finally, this process is supported by an asset information system that contains all relevant fixed and variable asset data. The data is usually linked to an asset inventory system, which models the infrastructure system as a hierarchical structure of networks, individual assets and their elements.

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- ABSTRACT 75 -

Human centred design in developing an integrated graphical user interface for future traffic management centres

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Inland waterway transport in the Netherlands is expected to increase in the near future. The Rijkswaterstaat Department of the Ministry of Infrastructure and Environment intends to enable and stimulate this increase by enhancing the service to waterway users. One way Rijkswaterstaat wants to reach this goal, is by an integrated approach of vessel traffic management and lock and bridge operation. At present, vessel traffic and operation of locks and bridges is mainly managed locally without adequate collaboration across operating areas. This situation should change to an integral approach where waterway traffic is managed from regional traffic management centres.

The basic principle of the integrated traffic management is that skippers submit an appropriate sailing plan before departure. Based on the combined sailing plans of all vessels, a traffic prediction can be made. Subsequently, each vessel will receive their expected time schedule for lock and bridge passages. Thereafter, the position of the vessels will be automatically monitored during the trip. Accordingly, their schedule will be updated. The operators in the vessel traffic management centres ensure a safe and efficient progress. For example, the skipper is informed in time about changes in operating times of bridges and locks or alternative itineraries if waterway obstructions or abnormalities occur along the route. Main benefits for the shipping industry are reliable Estimated Times of Arrival (ETA), facilitated by efficiently (co)operating traffic management centres.

The consortium of Arcadis, PAConsulting and **vhp**human performance has developed a reference design for the Future Traffic Management Centre (scope 2025) in cooperation with Rijkswaterstaat.

vhp was asked to develop the graphical user interfaces (GUI's) for the operators in the Traffic Management Centre. A human centred approach was applied in this project.Instead of a technical approach, this project used the operator tasks and the associated information and control needs as a starting point.
Next, an operating philosophy was created describing the way information is presented in the GUI and how the operator interacts with it. Furthermore, it describes how the GUI facilitates the collaboration between different operators and between traffic management centres. This overview is used for the further development and prototyping of the GUI. During prototyping sessions several experts from Rijkswaterstaat were asked to express their views on the GUI design. This process has led to a design that is supported by all stakeholders.

Four GUI's were developed for the different types of operators:

- GUI for bridge and lock operation
- GUI for bridge and lock planning, in which changes can be made on the automatically generated schedule for passage times

- GUI for Vessel Traffic Control, with which the traffic and safety through a VTS-sector can be controlled
- GUI for Waterway Network Management, for the initiation of alternative itinerary scenario's if waterway obstructions or abnormalities occur along the route.

The result is a functional design of the GUI's for the different roles in which:

- all technical systems are monitored and controlled from an overarching user-friendly shell.
- only information strictly needed to perform the task is displayed to the operator, to avoid information overload and to keep the operator focussed to his task.
- all information related to a geographical position is integrated in a layered map, so it fully contributes to the creation of situational awareness to the user.
- supporting general and detailed information to the task is accessible through a separate window, in which the information is visually linked to the GIS.
- system intelligence is used to adequately alert the operator to dangerous or undesirable situations.
- forecasting tools are available to allow the operator to obtain an accurate view on the traffic situation in the nearby future (the fast-forward button).

The design is embedded in functional requirement specifications of the GUI's. These will be tested further in a pilot scheme over the coming months.

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- ABSTRACT 77-

Climate Change and Inland Waterways Transport: When and How to Adapt – the US Experience

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Since the early 2000's, the heartland of the United States has experienced a series of climatological events that have been unprecedented in both magnitude and in terms of frequency. Some have described the situation as moving from episodic to chronic.

The primary inland waterways transport network in the United States resides in the heartland of the nation, stretching from Minnesota, Illinois and Pennsylvania to the North along the Mississippi River (and tributaries network) through the middle of the country to the Gulf Coast from Florida to Texas. Each of these climatological events has had a marked and in some cases dramatic impact on the operations and operators of transportation assets – towboats, barges, terminals, port facilities, and on the network assets themselves – the locks, dams, levees and other aids to navigation.

This paper will document and chronicle these events beginning with the 2005 high water and hurricane events (Katrina and Rita) and continuing through to the present. The events to be reviewed include:

- The Ohio/Mississippi River flooding of 2005
- Hurricanes Katrina and Rita in 2005
- The river freezes of 2007
- The upriver flooding of 2008
- Hurricane Gustav in 2008
- The midcontinent ice storms of 2009
- The Cumberland River flooding of 2010
- The systemic flooding of 2011
- The drought of 2012
- Hurricanes Isaac and Sandy in 2012

Based on this recent historical record, the paper will evaluate the responses to these events by the private operators responsible for delivering transport services and the cooperative efforts between these operators and the governmental agencies. In the US, the primary governmental unit responsible for operating the waterways system is the US Army Corps of Engineers. The unit for regulating operations is the US Coast Guard.

The paper will summarize key findings as a result of this chronological review, identify best practices, make recommendations for adapting and maintaining resiliency, and will offer thoughts on areas for further research.

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- ABSTRACT 78 -

Nautical Depth Solutions to Fluid Mud in Channels

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Over the last 200 years, muddy river, estuarine and coastal ports and waterways have been managed using hard engineering structures (sea defences, channel training walls and groynes, weirs, etc.) and by traditional dredging and placement. As dredging costs have risen and acceptable placement areas have dwindled, soft engineering, or "working with nature" methods have become more attractive.

Nautical depth is one such. In its original form of Passive Nautical Depth it applies to naturally occurring fluid mud (high concentration suspensions of fine sediment) layers in fairways and basins through which vessels can sail in safety. It uses an alternative bathymetric survey technique which has been adopted widely around the world. At suitable sites, such as the pioneer port for this technology, Rotterdam, multi-billion US$ benefit has arisen during almost 40 years from savings and increased earnings. Proportionate benefit arises at smaller ports and channels to which this technology is applicable. The practice has been reviewed and ratified by the World Association for Waterborne Transportation (PIANC) for worldwide use. More recently a second, more sophisticated, adaptation of the nautical depth concept emerged, called Active Nautical Depth. It involves creating and/or conditioning fluid mud.

Passive nautical depth is a bathymetric survey technique. It involves nominating a rheological parameter within a natural fluid mud suspension above which is safe for a vessel to sail. Active Nautical Depth It involves creating navigability by deliberately fluidising the settled bed. The Navigation Engineering Sub-Committee of the Waterways Committee of the Coasts, Oceans, Ports, and Rivers Institute has examined the applicability and potential usefulness of passive and active nautical depth in U.S. ports and waterways.

Field, laboratory, and numerical experiments over the last 40 years have shown that for a nautical depth criterion of 1200 kg/m^3:

- Vessel squat is reduced
- Trim may be changed, depending on vessel shape
- Tug assistance may be required for zero or negative underkeel clearance
- Additional power is required
- Turning circles are tighter
- Pilots should be trained on the modified controllability of vessels sailing in fluid mud.

While clogging of cooling water intakes has been mentioned as a possible side effect of sailing through low density fluid mud deposits, no evidence was found that it is a problem. A National Research Council report (NRC 1996) notes that deep draft vessels are known to collect substantial sediment quantities in ballast holds, even when recommended filter screens are in place. Clogging of filter screens by organic material is a known problem, with several technologies available to clean the screens, which would also be useful if sediment were to be a clogging agent.

Economic benefits associated with use of the nautical depth method accrue primarily through a reduction or elimination of repeated dredging of large volumes of low density muddy water plus transport and disposal of the dredged material. Environmental benefits include reduced energy consumption from dredging and transport of dredged materials, voidance of material placement disruptions and, for Active Nautical Depth, a shift from an anaerobic to an aerobic environment. The latter benefit is associated with possible reduction of contaminants in the wider water body because adsorbed contaminants are less liable to be remobilised and the effects of aerobic bacteria on removal of the pernicious active ingredient tri-butyl tin (TBT) in now-banned anti-fouling paint biocide. This shifts the mud from being an undesirable waste to a resource with a beneficial use.

The Navigation Engineering Committee have concluded that Passive and Active Nautical Depth offers significant potential economic and environmental benefits for ports and channels where fluid mud accumulations impede navigation.

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- ABSTRACT 79 -

A rapid procedure for estimating the ability of lock gates to withstand ship collisions

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Ships travelling on inland waterways inevitably have to pass through lock structures. During this critical operation, collisions are likely to occur. For example, such accidents may arise when it is impossible for a vessel travelling too fast to stop before reaching the gate. Unfortunately, such situations will be more recurrent in the future, for the two following reasons:

- due to its attractiveness, river navigation is increasing all over the world. As the traffic is growing, the collision probability has mathematically to follow the same trend.
- larger ships have to be used for developing and improving commercial river navigation. However, most of the time, maneuvering such vessels is much more difficult especially in confined places like lock chambers.

As a consequence, in the near future, it is reasonable to believe that lock gates are going to suffer more frequent impacts involving larger ships. This will force engineers to think about more crashworthy structures. For assessing the ability of a structure to withstand a collision, it is current practice to resort to finite elements software, but this may not be convenient when pre-designing a lock gate. The main reason is that this method rapidly becomes time expensive, especially if an iterative process is desired for optimization purposes. As a consequence, it is essential to provide engineers with some other tools allowing them to make a quick estimation of the crashworthiness characterizing their structures.

Considering the class of the waterway where the lock is positioned, it is possible to deduce the mass and the velocity characterizing a potentially striking vessel. Such information may also directly be provided by the client. Engineers therefore know the total energy they have to account for when designing their structures against ship impact. But it is much more difficult for them to rapidly evaluate if the current configuration of the gate is sufficient or not regarding crashworthiness. This is particularly the case when time effectiveness is required. In order to fill this gap, we will present a simplified methodology allowing for a quick prediction of the ability for a lock gate to withstand an impact.

The idea of our new procedure is to devide the structure into large structural entities called super-elements. Each of them is characterized by an analytical law relating their deformations to the penetration of the striking ship. As the vessel is moving forward during the collision process, super-elements are progressively activated and the total dissipated energy is computed. By comparing the maximal amount of energy dissipated by the structure to the assumed initial kinetic energy of the vessel, it is possible to know if the current design is sufficient or not.

The main advantage of our new procedure is that it drastically reduces the time needed for getting such information. In order to estimate its accuracy, we will perform comparisons with results given by the finite elements software LS-DYNA. Two different types of gates will be considered: plane and mitered gates (with various support conditions).

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- ABSTRACT 80 -

Cross border cooperation on river management along the river Meuse

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The Border Meuse is a typical rain-fed river, with high discharges when there is significant rainfall and/or snow melt in the upstream river basin. This river forms over more than 50 km the border between The Netherlands en Flanders, Belgium. Two water authorities, one at each side of the border, are responsible for the river management of the Border Meuse. In the past, each water authority had its own vision on river management. There were no common goals, no common policy and hardly any common operational river management actions.

Cooperation seems evident. As the Border Meuse forms the border between the two countries, these countries also share the common floodplain of the river. Measures taken at one side of the border always affect the other side. Further on, the challenges for a durable river management are huge and each individual authority can't solve it alone: nowadays the level of flood protection is already high, but it has to be put at an even higher level due to economical and social reasons. Both river authorities also have to take measures to remediate the negative impact of climate change. Thirdly, recent European legislation (Water Framework Directive, Flood Directive) stimulates river authorities to cooperate as well.

Due to these reasons, in 2005 the Bilateral Flemish-Dutch Meuse Commission was founded to stimulate the cross border cooperation on river management along the Border Meuse. The Bilateral Flemish-Dutch Meuse Commission is a commission on a high administrative and multidisciplinary level. The commission deals with the implementation of policy, operational river management and the development of a common long term vision.

Nowadays, both river authorities cooperate intensively on several aspects dealing with river management. Along the Border Meuse, a common hydrological monitoring network is set up. All data is automatically and instantaneously exchanged. This hydrological data is published on the national water websites in Flanders and in the Netherlands. Extra topics were developed so that each person can consult the data in its own reference level. Based on the hydrological timeseries of water levels and discharges, Flanders and the Netherlands have made common statistical analysis for extreme events along the Border Meuse.

Based on all this data, one common hydraulic model for the Border Meuse was developed. Flemish and Dutch experts work together on the updating and the calibration of the models. These models are used to set up a common vision on flood protection, which is based on 5 common principles. Based on the principles and the underlying technical data and instruments, common flood protections plans for a further increase of the flood protection level are developed and carried out. Flanders and the Netherlands have a close collaboration on the implementation of the European Flood Directive. For the Border Meuse, common flood hazard maps (with flood extent and water depths) are prepared.

The presentation will give an overview of the collaboration of river management along the Border Meuse. Based on our common experiences, also the "lessons learned" will be given.

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- ABSTRACT 81 -

Enabling accurate flow gauging at weirs with Larinier fishpasses

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The EU Water Framework Directive, which was transposed into UK law in 2003 and made operational in 2012, sets environmental goals for integrated river basin management for Europe and uses ecological indicators to assess the status of the water bodies. One such indicator is fish population; however, fish often encounter barriers to their movement at weirs that are used for flow gauging. Having identified the need to combine easy fish passage with highly accurate flow gauging, the UK Environment Agency commissioned HR Wallingford to determine stage-discharge relationships for super active Larinier fishpasses for heads up to 0.9m. Larinier fishpasses, commonly used in Europe, have a series of vertical baffles and interconnected pools that allow migration of a large variety of fish species such as salmonids and coarse fish.

An experimental programme was carried out in the General Purpose Flume on Larinier fishpasses with baffle heights of 75mm, 100mm and 150mm set on a triangular weir having a 1V:2H upstream slope and 15% downstream slope, as per BS ISO 26906:2009 “Hydrometry – Fishpasses at flow measurement structures”. This unique test facility is fitted with a certified volumetric tank and high accuracy micrometer gauges which provided the accuracy required for British Standards Institute/International Standards. For each size of baffle, stage-discharge values were obtained for the fishpass (reproduced at a scale of 1:2) operating in modular conditions (i.e. no influence of the downstream water level on the upstream level). The modular limit, i.e. the transition between modular and drowned flow) was also determined for a range of heads through a series of tests with increasing tailwater levels.

The analysis of the results was performed taking into consideration the results of earlier HR Wallingford research on 100mm baffle Larinier fishpasses carried out in 2005, which was used for the development of BS ISO 26906:2009. Under modular conditions, three phases were observed for the coefficient of discharge in relation to the gauged head: a rise for heads up to 0.08m, followed by a fall up to heads of 0.25m and then a constant value phase for increasing heads up to 0.9m. As no systematic trend was apparent for increasing baffle heights, the same predictive formulae were found to be applicable for all baffle heights in the range 75 mm to 150 mm. Slightly revised equations (in relation to those in BS ISO 26906:2009) were proposed for the variation of the discharge coefficient with gauged head. As regards the modular limit, the earlier recommendation for the modular limit of the Larinier fishpass was considered still to be valid.

The following recommendations were made with regard to the current guidance given in BS ISO 26906:2009, for implementation in a near future revision of the Standard:

- adopt revised equations for estimation of the coefficient of discharge under modular conditions
- raise the maximum operational head from 0.60 m to 0.9 m (for Larinier fishpasses in the range 75 < baffle height (mm) < 150
- keep the equation for modular limit unchanged.

In practical applications fishpasses with Larinier baffle heights ranging between 75mm and 150mm can now be employed to suit the circumstances at a particular site for fisheries purposes without compromising the accuracy required of gauging stations.

Example of fishpass at weir

Model fishpass - view from upstream

Mechanical and Electrical Engineering Lessons Learnt from Navigation Structures - Presentation of the final report of PIANC WG 138

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Navigation locks are located throughout the world. A number of different gate types are utilized for navigation structures with their own unique design features, including lock service gates, fill/empty gates, and dam gates. A variety of mechanical/electrical systems are used to operate these gates. Two typical methods are hydraulic cylinders or electrically operated gear driven machinery.

Some of the design considerations for selecting operating machinery include the type of gate, loading conditions, site conditions, operations, maintenance, and operator preference.

A number of mechanical/electrical design manuals and guidance exist for lock operating machinery. However, informations on comprehensive “lessons learnt” from actual installations are limited. Problems with mechanical /electrical systems quickly emerge causing expensive unscheduled closures. A comprehensive “lessons learnt” on navigation operating machinery will help facilitate the design of new construction or rehabilitation, and in troubleshooting existing operational and maintenance issues.

The intention was to provide a comprehensive summary of lessons learned and best practices that can be incorporated into future lock operating machinery designs. The now presented report will include a summary of relevant guidance documents from various countries. The working group provides guidance on the choice of systems to use in future designs for navigation structures.

This final report now will be presented by Chairman Dipl.-Ing. Rolf Kuehlewind - German Waterways and Shipping Administration (WSV) - Waterways and Shipping Directorate South.

SMART RIVERS Conference 2013

- ABSTRACT 83 -

Smart Mechanical Drive Solutions For Locks - Weirs - Moving Bridges

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New navigation projects, as well as refurbishment programs, are very often coming across the solution of steel structures drives:

- Opening/Closing of lock doors,
- Emptying/filling of lock basins,
- Regulating water level with weirs,
- Moving bridge motion.

From the approach standpoint, each project has its own specificities, with the need for heavy or moderate loads, low or medium speed motion, safeguard position by holding in place or lowering down, frequent or occasional operation.

The applications have in common the need for maximum reliability, low or free maintenance, reduced total cost of ownership and total operating cost, and being more environmentally friendly.

Mechanical drives have been employed for decades in hydraulic infrastructures, for instance:

- Chain hoist on river weirs or Stoney gates
- Cable hoist on rolling and lifting locks doors
- Electromechanical jacks on weir gates
- Racks and pinion for vertical or horizontal weir gates

The complexity of the operations requires integration of the drives within the following functions:

- Protection against overloads
- Monitoring and controls
- Safeguard position, contingency operations
- Environmentally friendly operation
- Low energy consumption

We will develop 3 cases studies where mechanical drives are used with specific smart features:

- Villeneuve / Yonne 1 – Yonne river - France
  - Weir drives with safeguard position ‘hold in place”
- Villeneuve / Yonne 2 – Yonne river - France
  - Weir drives with safeguard position ”let the gate go down”
- Ramspol bascule bridge – Zwarte Meer N50 - NL
  - A power consumption bascule bridge compatible with solar panel output

SMART RIVERS Conference 2013

- ABSTRACT 84 -

Infrastructure for inland waterways in the post-carbon economy. A qualitative approach.

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In a first part the post-carbon economy is explained not only as the goal of environmentalists and those uneasy with climate change, but also as the imminent final outcome of our current situation, since carbon resources are finite and subject to depletion. A short overview of the carbon dependence of our societies in general and the carbon dependence of inland navigation in particular underlines the importance of the subject. A focus on daily practices in the construction, maintenance and operation of inland waterways makes it clear that, in the long run, some changes need to be made.

In the second part, some possible future scenarios are discussed. Given the available amounts of carbon based fossil energy resources (oil, coal and gas), and given the capacity of turning these resources into energy available for consumption, it becomes self-evident that sooner or later today's availability of massive amounts of fossil fuel based energy will no longer exist. Transitioning towards lower dependence on fossil fuels is necessary. Alternatives such as biofuels, solar, wind and nuclear are discussed as well as the earlier energy transitions mankind has made. For a good understanding, those transitions were manpower and wind to steam (coal) and steam to oil. The development of future scenarios results in a timeframe. Predicting is difficult, especially when it comes to the future. Despite this uncertainty, one realizes that the waterways our modern societies operate, and the infrastructure we build, are meant to last for a number of generations. Arguments are made that the uncertainty about the timeframe of a transition to a post carbon economy might be much smaller than the predicted lifespan of today's newly built infrastructure. Therefore this paper is a call to take into account a future with less available energy, while designing infrastructure, while planning for the future and even while developing new policies on any matter whatsoever.

The third part starts with the case of the Kentucky River. This rather shallow river used to be unsuitable for meaningful shipping. The construction of 14 lock and dam complexes made the upstream territories accessible to vessels of considerable size. At the moment only the 4 lower locks are still being operated. The other locks are strengthened at the upper gate with concrete bulkheads poured into the water, to prevent the weakest link in the structures from giving way. This set of lock and dam structures have only been operational for a handful of decades in the 20th century. It is high speed resource depletion (ie. logging of oak forests) that is the root cause of this story. Anyway it is an example of infrastructure, built for a foreseen future that did not become reality. When the story of the Kentucky River is extrapolated to more abstract levels, the following question can be asked: "Can we, with public funds, build infrastructure that is inadaptable to a future with restricted energy supply?" The paper presents arguments that the key answer to that question lays in the existence itself of inland navigation. In its essence inland navigation is a low energy transport mode. In every future scenario inland navigation will play a role to support society, as it has done in all extents of human history. With careful design of its infrastructure, inland waterways might serve future generations even better.

The paper ends with a limited list of examples of recently built infrastructure, mentioning some weaknesses with regard to energy consumption.

Collaboration Walloon and Dutch authorities at fourth Lanaye lock

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Since September, 2011, the fourth lock in the Walloon Lanaye lock site has been under construction. This lock, with dimensions of 220 x 25m, is being added to the existing lock capacity of two locks with dimensions of 55 x 7.50m (1936) and a lock of 136 x 16m (1965). With the new lock, the waterway connection between the Albert Canal in Belgium and the Meuse waterway in The Netherlands will be improved importantly. Barges will pass the new lock starting in 2015. Long waiting times will then belong to the past.

A special feature is that the new lock is situated 90% on Walloon and 10% on Dutch territory. The Belgian – Dutch border is located through the 4th lock. That is why the Walloon, as well the Dutch, governments had to decide on the construction of the fourth Lanaye lock. Cooperation and coordination were necessary to realise the project. A number of phases can be distinguished:
1. Principle decision to build a new lock
2. Negotiation cooperation structure
3. Studies
4. Authorisation stage
5. Decision execution.
6. Realization

The first two phases mainly were in an administrative atmosphere, resulting in a joint declaration of February 2001 in which appointments were created in the size of the lock and the means of cooperation and finance. In the follow-up stages 3-5 there was, on the basis of that statement, an intensive cooperation in the elaboration of the plans. For the construction of the new lock in stage 6, the Walloon government is totally responsible.

Issues which required the consent of authorities on both sides of the border for the design of the fourth Lanaye lock were:
- Size of the new lock
- Hydraulic conditions in operation
- Compensation of nature
- Future management

The contribution to the conference will explain the cooperation between the Walloon and Dutch water managers (SPW-Voies hydrauliques de Liège and Rijkswaterstaat), especially how they resolved the issues mentioned above.

SMART RIVERS Conference 2013

- ABSTRACT 86 -

Smart use of social media to inform and influence the users of the fairway project Willemsroute: it works!

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In the past decade, media, especially social media, has become increasingly important in communications. In government communicationsthe use of social media has, apart from the use of brochures and free publicity via radio/TV. etc., taken flight in the process of informing and influencing citizens. Almost every administrator increasingly uses twitter, facebook and apps for smart phones to get their message to the public as quick as possible. The waterway administrator Rijkswaterstaat (Ministry of Environment and Infrastructure, The Netherlands) has followed these good examples with the project 'The Willemsroute', and with success

Positive thinking

In the period 2009-2017 Meuseworks (De Maaswerken) are upgrading the Meuse and Juliana Canal to a class Vb-waterway, to enable vessels up to a maximum length of 193 m, width 11,40 m and depth 3,5 m to take this route. During this period several locks are under construction or extension. This can result in longer waiting times and even blockades for users of the waterway. The commercial vessels as well as the recreational users are affected by this disturbance.

In the past government communications were focussed on giving information about the inconvenience and longer waiting times, and to discourage recreational craft from using the route under construction. This was done mostly by using the usual channels like radio, TV, internet, press releases and brochures.

The Willemsroute decided to use a different strategy. This strategy is to encourage the recreational users to take an alternative route, and in the course of that process to inform him of the benefits and beautiful scenery he will pass along that way. Motorboat users are especially asked to take the 'Willemsroute', which starts at the lock of Panheel and leads through the Canal Wessem-Nederweert and Zuid-Willemsvaart (Belgian territory) to Maastricht. For a long stretch this route is located in Flanders (Belgium).

This new communications strategy does not only intend to offer a more pleasant and safer journey to recreational waterway-users, but can also increase safety and assure a positive traffic flow for professional bargers on the Juliana Canal. A subsidiary effect of the strategy is the positive economical/touristic impact on the Dutch as well as the Flanders Limburg region.

Social media approach: be good and let others tell it

The Willemsroute strategy is not only built on social media but on several means of communication. During the Maaswerkenworks the main points of attracting recreational bargers are a 50% discount on the Flanders vessel vignette (obligatory in Flanders), a paper 'chart' with broad information of the route (which is also distributed at the lock of Bocholt, Belgium) and the website www.dewillemsroute.eu. In addition the project takes every opportunity to take advantage of free publicity in special uppermarket magazines on boating etc. These traditional means of communication have for the last two years been supported by web TV (broadcasted on the website), email-newsletters and a facebookpage, twitteraccount and mobile apps for

Android and Iphone. Via these last cited media the recreational waterway user is given, apart from the regular fairway information, a mix of area information, titbits and offers along the alternative route. This process is not executed by Rijkswaterstaat but by a hired professional process guide, a moderator. This person does not only distribute the information but also tries to stay in contact and to enlarge the 'community'. The ultimate goal of this approach is that waterway users share the information with their own 'community' and also share their stories with fellow sailors. This total approach has proved to be successful as over the past four years: apart from a +90% positive rating of the Willemsroute users, the number of recreational vessels passing the lock of Bocholt has increased from 342 in 2009 to 615 in 2010, 1024 in 2011 and even a further increase in 2012 of ± 6%. Furthermore: in about two years the number of followers on twitter has already mounted up to 2000, and our facebook community is growing day by day.

Collaboration with partners

This success is not only a merit of Rijkswaterstaat Limburg and the moderator. To achieve this great result since the start of this project, Rijkswaterstaat is collaborating intensively with the Dutch Watersportverbond, Koninklijke Schuttevaer and partners in Flanders: NV De Scheepvaart, Toerisme Limburg and Promotie Binnenvaart Vlaanderen.

Small successes for some, big successes for others

Although the target group and reached population seems small to some professional communication-executives, for the Willemsroute project partners the achieved goals are considered a great success, all the more so because the project is communicating in a small niche: recreational bargers with an average age of 65.

With this in mind the project partners are proud to be awarded several recommendations for instance, the director general of Rijkswaterstaat has considered the Willemsroute-project as good practice and example for communication with our 'clients'. In 2012 the partners were furthermore surprised to learn that the Dutch ANWB had awarded the Willemsroute apps a position in the top 10 of 'clever apps for the recreational waterway user'.

The works on the Meuse/JulianaCanal are expected to end in 2017. In the course of the next few years the Willemsroute project will consider options to continue its activities after the delivery of all the works.

For more background information about The Willemsroute please surf to www.dewillemsroute.eu or contact the projectleader: Lilian Charpentier, tel. + 31 6 532 16 210.

SMART RIVERS Conference 2013

- ABSTRACT 87 -

The impact of large-scale changes in the river system on river features and operational management

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The large-scale customizing of a river due to flood prevention and adaption of navigation channels and structures because of increased ship dimensions has a great impact on the environment. Working according to a structured approach whereby the administrators and stakeholders are closely involved leads to the achievement of the desired objectives.

The Meuse works is an integral program along the River Maas or Meuse. The goals are the improvement of the navigation channels and structures, flood prevention, nature development and gravel extraction. The planning period began in 1997, the execution started in 2005. The work will be completed in 2022. The total project cost is € 1.8 billion. Part of the work is carried out by public/private partners. The contribution of these partners to the program amounts to a total of € 0.6 billion. The integral program consists of 52 projects that are carried out over the years. The structured addressing of the works, monitoring the frameworks and the coherence of the program is crucial.

Each intervention in a system has effect. This effect is certainly the case in a great program like the Meuse works that stretches over a distance of 220 km in and along the River Maas. It has a great impact on the environment and leads to major changes in the River system, the maritime settlement and water management. But it also affects other functions of the River such as ecology, agriculture, living etc. These changes must be adequately addressed so that users are appropriately served and other stakeholders compensated where needed.

One of the tools to analyze the effect on the features of the River is the use of the functions of the MPNW (management plan national waters, in Dutch: BPRW). This plan has 3 levels. The first level is the functions associated with the primary task of the administrator like care for flood prevention and enough water. The second level is the function of shipping. And finally, there are functions associated with the administrator's other tasks and services like recreation, nature, energy etc. This method is a tool to get a first impression of where effects will occur if one of the functions of the River undergoes a change.

The next step is to inventory all the features that have an influence on the stakeholders, to take note of the policies that is used by the various stakeholders and then to start conversation with stakeholders and administrators about their interests and on the necessity and possibility for mitigation and compensation. The final outcome after discussions with 4 provinces, 42 municipalities, 4 water boards, other stakeholders and many citizens is a program consisting of 40 projects that contribute to the various (integral) objectives and 12 projects intended for mitigation or compensation of undesirable effects on other functions.

At the start of the execution of each of the projects a detailed investigation and analysis is made of the cohesion within the Meuse works program and the effects on other functions but at a more local scale. At this stage of the execution, local stakeholders and administrators are involved in

all phases of the project. The insufficient involvement of stakeholders and administrators might have major adverse effects.

Changes within the project may cause effects on the integral Meuse works program and thereby also on other features and interests of stakeholders along the River. This must obviously be avoided as much as possible.

The changes in the system performed by the program (the implementation of the projects) have a big effect on the working method of the administrator. Not only after completion of the program, but also during the execution and this requires significant and necessary effort. The interim situation changes constantly. The administrator will have to take measures to stay in control during the execution.

After execution, the administrator will be responsible to maintain and control the new system to make sure the original objective is optimally served and to avoid adverse effects on stakeholders. That means that there must be a good analysis so that again the MPNW again can serve as a tool to map any adverse effects through management measures.

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- ABSTRACT 88 -

Barge Traffic System: a strategic tool for the Port of Antwerp

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Before the introduction of the Barge Traffic System, there was no coordinated approach between different terminal and barge operators with regard to barge handling. Especially for container barges calling at multiple terminals during one port stay, this resulted in much rescheduling of loading and unloading activities, poor communication, inefficient management of sailing schedules, inefficient utilization of quays, etc. To resolve this issue, the Antwerp Port Authority introduced the Barge Traffic System (BTS).

The Barge Traffic System (BTS) is a free web application developed by the Antwerp Port Authority in close cooperation with the container barge sector. The system came into use in 2007 and was primarily set upfor the container barge sector in order to simplify the process of barge handling in the port. In addition, also conventional and tankbarge operators and terminal operators can register to consultreal-time information on lock scheduling and barge positions.

BTS acts as a singleuser-friendly communication platform for barge and terminal operators, harmonising the process of loading and unloading of containerbarges within the port. By providing transparency during the process of planning and handling, the Port of Antwerp and the port community aims to reduce lead times for container inland navigation and optimise the use of equipment and people for the terminal operators in the port. Between 2007 and 2013, three updates of the application have been worked out in order to enhance and fine-tune the barge handling process in the port. Data analysis showed that lead times for container barges in the port during this period were substantially reduced.

BTS is compulsory for all container terminals and all barges loading and/or discharging containersin the interest of efficient handling and smooth control of the barge container traffic in the port of Antwerp. In the next stage, a similar announcement and planning system will be developed for the other commodities as well. The research for the requirements of the tanker operators and liquid bulk terminals will start up in 2013.

BTS shows how collaboration and operational excellence improve the efficiency of the port and thus improves the position of the Port. Through the implementation of BTS, the Port of Antwerp takes up its responsibility as a partner within the supply chain and optimizes the supply chain for the port users.

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- ABSTRACT 89 -

HYDROAXE and the river Meuse, from floods modelling to operational excellence for management of inland waterways transport

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For more than 15 years, following the main floods in the Meuse catchment during the nineties, the Hydraulics Laboratory of the Université catholique de Louvain (UCL) has been working on the modeling of the river Meuse flows on request of Waterways Administration of the Walloon Region (SPW-DGO2).

The research aims at floods modelling of the upper and mid-reaches of the Walloon Meuse (from French boarder to Liege) and the short-term effects of flood events, particularly the localisation of potential damages. This modelling includes in real time flap gates operation during the floods. Year after year, the model has grown with new functionalities, in particular use of a Geographic Information System (GIS) combining the floodplains (obtained by LIDAR) and the river Meuse minor bed (bathymetry) with automated determination of the cross sections profiles. On the other hand, automated procedure is provided for calculation and visualization of flooded areas on GIS and Google Earth maps. Dam flap gates movements are also included in order to simulate and predict discharge and water levels not only during flood events but all along the year. These flap gates are themselves regulated and the model accounts for those control rules.

The first part of this presentation is devoted to the initial context of HYDROAXE: types of floods on the river Meuse, natural features of the river, and hydraulic structures from the French boarder to the city of Liege (minor and major beds, tributaries, islands, control dams, hydroelectric power plants, etc.). The geometry of the model was based on these elements.

The second part is focused on mathematical and numerical modelling. We explain briefly the criteria imposed by the specific situation of the river Meuse and the operational constraints that oriented the choice of the physical model used for the calculation of water levels in HYDROAXE (unsteady flows, real time calculation requirements, etc.).

In a third part, we present the topographical information necessary as input data for the model and the way the GIS is used to process this information in order to derive the cross-section profiles used for the calculation of the water levels in the software.

The challenge of the model is the need for computing in real-time what will happen, taking into account hydrological forecasting for the next 18 hours, also computed in real time. So, a simulation has to cover, in less than a minute computational time, a 66-hours (48 hours of re-calculation of the last observation in order to re-calibrate the model, 18 hours of forecasting according to hydrological predictions) evolution along 115 kilometres of the river Meuse from the French boarder to the city of Liège with a spatial step of 100 meters. The data set consists of 1 inlet hydrograph for the river Meuse itself and 15 for its tributaries, the water level evolution at

the end of the river reach in Liège, the gate positions for the 13 dams and the discharge of 4 hydroelectric power plants.

The last part of the presentation consists in a quick overview of how the information system is organized and the way the process is performed to derive the flooded areas from the 1D results. The flooded areas are reported in the GIS and may be compared with the 1993 flood as a reference for decision makers. This information has now moved to a friendlier interface using Google Earth for the visualization of the floods areas: as an example, flooded areas near cities of Dinant and Engis are given following the crisis scenario achieved for the work package 4 (WP4) of the European project AMICE (www.amice-project.eu).

To conclude the presentation, we indicate the on-going developments of HYDROAXE concerning a point that appears as challenging for an accurate prediction: the discharge relationships for the gates and flap gates. Scale models have been built to mainly explore the flow behaviour in case of change in regime, for example from overflow to underflow, or mixed situation. Numerical simulations are also performed with Fluent 14.5.

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- ABSTRACT 90 -

Navigation studies for the Seine-Scheldt East project

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The priority project n° 30 of the TransEuropean Network of Transport is the development of a large gauge fluvial network connecting the Seine and Scheldt River basin. In the framework of this global project, Wallonia intends to modernise to class ECMT Va (2000 t) itsmain waterways still limited to class IV (1350 t): Upper Scheldt, Canal Nimy-Blaton-Péronnes, Canal du Centre, the south part of the Canal Charleroi-Bruxelles and Lower Sambre. This part of the Seine-Scheldt development is known as the Seine-Scheldt East project.

The Seine-Scheldt East project encompasses several major works: building of two new weirs on the Upper Scheldt to improve the flood control and water level management reliability and safety; building of four new locks on Canal du Centre and Canal Charleroi-Bruxelles with a chamber size adapted to class Va vessels; and improvement of some waterways segments for safer and more fluid navigation with larger vessels.

This paper presents some relevant methodology and results of the nautical studies performed as support to those waterways' improvements. In particular, three critical sections were investigated as they are possible future bottlenecks for the expected traffic increase: (1) on Upper Scheldt, crossing the city of Tournai is currently restricted by the Pont des Trous, a heritage bridge of which the central arch is only 11m wide; (2) the Canal Nimy-Blaton-Péronnes was initially designed for class II vessels (600 t) and several curves are now too narrow; and (3) the Lower Sambre also presents sharp and narrow bends. These studies were initiated by the Service Public de Wallonie and sub-contracted to ALKYON Hydraulic Consultancy & Research.

For each waterway, some alternatives were drawn and evaluated on plan. Navigation simulations (using the SHIP NAVIGATOR software by ALKYON) allowed the evaluation of nautical fluidity and safety for each alternative. Additional sketches and cost estimations of the required works completed the analysis and enabled the choice of the most efficient solutions.

Some general conclusions may be drawn for the narrow waterways investigated. A vessel size increase can rapidly result in a significant capacity loss, when crossings become impossible on long distance and large waiting times are imposed onvessels. On the other hand, a costly enlargement of the whole canal is not necessary to restore and improve its capacity. Adequately located crossing areas may be sufficient in a first stage.

SMART RIVERS Conference 2013

- ABSTRACT 91 -

Values of Inland Waterways

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In the past, rivers and canals were developed, improved and/or managed to meet mainly the purpose of the transport of freight. As such, the inland waterway networks were created. Apart from freight transport, other purposes like power generation, irrigation, flood alleviation, etc. were linked to these rivers and canals. Besides these deliberate and intended purposes, further benefits and uses of inland waterways have come up during the last decades: recreation, heritage, biodiversity, as well as environmental values in general. Also, urban developments are gaining increasing public interest. Enabling and developing these additional waterway uses proves to have its own economic benefit. The full spectrum of waterway functions has, however, not yet fully caught the public awareness. Nevertheless, with the changing role of inland waterway transport in some countries or in some regions becoming a reduction or even vanishing of commercial shipping, the **multi-functionality** of waterways is something that decision makers should be aware of, whether on a regional, national or international level. It is about navigation, but not all about navigation.

In 2009, InCom launched the PIANC Working Group 139 “Values of inland waterways” with the objective of investigating and reporting on the possible additional values and benefits of navigable waterways. The economic and environmental advantages of cargo and passenger transport via Inland Waterways are well-known. Apart from this, it is recognised as helpful to consider the whole range of uses and benefits in managing, developing or investing in inland waterways. These different uses and benefits were classified in four categories in order to allow a complete evaluation of the benefits generated. These categories were associated with Navigation, Waterway Management, Water Consumption and Miscellaneous uses.

Once these uses and benefits were identified, The Working Group adopted seven key aspects against which these uses were evaluated: physical aspects of the waterway, operational aspects, economic, environmental and social ones and the interaction and balance of interests among them.

After almost three years of investigating this topic, it is shown by the Working Group that the recognition of the possible additional uses opens a wide range of values for the society, in the developed as well as in the developing countries. How these different values are handled depends on the historical background and on the specific needs of each single country. Therefore, sharing these experiences in using inland waterways can prove to be very interesting for all countries dealing with inland waterways.

At the time of the Smart River Conference in September 2013, the Working Group will be at the final stage of its working procedure. As a result, the preliminary conclusions of the report can be presented: the values and benefits of Inland Waterways which can be considered as important for society. It will be shown how these values are related to those parameters associated with the key aspects taken as a basis for the evaluation, how they reinforce or conflict with each other and what can be seen as quick wins. The presentation will point out the difficulty in finding a balance of interests, depending on the principal stakeholder. A few cases from different countries (best practices) that will appear in the report will be presented to show the combination of different uses along the same waterway and their joint benefits for society.

SMART RIVERS Conference 2013

- ABSTRACT 92 -

How to Produce IENC Charts by MobileMapping

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Inland ECDIS is a system which displays Inland Electronic Nautical Charts (IENC) and additional information. Its purpose is to contribute to the safety and efficiency of inland navigation and consequently also to protection of the environment.

In accordance with RIS guidelines the Flemish inland waterway authorities nv De Scheepvaart (DS) and Waterwegen en Zeekanaal nv (W&Z) have produced IENC's in usage5 in 2007 for the waterways class Va and above to feed the inland ECDIS systems.

The first set of charts was based on data from our geographical information system (GIS). In order to collect the requested data (shoreline, bridges,…) two different methods were used. Firstly, a land surveyor was appointed to collect the requested data from several waterways. This proved to be a very costly and time consuming method. The outcome was that only the most needed objects were measured and the charts were very basic.

Secondly a contractor collected data about one of the waterways, using mobile mapping. This proved to be a very fast and qualitative way to collect the requested data. But this contractor used the same limited list of objects as the land surveyor.

Both waterway authorities decided in 2012 to upgrade their charts to the new standard. As a result, more objects will be shown on the charts, which improves the safety and the efficiency on our inland waterways.

Moreover, there is the intention to produce these charts area-wide and to offer them free of charge for commercial and non-commercial use. Thus, the charts can be used by both commercial partners and recreational skippers to navigate safely on our waterways.

The new and improved charts are compatible with existing software used by waterway authorities. That way they can use the charts as a background map to visualize ships and their positions in our RIS-systems (e.g. at locks and bridges).

Problem:
Currently our GIS still contains data from 2007, and earlier, and lacks several indispensable objects such as traffic signs, buoys and others. Even worse, for some of the waterways, no data is available at all.

Solution:
In order to generate new charts, in the usage 7 standard, we shall tackle this project in three clear phases. First, a contractor collects the raw data using mobile mapping. Second DS or W&Z revises and completes the data with names and other attributes. Finally another contractor will convert the dataset into IENC

The data collection will be done using mobile mapping, but in order to determine whether this would happen with LiDAR-data or panoramic pictures a test case was needed. By comparing these methods it would be clear if there was an important difference in quality.

Based on the IENC-encoding guide, an inventory has been made of all the necessary objects. For each objects the necessary attributes have been determined.

Throughout the different stages of the project, every contractor must provide the collected data in a specific format and a well-defined database. The information in that database can ultimately be converted into the desired charts.

Test case:
In order to compare mobile mapping using LiDAR and using panoramic pictures a test case of 20 km on the Albertkanaal was carried out. Two contractors boated the same route, each using their preferred method to collect data. They both gathered approximately 3.500 objects on this route.

Both datasets where loaded into our GIS to compare them with the dataset which was used during the production of our charts in 2007. After a thorough analysis, we discovered that there wasn't much difference in accuracy between the three results. All coordinates of an object were in a 10 cm radius.

Our conclusion was that both systems fulfilled the requirements imposed by us in order to make IENC's, but both systems also added different benefits for our organisations. The panoramic pictures are ideal for exploring the environment of the waterway. These pictures are a huge replenishment to our future fairway information site. Skippers for example will be able to explore their route and destination on the internet.

The advantage of the LiDAR-scanning is that it gives a 3D-image of the waterway, including the shape of the banks. This can be used to make 3D-images of bridges, locks,…

Conclusion:
Based on our findings during the test case, two tenders were published in September 2012. In the first one we ask for panoramic pictures and LiDAR-data of the approximately 1.064 km of inland waterways in Flanders. The tender also contains an inventory of all the required objects to produce valuable charts.

The data will be collected from the water and the ship will have to boat alongside both banks to have a detailed view on the banks. After processing the data, the contractor will have to deliver the data in the requested format.

The second tender involves the conversion of the data into IENC and the maintenance of our charts during the next three years, both tenders have an identical structure. The waterways are divided into 16 plots. Data will be processed per plot, therefore, we will be able to gradually produce new or upgraded IENC's.

The objective is to have a complete set of charts in the first quarter of 2014. This means that in a little over one year there will be IENC's for 1.064 km off inland waterways. Afterwards our GIS will be more up-to-date and complete than ever before!

The future challenge will be to keep this data up to date.

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- ABSTRACT 093 -

LOCKFILL: A mathematical model for calculating forces on a ship while levelling through the lock head

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In the Netherlands, the most conventional method of filling and emptying a navigation lock is through the lock heads. This is made possible by the relative small water level differences in the Netherlands, often smaller than 4 m, sometimes up to 12 m. A good design of the filling/emptying system is important for safety and comfort during levelling as well as minimizing the transit time through the lock. To ensure a safe and comfortable passage, criteria for the longitudinal forces have been set [1]. These criteria often limit the levelling time (and thus the transit time of the navigation lock).

Although physical experiments are an accurate way to determine the longitudinal forces during levelling, it is not efficient to perform these measurements in an early stage of development. Therefore, a calculation method was developed at Delft Hydraulics (now Deltares) to make a fast calculation of the longitudinal forces occurring during levelling, called LOCKFILL [2] [3]. With LOCKFILL several preliminary designs of the filling/emptying system can be assessed without the need of physical model tests in an early design stage or performing CFD calculations.

LOCKFILL is capable of calculating longitudinal forces and levelling time in cases where levelling is achieved through the lock heads, i.e. gate openings in the lock gate and culverts with stilling chamber. LOCKFILL takes the different force components into account; translator waves, decrease in momentum, friction, filling jet effects and density difference effects.

In the mathematical model, the lock chamber is schematised as a rectangular container and the ship as rectangular block. Movements of the ship are not taken into account. Flow rate and water levels are calculated from which the different force components are derived. The filling jet is schematised using a geometric description based on Rajaratnam [4] [5]. Density difference is taken into account, the method is based on the thesis of Vrijburcht [6].

The recent increase in projects involving navigation locks in the Netherlands has lead to the development of a new version of the software. This new version will become available for users (institutes, engineering companies) in 2013.

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SMART RIVERS Conference 2013

- ABSTRACT 94 -

Structural rehabilitation and lengthening of three 50 year old locks in Limburg, the Netherlands

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After the floods of 1993 and 1995, it became clear that the area surrounding the Maas River needed better flood protection. This was the starting point for the “Maaswerken”, a project by Rijkswaterstaat, combining three goals: improved protection against floods, improved value of the Maas and its vicinity for nature and improved navigation along the MaasRiver.

The route was to be made navigable for container vessels and two-barge push-convoys with a length of 190m, width of 11.4m and draft of 3.5m. The existing locks at Born, Maasbracht and Heel were required to be lengthened to meet this need.

Additionally, the chamber walls of these locks had deflected more than expected due to ground pressure to the rear of the walls. Although the locks had been in operation for approximately 50 years and were operating within their structural capacity, it was concluded that the factor of safety on the imposed loads was less than permitted by current design standards. It was thus necessary to also rehabilitate the existing chamber walls.

Lengthening of the Locks:
In order to minimize the extent of the works and the impact on the local surroundings, the locks were lengthened from the upstream side.
This had a significant consequence: as the channel bed on the upstream side is higher than the ground water level, it was necessary to ensure that the channel bed was adequately waterproofed and remain so during the works. This was one of the first and most significant risks encountered during the project.

Modification of the existing upper head:
When lengthening the locks from the upper harbour, the upper head required major modifications as the structural system changed significantly. The dissipation chamber deck, which is located at the upper sill level, needed to be removed and thus the level of the lock floor at this location became the same level as the lower sill.
This had the effect of changing the structural system from a pair of cantilevered walls with an intermediate support (due to the dissipation chamber deck) to a cantilevered wall with no intermediate support, supported only by the lock floor. The adequacy of the existing structure needed to be assessed.

Structural rehabilitation of the existing civil structure:
It was noticed prior to the project that the operational width of the locks had reduced due to an inward movement of the concrete walls. An extensive monitoring program was therefore undertaken between September 2004 and May 2005.

Based on these measurements and a review of the original design calculations, it was concluded that cyclic movements of the walls had caused the soil behind the walls to densify, which in turn resulted in increased soil pressures and deflections and thus a reduced residual wall capacity.

The contract required that the existing chamber walls were to be rehabilitated in order to possess sufficient capacity to satisfy the requirements of modern codes of practice. The densification of the soil was to be included in the calculation of the walls' capacity.

Solution:
The BESIX-MOURIK joint venture proposed a solution in which the ground behind the chamber walls would be excavated to reduce the ground pressure. The lock platform level was maintained through a precast concrete deck over the excavation.

To determine the level of the excavation that maximizes the structural safety of the existing walls, a reverse engineering approach was developed using the concept of "proven safety".

The different design situations that arise due to uncertainty in the assumptions (soil parameters, soil densification, water level in the lock etc.) all had to be combined. This led to a large number of design scenarios that were to be checked and the proven strength was different in every scenario. However, safety was proven in all scenarios.

The increase in soil pressure due to densification needed to be determined to demonstrate safety. The project specification stated that ground pressures were to be calculated in accordance with the advice of Geodelft, based on a German method. The increase in ground pressure was assessed by applying cyclic loading to the structure in a simulation model, the advantage of this approach being that different effects such as excavation, densification of the soil and the effects arising from the presence of an adjacent lock could be investigated in a single model. This resulted in a set of soil pressure coefficients that included all variables in a single set.

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- ABSTRACT 95 -

Numerical modelling of passing ship effects in complex geometries and on shallow water

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The ongoing trend of increasing vessel traffic intensities means that passing ship effects are becoming more important on fairways and in ports. Dedicated passing ship software, often based on linear panel methods, is available to calculate efficiently the effects of passing ships on moored ships. However, those types of models particularly cover basic geometries and deep water, so they do not provide detailed representation of interaction with a non-uniform layout or representation of nonlinear effects caused by shallow water and shoreline slopes.

A recent development by IHE and Deltares is the modelling of passing ship effects using the open source numerical wave and current model XBeach. Such a model allows calculation of passing ship effects including the influence of arbitrary geometries. Nonlinear shallow-water effects, such as steepening and breaking of ship-induced waves, are also included.

The presentation and paper will describe this recent model development and a first validation of the method based on laboratory data. An in-depth example of a recent practical application will show the benefit of this approach. This case study involves high and steep ship-induced waves that occurred close to the main Rotterdam storm surge barrier (Maeslantkering), which led to a fatality. The XBeach model results provided the information required to identify the cause of the high and steep ship waves, which proved to be a combination of the local complex geometry, the influence of shallow areas, and the interaction of the ship-induced waves with the shoreline. In addition, a numerical analysis of possible layout changes provided input for the Dutch Ministry of Public Works (Rijkswaterstaat) to evaluate possible mitigating measures. In this way these models and studies can contribute to the safety and maintenance of ports and waterways by providing the technical basis for rules and regulations (e.g. maximum sailing speeds) and by providing information on local hydraulic load conditions (e.g. wave loads).

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- ABSTRACT 96 -

The Dutch Waterway Guidelines 2011 – content and recent developments

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The Dutch Waterway Guidelines 2011 (DWG) evolved over the last decades both from practical nautical knowledge and scientific research. They provide guidelines for design of CEMT classes I to V and recreational waterways from a shipping traffic point of view. The DWG treat waterway sections, locks, bridges and inland ports, but are limited to waterways without currents or with a longitudinal current up to 0.5 m/s.

The DWG are obligatory for Rijkswaterstaat and are (inter)national leading in case of waterway design. The DWG are available in both the English and Dutch language.

The use of the DWG in waterway design is treated by means of a flow chart. After a short introduction on the history, status and use the DWG, we will describe in separate sections the different building blocks of the design process. Chapter 2 goes into the phenomenon reference vessel or design standard vessel. Besides commercial vessels like motor cargo vessels, push tows and convoys, leisure crafts and seagoing vessels are treated. In chapter 3 waterway sections are reflected. Depending on the intensity of the shipping traffic, a specific waterway profile is needed; distinguished profiles are normal, narrow and single lane. Also, hydraulic parameters and hindrance of wind is reflected. Furthermore, dimensions are given for straight sections and curves. Chapter 4 goes into locks. After a reflection on the required capacity, dimensions of locks for commercial vessels, leisure crafts and mixed traffic are treated. Also, lock approaches (harbours), consisting elements (funnel, waiting area) and lighting of the complex are reflected.
In chapter 5, bridges are treated, both fixed and movable, distinguished for commercial vessels and leisure crafts. Important aspects include headroom and navigation width. Furthermore, bridges over locks, waiting area, guiding fenders, lighting and radar disruption are treated.

Chapter 6 treats inland harboursthat are categorised in longitudinal quays, lock approaches, docks, overnight stay harbours and harbours for leisure crafts. Dimensions of harbours and berthing places are given, and the way to determine the requested capacity of overnight stay harbours. Chapter 7 deals with principles and methods of operation of locks and bridges. In chapter 8, maintenance including hindrance aspects is treated.

The current version of the DWG is restricted to CEMT class V waterways. Furthermore, enhanced by innovations, new legislation, decrease of budgets for construction and experiences of users, the DWG are evolving. Two recent developments are discussed:

- In 2012, research was carried out for extension of the DWG to class VI. The study consisted of an extrapolation of the existing DWG (that are limited to an intensity of 30.000), followed by simulations to establish the width needed for the waterway. At the end of 2013 the results of the study are expected to be integrated in the DWG.

- Regarding lock approaches, several developments are taking place. At the moment design is being carried out of a third Beatrix lock and its approach harbour, which on the riverside has a variation of the water level over 1.0m. Different from the DWG that recommend floating fenders for waiting- and lay-by area in this situation, the designers are planning mooring dolphins. In addition, a study is being executed to establish if a connection between funnel and waiting area (as prescribed by the DWG) is still necessary.

The paper will give in the first part a brief overview of the contents and use of the present version of the DWG. The second part will focus on the recent developments that will likely be incorporated in the future versions of the DWG.

Integrative Waterway Management on the River Danube

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Modern waterway management is a recurrent task consisting of three main system elements: monitoring the current status of the waterway (surveying of the riverbed, bathymetry, water level gauges etc.), planning and executing interventions within the fairway (dredging works, readjustment of the fairway etc.) and providing information to the users of the waterway (signalling, shallow section information, electronic navigational charts, notices to skippers etc.). These recurrent tasks constitute the elements of a "waterway maintenance cycle" for which performance indicators may be defined in order to track the quality of the level of service provided by waterway administrations in maintaining waterway infrastructure.

The Danube is a European waterway of international importance and it is navigable for international cargo vessels at a length of 2,414 kilometres. The overriding aim with regard to the maintenance and optimisation of waterway infrastructure on the Danube and its navigable tributaries is the establishment and year-round provision of internationally harmonised fairway parameters. As waterway management lies in the national competence of the individual Danube countries, this framework has entailed differences in national procedures regarding waterway infrastructure maintenance and the budgets, equipment and human resources involved.
Users of the waterway, i.e. shippers, navigation companies, freight forwarders etc., are in need of one continuous transport route irrespective of national peculiarities, which means that differences in levels of service in national waterway management should be levelled out as far as possible along the Danube and its navigable tributaries.

Political backing for the efforts in harmonising the quality of waterway maintenance and management was provided in June 2012 by the "Declaration on effective waterway infrastructure maintenance on the Danube and its navigable tributaries" signed by most of the Transport Ministers of the Danube countries. The declaration came about in the framework of the EU Strategy for the Danube Region (EUSDR) which has the establishment of effective waterway infrastructure management in the Danube region by 2015 as a target in Priority Area 1a on inland waterways.

Among the central work packages of the Network of Danube Waterway Administrations – data and user orientation (NEWADA duo) project is "integrated waterway management" which will focus on the "waterway maintenance cycle" described above. Waterway management related performance indicators will be elaborated by the managing directors of all Danube waterway administrations which are involved as partners in the project. This will enable the comparison, monitoring and enhancement of the quality of service of waterway infrastructure maintenance over the entire course of the Danube waterway. One of the topical developments of this project is the implementation of an ICT-based waterway management system which will support and facilitate the decision-making process in modern waterway management by taking into account all relevant processes and available data. In addition, the system will be able to include, store, and compare historical data for all processes related to waterway management (e.g. riverbed bathymetry, dredging, water level gauges, costs and quantities of maintenance works).

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- ABSTRACT 98 -

Lock generated waves in the Seine-Scheldt-East network

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The priority project n° 30 of the TransEuropean Network of Transport is the development of a large fluvial network connecting the Seine and the Scheldt River basin. Within this global project, Wallonia intends to modernise to class ECMT Va (2000 t) its main waterways still limited to class IV (1350 t). In this framework, known as the Seine-Scheldt East project, 4 new locks of class Va will be built in the Canal du Centre at Obourg and in the Canal Charleroi-Brussels at Marchienne-au-Pont, Gosselies and Viesville.

Besides the hydraulic and nautical design of these works, lock generated waves have to be investigated in detail. When emptying a lock chamber, water is released into the downstream reach. Similarly, when filling a lock chamber, water is withdrawn from the upstream reach. These phenomena create a positive or negative surge in the corresponding reach and may hinder the waterway navigation, namely by raising the vessels close to the bridge decks (reduced clearance) or by lowering too much the water level over sills. The upgraded locks may generate enlarged wave amplitudes, depending on the filling / emptying hydrograms. As regards the Seine-Scheldt East project, these waves may present significant amplitudes, as the canal cross-sections are quite narrow. As some reaches are short, wave reflection and super-imposition resulting from multiple lock cycles will furthermore increase amplitudes.

The super-imposed waves are analysed carefully thanks to a 1D numerical model for transient flows. This model, developed at the Hydraulics Research Laboratory in Châtelet and already tested against the fourth Lanaye lock case, is based on the Saint-Venant equations linking the water levels and the velocities. The solution is given by a characteristic method applied on a fixed grid representing the channel network. It depends on the geometry and silting of the reaches, the Manning friction parameters and the local head losses. The initial water level and several external boundary conditions, e.g., sluice gate opening or solid walls, can be prescribed. To reduce the 2D network to a 1D problem, internal boundary conditions are introduced to represent the geometrical discontinuities (area modifications, junctions of channels, local obstacles, …). The stability of the explicit numerical scheme is ensured by a Courant condition.

The model is first calibrated against the existing Class IV locks thanks to field data. Two measurement campaigns were implemented: (1) in November 2009 in the Havré-Obourg-NimyCanal and (2) in October 2010 in the Charleroi-Brussels Canal. The water level was measured at several locations in the locks and in the reaches by pressure gauges. After a day without navigation, the locks were emptied simultaneously and, some hours later, filled simultaneously.

The measured water level oscillations were thus mainly affected by the lock generated waves in controlled conditions until the beginning of navigation. After the model calibration, the geometry of the new locks of Class Vb is introduced. Several super-impositions of waves are considered according to the natural frequency of the reaches in order to find the worst configuration that induces the maximum discharges. The resulting maximum wave amplitudes are compared with the bridge deck and lock threshold levels. The lock design is then validated.

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- ABSTRACT 101 -

Management of ship waste along the Danube: Approaches, challenges and solutions of a transnational approach

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As the **second** longest river in Europe, the Danube is **one** international waterway, connecting **10** countries on its way to the Black Sea.
There are in fact 10 different social, economic and political systems at work when dealing with inland navigation on this international transport corridor. This uncoordinated approach has affected the manner in which ship borne wastes are dealt with. There is an urgent need to integrate all key features into a cohesive whole in order to allow for a fluent unhindered passage of all flag state vessels on a clean well-kept international waterway.

Problems & Challenges

Solutions have to be found in order to allow vessels on the Danube to dispose of their waste in user-friendly standardized waste collection facilities located throughout the 10 riparian countries, thus avoiding illegal discharges.
Past initiatives have focused on improving the waste collection system at a national level, but since 2009 the focus has been on creating a joint transnational ship waste management system along the Danube(www.wandaproject.eu).
The proposed paper focuses on the key aspects for the further development of this system:
- An international framework for the Danube riparian countries is necessary to achieve uniform and compatible solutions. A common approach is facilitated by the development of an international agreement in the framework of the CO-WANDA project (**CO**nvention for **WA**ste management for inland **N**avigation on the **DA**nube) with a duration of 2 years (2012-2014).
- A network of user-friendly waste reception facilities needs to be developed along the Danube. Several solutions have been identified (e.g. mobile collection vessels, onshore facilities, suction vehicles, etc.) and prioritized depending on costs and time requirements.
***- An international harmonised financing model secures the sustainment of waste collection services*.** Based on the polluter-pays principle, waste prevention as well as indirect payment procedures, several pilot actions have been planned In the CO-WANDA project. These include using electronic vignettes on the Danube, employing RIS-River Information Services as a tool in the collection of ship waste and analyzing the special case of the Maritime Danube Ports.

Conclusions

The development of transnational coordinated solutions for ship waste management is necessary along the Danube, and the riparian countries have joint efforts in finding solutions. A common international agreement builds the basis for providing user-friendly state of the art facilities and for implementing a harmonised financing system.

Strategic Environmental Assessment for institutional decision making: a case-study from the Walloon Region, Belgium

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The constantly growing interest in developing inland waterways as an alternative to road transportation for economic and environmental reasons often leads to institutional programs defining a coherent strategy for a whole territory. These programs are then implemented through local projects, which contribute together to the overall strategic objective.

Although the assessment of the environmental impact of projects at a local level is now rooted in the practices by most countries worldwide, the evaluation of the global impact and potential alternatives of a whole program is yet to be adopted as common practice. Following that need, the European Union requires, through the European Directive 2001/42/EC, also called 'Strategic Environmental Assessment' (SEA) – Directive', that specific public programs undergo an assessment of their effect on the environment prior to their adoption.

Theoretically, the SEA entails the integration of environmental considerations in planning and programming procedures and decisions. It is in fact an "up-stream" process that allows identifying optimal options at an early planning stage when modifications can still be considered and integrated. Moreover, as an iterative process, the SEA allows a progressive amendment of concerned programs. The SEA can as such be considered as a decision support tool to increase the global awareness of all involved parties.

European experience has notably confirmed that the contribution of SEAs has improved the organization and structure of the whole planning practice through 1) transparency and improved communication, 2) global impact and costs control, and 3) improved compliance.

The consultation phase has increased the transparency of planning procedures, which in turn have increased their efficiency by easing the collaboration between involved parties and authorities. SEAs have up front demonstrated the worthlessness of some expensive theoretical mitigation measures that could then be avoided. The SEA contribution has been demonstrated to improve compliance with the requirements of the specific environmental policy concerned.

The SEA conducted in 2011-2012 for the Walloon program called "Seine-Scheldt inland waterways and connections in the Walloon region" in Belgium is a good case study. This program is part of the Seine-Scheldt global project which will provide a large capacity transport axis between the Parisian region, the Seine estuary, Northern France, Belgium and the Netherlands. It will connect a high density of activities, areas and maritime ports.

This Walloon program is defined as the participation of the Walloon region in the development of European inland waterway transport. It identifies the works to be undertaken by the Walloon region on its territory. Three axes are concerned: the Lys River, the Upper Scheldt and the eastern axis of the Seine-Scheldt, also called the "Walloon backbone".

The SEA allowed for the identification of five realistic alternatives to the original program. These alternatives were elaborated and assessed, together with the main program, for all relevant environmental aspects. In order to evaluate the environmental effects related to the implementation of the program or its alternatives, the considered territory has been divided into eight sections. For each section, an impact assessment, considering clearly defined site-specific evaluation criteria, was conducted. It resulted in a matrix that was used as a basis for a multi-criteria analysis providing a tool for decision support.

The SEA therefore (1) proved the need to implement the originally defined program, (2) identified another very valuable alternative, further developing the program through greater economic benefits, (3) identified black points and sensibilities of the program and its territory at an early stage of the procedure, and (4) identified and described the mitigating measures to be taken as a priority.

In the specific context of the Walloon program, the SEA proved to be a major advantage for environmental protection and decision making. Occurring at an early stage of the planning procedure, the SEA allowed the dissemination of its conclusions into the next steps of environmental protection (e.g. EIAs), and promoted support and acceptance by all actors of the territory.

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- ABSTRACT 104 -

Environmental impact of modernizing inland waterways in Urbanized areas: a case-study from the Albert Canal, Antwerp, Belgium

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The continuous growth of the Port and City of Antwerp, along with the increasing traffic to the Netherlands, Brussels and other European cities, has resulted in a heavily congested region. The area east of Antwerp is characterized by a dense network of highways, railways, waterways and industrial sites and dwelling areas. It has been occupied for about two centuries by various industries, many of which are being abandoned or transformed over time into new businesses. Because of its industrial heritage, the area faces a heavy environmental burden with a poor air quality and historical soil and water pollution from accidental spills, uncontrolled dumping and the discharge of untreated waters and chemicals.

The recent Antwerp Master Plan should provide a sustainable solution for the local mobility problems by optimizing the waterway and road infrastructure. A corner stone in this ambitious plan is the widening and deepening works of the Albert Canal. This waterway is the connection between the Scheldt river and the Meuse river, and is as such linking the Ports of Antwerp and Liège. East of Antwerp the capacity of the Albert Canal is compromised by the limited passage width and height of the existing bridges, despite the various improvement works in the previous century.

The main objective of the modernizing works is to make the canal accessible to barge convoys with a capacity of 9.000 tons, for which a vertical clearance of 9,10 m and a depth of 6 m are required. Further, the canal will be widened up to 63 m and berthing places will be constructed to allow for the safe passage of crossing vessels and large barge convoys. The widening and deepening of the canal results in a massive soil displacement of more than 2 million m^3. An important part of this volume of soil is polluted, and needs offsite treatment prior to reuse. Other particular issues related to the industrialized urban environment include, amongst others, the elimination and replacement of bridges and the relocation of roads, pipelines and a high voltage power line pylon.

Changes in the regional territory plans requested the preparation of a Strategic Environmental Assessment (SEA). A number of high level developing scenarios were elaborated and their environmental impact on the adjacent areas were studied and evaluated. The subsequent demand for an exemption of the Environmental Impact Assessment (EIA) was prepared for the scenario having the least impact on the environment. In particular the potential impacts of the construction phase were examined in detail.

Amongst the major impacts were identified the excavation of contaminated soils and sediments during the earthworks and dredging operations, the traffic conditions and overall mobility due to the removal and reconstruction of bridges and roads, the loss of biodiversity in the verges along the canal, the loss of natural and cultural heritage (protected landscapes and monuments) and a

number of health and safety aspects such as the relocation of the high voltage line, noise and dust pollution.

Mitigation and monitoring measures include local mobility plans with mandatory truck routes, the construction of step-out locations for fauna in the canal and a fish passage. The reuse of the excavated soils is to be maximized. In places with soil and groundwater contamination, targeted remediation works may be executed in combination with the civil works at the canal when subject to detailed planning. The vicinity of Antwerp also shows also a major potential for archaeological findings for which a specific action plan for preliminary investigations was prepared.

The SEA and EIA studies for the modernization works at the Albert Canal have clearly demonstrated that environmental and social impacts of infrastructure works in urbanized areas should not be underestimated. Considering the many aspects to be evaluated and the output of the public consultations, these studies may have a serious impact on the overall project time schedule. However, they may reveal a number of opportunities and synergies that will eventually lead to a net benefit for both the environment and the overall life quality in the area.

Cameroon Douala Harbour – Reconstruction works of quay 52 without disturbing day to day operations

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The Port of Douala (operated by the company PAD) lies on the estuary of the Wouri River on the Atlantic coast in the southwest area of Cameroon. The port is linked to the sea by a 50km access channel that is divided into two parts. The inland part (25km) of the channel has a width of 150m and requires constant dredging due to sedimentation.

PAD is responsible for the management, promotion and marketing of the port. The maintenance and refurbishment of port equipment is therefore its responsibility. Besix was selected by PAD for the global reconstruction of quay 52, a berth that accommodates vessels delivering raw material such as gypsum and clinker. The site, operated by the Cameroonian cement manufacturer Cimencam, part of the Lafarge group, is located on the downstream side of the Wouri Bridge, linking the centre of Douala to the Bonabéri neighborhood.

The existing sheet piles at the quay were heavily corroded and there was therefore no guarantee of the structure's stability. Many holes were also present in the front sheet piled wall leading to settlement of the quay. A new quay wall was thus required to guarantee stability while permitting the use of the crane rail that is situated adjacent to the existing capping beam.

One of the project requirements was that construction works had to be undertaken without disturbing the day to day operations of the cement factory and thus no interruption of the berthing and unloading of vessels at the existing quay wall were permitted during construction.

To achieve this, a temporary relocation of the berthing line was the only solution. Due to the limited reach of the unloading equipment on the quay, a maximum relocation distance of 3.4m was permitted. This constraint led to the construction of a totally new quay wall in a confined space of 3.4m.

A movable temporary fendering system was used to guarantee the position of the berthing line, which consisted of the final fenders fixed to a temporary steel structure. Eight of these fender systems were provided along the length of the quay and were moved to allow access to the works and the berthing of vessels. For safety reasons, all works were interrupted during the berthing of vessels.

One of the main challenges of the project was the drilling of anchors in the limited working space between berthed vessels and the existing wall. Drilling equipment was mounted on anexcavatorlocated on the quay wall and thedistance between the equipment and the vessel was locally only a few centimetres. The maximum length of individual anchor elements (drilling tool, temporary casing, manchette tube) was limited to two metres and could thus be placed within the confined working space. This method was time consuming but was the only feasible solution.

The relocation of the berthing line also made the following possible: the driving of steel sheet piles next to the vessel; a safe working area for preparation (formwork, installation of reinforcement) and the pouring of the new capping beam.

The no disturbance constraint, combined with the need to ensure the stability of the existing quay wall during construction, resulted in a project that was unique and significantly more challenging than the construction of a new quay wall.

MEKONG DELTA TRANSPORT INFRASTRUCTURE DEVELOPMENT PROJECT

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The Mekong Delta in Vietnam is renowned for its highly productive land and richness in natural resources. The region produces about 45 percent of Vietnam's agricultural products, while utilizing just 31 percent of the country's agricultural land. More than half of the entire area of the region (2.1 million ha) is under rice cultivation. Known as the country's rice basket, the Mekong Delta produces circa half of the rice consumed in Vietnam and 80 percent of Vietnam's rice exports. The delta produces circa 40 percent of the country's seafood and over 50 percent of Vietnam's seafood exports as well.

The growing population and expanding trade in the delta is putting a lot of strain on the transport and logistics systems in this region. There are 18 million people in the delta who solely rely on just two major routes into Ho Chi Minh City, which are becoming increasingly congested. Currently, the quality of the road and highway networks in the Mekong Delta is very poor. While there is great potential for water transport with 700 km of coastline and 13,000 km of navigable canals, a significant amount of these waterways is in serious degradation. Insufficient availability of proper infrastructure in the Mekong region increasingly hampers the supply chain efficiency in the region and its economic development. The opportunity for improvement lies in the availability of two major transport modes in waterways and roads and the numerous interfaces between them, which make the delta an ideal region for enhancing multimodal transport efficiency.

The Mekong Delta Transport Infrastructure Development Project (MDTIDP), co-funded by the World Bank (US$ 380 million) and Australia (A$48 million), addresses the multi-modal potential of the delta. The project's main aim is to revitalize the inland waterway network and improve the roads, highways and related infrastructure. The project is improving access to markets and services for the rural poor by upgrading 415 kilometers of rural roads, including 118 bridges. The project is also upgrading 58 kilometers of feeder canals by widening waterways, reinforcing river banks and providing navigation aids. This is the first multi-modal transport and logistics project in Vietnam and the complex issues involved in the policy and planning for multi-modal transport and logistics services are new to the government. This project therefore serves to demonstrate how multimodal transport projects can be developed and designed, but also plays a major role in raising awareness of multimodal transport.

The project commenced in 2010 and it is envisaged that it will be completed by 2016. While the Mekong Delta Transport Infrastructure Development Project introduces a new approach to transport planning in Vietnam, it further contributes to the development of the Mekong Delta by building on previously financed investments in national roads, provincial roads, waterways and port facilities. By 2016, the Mekong Delta will benefit from the advanced infrastructure provided by this project. How the Delta will develop in the future remains uncertain. However, it is clear that the Mekong Delta Transport Infrastructure Development Project plays a crucial role in safeguarding the economic development and contributes significantly to the desired poverty reduction in this area.

Accelerating Collaboration on the Ouse Washes

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The Ouse Washes is one of the largest and most complex pieces of flood defence infrastructure in the UK, in places nearly 400 years old. Agreeing a long-term strategy has proved difficult over successive generations due to the diverse interests and enormous challenges faced. A four-month accelerated collaboration programme delivered by Royal Haskoning DHV, Green Ventures and IBM on behalf of the Environment Agency created a visual model of the role and operation of the Ouse Washes and the key challenges facing the system. The Great Ouse river system is critical to the overall wellbeing of the area it supports. The management of the Ouse Washes is often perceived as controversial, as the EA attempts to control the balance of flood and drought with consequential local impact on transport, agriculture and nature conservation. Both stakeholder and public comprehension of the network is poor. A changing climate with more extreme patterns of weather and changing land use are already presenting new challenges. These challenges are set to grow in the future.

The model development involved aligning the thinking and the evidence base from within the Environment Agency with 12 other key stakeholder organisations. The resulting visual model delivered an understandable, engaging and agreed picture of how the river functions and is managed, and built an evidence-based common understanding of the Ouse Washes. The tool communicated the challenges and priorities for achieving sustainable management of the Great Ouse in a powerful and accessible way. The model will be used in future by all stakeholders for much wider engagement locally and regionally. Importantly the model and the visualisation process are providing an agreed platform for a shared strategy development process.

The accelerated collaboration approach was originally developed in partnership with Peterborough City Council, resulting in “the Peterborough Model”. A visualisation model is used as a focal point for both data and decision making. As a single trusted source of base-data, the model is a collaboration tool for professional partners. The process of collaboration and visualisation also creates a platform that is engaging to the communities and the wider public. The sharing and visualisation of base-data provides a common tool for evaluating the present situation and the options for the future. It also provides a visual tool that can be presented to wider stakeholders building a more common understanding of the day-to-day function of a place whilst increasing buy-in for change. An evidence-based visual model brings data to life, making complicated information more engaging, more accessible and easier to understand.

“*The approach using the Peterborough Model is an excellent means to get common understanding of complex places. Our major flood defence infrastructure in the Fens, particularly the Ouse Washes, provides significant protection benefits for people, property, business and farming. This landscape has significant sustainability challenges ahead, requiring key decisions on local strategy and capital investment. Being able to explain the purpose and operation of these assets in a visually engaging way allows a much improved dialogue between stakeholders and the Environment Agency, and enables us to move forward, setting the right course on decisions that will affect communities, the environment and the economy for many years to come.”* Dr Geoff Brighty, EA Anglian Region Central Area Manager

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- ABSTRACT 108 -

Automatic Identification System (AIS) Data Integration and Quality Analysis with Industry Reporting

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Recent advances in technology have allowed for the development of new tools to analyze data and improve the quality of shipping information reported by the navigation industry. One of the tools that has emerged is the U.S. Coast Guard's (USCG) Automatic Identification System (AIS) which tracks the geographic position of commercial vessels that can be combined with the traditional Federal shipping and location reporting requirements with AIS GPS accurate location data. This has tremendously enhanced the Federal knowledge of shipping traffic density and freight flow for budget decision making.

The AIS allows the U.S. Army Corps of Engineers (USACE) to validate the recorded and reported track of vessels. One of the USACE responsibilities for managing waterways infrastructure is to determine where to make capital investments with regard to construction, operations, and maintenance by monitoring the vessel activity and commodity movement on waterways supports decision making relating to this responsibility.

This paper discusses the current process of validating and verifying reported vessel movement data through Vessel Operation Reports (VOR) versus AIS data; identifying decision support data elements such as unreported vessels and characteristics, commodities carried, and user ports and harbors; and the AIS role in the decision support process. The purpose of this paper is to find unreported vessels, with the end result being the cataloguing of previously unrecorded tonnage and vessel movements. These missing tonnage and vessel movements make up a significant percentage of the tons and trips for individual ports. Obtaining complete and accurate data are essential to justify the federal expenditures for navigation project operations, maintenance, rehabilitation and improvement, and for justifying the construction of new navigation project.

Collaborative efforts between the U.S. Coast Guard and maritime shipping owners will be presented indicating improvements to data quality and integrity.

Technical-biological river-bank protection - a contribution to the ecological upgrading of the banks of Federal waterways in Germany – First experiences from a field test along the River Rhine

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The implementation of the European Water Framework Directive into national legislation is steadily raising the significance of ecological aspects in all development and maintenance activities on German Federal waterways. Besides the provision of the safety and ease of navigation, there are now also ecological targets to be attained, such as the improvement of the structural diversity and quality of the watercourses to improve the living conditions of plants and animals in the river itself and along the riverbanks.

Purely technical-engineering bank revetments like rip-rap usually do not support near-natural plant growth, so that at such sites both flora and fauna are characterized by weak species diversity and a high portion of invasive species (neophytes, neozoa). Conversely, technical-biological river-bank stabilization offers possibilities of ecological upgrading and strengthening of the ecological potential.

In a joint research effort, the German Federal Institute of Hydrology (*BfG*) and the German Federal Waterways Engineering and Research Institute (*BAW*) are currently making a field test of technical-biological river-bank protection along a 1-km reach on the River Rhine near the town of Worms. The aim is to gather data and experiences on how different bank-revetment methods using plants or combinations of plants and technical structures can stabilize the banks of navigable waterways under conditions of intensive traffic, heavy hydraulic loads, and wide variations of water levels.

The project includes comprehensive components of technical, vegetational, and faunistic monitoring over a period of five years, for the time being, to study the potential of plants to resist hydraulic stresses and the effective ecological potential of the different construction methods.

The presentation presents first findings regarding the development of vegetation since the establishment of the test reach in late 2011, for instance about the behaviour of willow brush mattresses, reed rolls and fascines.

The observations of fish highlight the importance of promoting certain bank structures, for instance by leaving fallen trees (coarse woody debris) or establishing shallow still-water zones that provide protection against wave impacts. While alien species were found to be dominant in the interstitial system of riprap revetments, native species were observed in large numbers at fascines, wooden debris, and root stocks.

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- ABSTRACT 111 -

Technical-biological Bank Protection on Waterways with High Traffic Frequency – First Experience Gained from a Test Stretch on the River Rhine with Regard to Bank Stability

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Since the EU Water Framework Directive (WFD) came into effect in 2000, ecological aspects have assumed greater importance in the construction, development and maintenance measures along the German federal waterways. In this regard, new concepts for bank protection are required, on the one hand, to prevent erosion and other negative effects resulting from hydraulic load due to navigation, and on the other hand, to take ecological aspects into account. Usually, protection is ensured with engineered revetments such as riprap.

Due to the demands of the WFD and to the importance of nature conservation in general, more environmentally friendly alternatives are necessary. A possibility would be to integrate vegetation into technical protection measures or even use vegetation only. As we have currently only very little experience with “green” bank protection applied on large navigable waterways, we investigate its load-carrying capacity, feasibility of application as well as ecological aspects within the context of a joint research project of the Federal Waterways Engineering and Research Institute (BAW) and the Federal Institute of Hydrology (BfG).

In this context we installed a 1-km-test stretch close to Worms at the River Rhine in 2011. The River Rhine is the main traffic route of the German waterways network with high traffic frequency and an extreme fluctuation of the water level. The aim is to gain more practical experience with these kinds of measures. In detail, nine subsections with different combinations of technical and vegetative components were constructed. Beginning from the original state, for a minimum of the next five years a comprehensive monitoring programme will be carried out and analysed. This paper describes the technical boundary conditions, the construction of the new bank protection measures and the first experience concerning the installation as well as the development of the individual measures during the first growth period of the vegetation with regard to ensuring erosion control and stability of the river bank slope.

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- ABSTRACT 112 -

Building Information Modelling for the Design and Construction of the Lock in Heumen

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The Rijkswaterstaat has commissioned the construction of a second lock, located adjacent to the original lock, on the Maas-Waal Canal in the Dutch town of Heumen [1]. Prior to the construction of the new lock, traffic was restricted to the passage of a single vessel at a time. This new lock permits two-way traffic for ships of the CEMT Vb class. At extreme water levels in the Maas, the lock acts as a dike for the Maas-Waal Canal and navigation on the waterway is limited or no longer possible [2].

The construction of the new lock was a design and build project and it involved many multidisciplinary parties: architectural design was provided by QWA, Delta Pi undertook the RAMS study, Lievense designed the new waterway, Boskalis built the new channel, Egemin was responsible for the mechanical and electrical installations, Mourik (Boorsma) designed and constructed the steel structure. All these parties were co-ordinated by the main contractor, BESIX, who also conducted the concrete and geotechnical studies.

Very strict reliability requirements were imposed on the project and the contractor was required to demonstrate that the lock gate would fail to close in the event of extreme water levels only once in every 10,000 operations. By means of comparison, the probability of failure for the recently constructed Nieuwe Waterweg is once in every 200 operations.

In order to ensure a well organised and efficient design and construction process, two major tools were introduced: Systems Engineering and Building Information Modelling (hereafter referred to as BIM).

Systems Engineering is a method of developing and managing a project in a traceable and demonstrable way by ensuring full compliance to the project requirements across all disciplines. It is also used to ensure that the consequences of each design choice that is made during the project are iteratively fed back into the global design process.

Under BESIX's initiative, the project was co-ordinated by following a BIM workflow. In general terms, BIM is a tool for generating and managing building data from the different project disciplines during the entire project life cycle. Thus, BIM is not software, rather a means of establishing inter-disciplinary rules for creating and sharing information.

In practice BIM often results in a three dimensional visual database containing intelligent parameterised objects. Key factors for efficient BIM are defining who models which objects, the information that should be contained in each object, when the objects should be shared with others and in which format.

For the lock at Heumen, three principal parties developed individual BIM models: BESIX produced a Revit model of the concrete structure, Boorsma produced a Tekla model of the

structural steelwork and Egemin produced an Inventor model of the mechanical and electrical components. By agreeing on a common project location and orientation and by selecting appropriate model exchange formats, the frequent co-ordination sessions were no longer 2D paper based, but 3D model based. The improved visual support and use of 'intelligent' model objects significantly simplified the co-ordination process. Collecting the different models from a web based document management system, the assembly of the different models into the central co-ordination model and the running of a clash detection session took a matter of hours and resulted in a clear report of the current model information, which was immediately usable for co-ordination meetings.

The models were additionally used to directly generate construction drawings. On the basis that model objects were remodelled after each co-ordination session, the different drawings were automatically updated to reflect changes to the model, thus eliminating the possibility of any drawing errors.

The 3D representation of the lock was also an excellent tool for project visualisation and comprehension, e.g. complicated reinforcement details were shared in 3D between the design office and the site.

To conclude, the use of BIM contributed to a more efficient information flow during the design and construction phases of the project. It is worth mentioning that the project was partly funded by the European Union within the framework of the Trans-European Networks. The completion of the project within the contractually specified deadlines was a prerequisite for obtaining this subsidy. The design started in February 2010 and the new lock was inaugurated in mid-December 2012, six weeks ahead of the deadline and within budget.

This successful integration of BIM has opened the path to a more intensive use of BIM models. BESIX is gradually implementing BIM on other projects for co-ordination and construction drawing production and also for the take off of quantities, 4D and 5D planning and model based facilities management.

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- ABSTRACT 114 -

GNSS-Integrity Assessment of an Integrated PNT-Unit in a Signal Degraded Inland Water Environment

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Within the framework of the project “Precise and Integer Localisation and Navigation in Rail and Inland water Traffic” (PiLoNav) an integrated Position, Navigation and Timing (PNT) Unit for inland waterways has been developed and implemented through the combination of Global Navigation Satellite Systems (GNSS) receivers and an inertial measurement unit (IMU), where the IMU is used for short-term stabilization and to assure continuous PNT solution in GNSS signal blockage areas. The aim of this integrated navigation system is to provide precise navigation capability with defined levels of accuracy, integrity and continuity.

Integrity in GNSS stands for the evaluation of the trust that can be placed in the correctness of the information supplied by a navigation system with or without augmentations. This trust can be increased by using only non-faulty GNSS signals for positioning estimation. GNSS integrity monitoring should on one hand perform self-consistency checks on redundant measurements, and on the other hand, trigger timely and valid warnings to users when it must not be used for the intended operation. Therefore, the implementation of a Receiver Autonomous Integrity Monitoring (RAIM) algorithm as a part of the PNT-Unit assures GNSS integrity. RAIM was first introduced in the aviation sector for only using reliable satellites during safety critical landing approaches. The need of RAIM in the maritime sector emerges from the requirements for maritime radio navigation systems as specified by the International Maritime Organization (IMO). Due to the limited manoeuver space on inland waterways, the requirement on positioning accuracy and integrity is very demanding.

This work summarizes the difficulties of a classical snapshot-RAIM algorithm for a non-augmented GPS-based navigation system in operational degraded signal environments. Such environments include inland waterways with bridges, locks and other natural and artificial obstacles that cause GPS signal blockage and multipath. As the RAIM algorithm is based on pseudorange redundancy, the number of visible satellites is crucial for the availability of integrity information. It will be shown that the environment described above often compromises RAIM availability and performance.

The use of three spatially distributed GNSS-antennas and receivers on the ship with known baselines provides the possibility to run multiple checks. First, the consistency of the single point positioning estimation used for RAIM algorithm initialization is checked using the known baseline lengths. Secondly, the availability of three independent RAIM outputs provides a way to self-validate those results. Both checks will be presented in more detail. First results, based on several hours of collected GPS-data during a measurement campaign which took place at the river Moselle in Koblenz in August 2012, are given.

This work is supported by the Federal Ministry of Economics and Technology (BMWi) on the basis of a decision by the German Bundestag under grant no. 19G10015A (keyword: PiLoNav).

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- ABSTRACT 115 -

PannonRIS – State of the art technology to support inland navigation

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The River Information Service in Hungary, the PannonRIS system' is permanently developed and operated in the framework of the co-operation between the **Ministry of National Development**, the **National Transport Authority** and the National Association of Radio Distress-Signalling and Infocommunications (**RSOE**). The PannonRIS website offers support for the Danube navigation 24 hours-a-day under www.pannonris.hu.

Figure 1: PannonRIS website

River Information Services (RIS) means the harmonised information services to support traffic and transport management in inland navigation, including wherever technically feasible, interfaces with other transport modes. RIS does not deal with internal commercial activities between one or more of the involved companies, but are open for interfacing with commercial activities. RIS comprise services such as fairway information, traffic information, traffic management, calamity abatement support, information for transport management, statistics and customs services and waterway charges and port dues.

By realizing the benefits of RIS for the safety of navigation and the environment the Hungarian Government issued an AIS transponder carriage and operation requirement in the year 2011. The EU co-financed IRIS Europe II project has provided the facility to purchase Inland AIS transponders that are kept as state property and used by the fleet operators after successful application.

An overview will be presented on the existing organizational and legal background in the field of RIS in Hungary. As a 'best practice' the transposition of the EU legislation into Hungarian regulation will be highlighted together with the tasks and responsibilities of the governmental and IWT sector commercial stakeholders. The strong practical co-operation between the different bodies has provided a stable background for the smooth introduction of the RIS key services and can form the basis for further improvements.

In the planned presentation it is intended to provide information on the experiences in the operation of RIS in Hungary, current developments and proposals for upgrading the PannonRIS system to provide enhanced services for the stakeholders.

River information services together with waterway maintenance and fairway signalling activities can ensure safe environment for inland navigation on the Hungarian section of the Danube. The presentation will include information on the co-operation between the commercial and governmental stakeholders in the field of RIS introducing the efforts to gain mutual benefits.

The European Union's Strategy for the Danube Region in its Priority Area 1a — To improve mobility and intermodality: inland waterways, also puts special emphasis on RIS formulated as "Implement harmonised River Information Services (RIS) on the Danube and its navigable tributaries and ensure the international exchange of RIS data preferably by 2015". In this regard Hungary plays a significant role in reaching this target by means of the participation of several organizations in different projects developing RIS or even using existing RIS services from different perspectives.

The foreseen presentation will include the introduction of the activities in Hungary in selected relevant initiatives, such as IRIS Europe 3 (TEN-T project), RIS-related topics in a project aiming to develop Danube ports (DaHar), and also the potential utilization of RIS services to support ship waste management along the Danube river.

Figure 2: Information flow between the PannonRIS Centre and governmental bodies

The Hungarian PannonRIS system is a European-level good practice project, representing the commitment of the transport ministry, responsible for waterway transport, and also fairly exemplifying the co-operation between the government bodies and the members of the related industry. All these are integral parts of the success stories, as the provision of safety infrastructure is identified as the basis of the realization of the current transport policies. The delivery of the Hungarian transport policy will result in a transport system which, while taking into account domestic and regional particularities, will represent European qualities with safety-oriented attitude. Safe transport is our common cause in Europe.

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- ABSTRACT 118 -

Shiphandling simulators for inland navigation: a tool that offers new perspectives

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Simulators have been in frequent use for some years in the fields of air and maritime transport, but their use in inland navigation is relatively recent. Firstly, the market for these expensive tools is very limited, and secondly, their design is extremely complex as they require both highly detailed topographical models and more advanced hydraulic models than for maritime use (less influence exerted by bottom and shore).However, using ship handling simulators could lead to changes in examination practices and modernise jobs in inland navigation. In this way, using simulators would help combat the shortage of personnel.

Currently, obtaining the Rhine boat master's certificate (the "grande patente du Rhin") depends on both passing a theory examination (oral and/or written) and having at least four years' practical experience of navigation on the Rhine. Handling simulators would, for example, make it possible to introduce a practical examination for checking the candidate's aptitude for working as a skipper. This would ensure a good level of competence and improve the safety of navigation. Similarly, passing a handling test on a simulator would make it possible to reduce the navigation time required before being able to take the examination. This would facilitate access to work as a skipper without reducing the level of qualification.

Using handling simulators would also allow the intensifying of both initial and continuous training, for example by making it possible to put learners in situations that were both specific (high water level, heavy traffic at the entrance to a port, etc) and varied (practise in handling several types of vessel). Crew members could therefore be trained to deal with unusual and complex situations in a shorter space of time than by acquiring practical experience on board a vessel. Simulators also increase the polyvalence of skippers, who are thus able to work on several types of vessel; this offers large companies an assurance of flexibility, particularly in the light of the development of certain market segments, such as container transport, for example.

Simulators also facilitate access to the profession for people changing carriers. They make it possible to construct compact routes for acquiring solely those skills which are lacking, for example for people who already have some experience in navigation. In this case also, qualified, operational crew members would be available more quickly.

In conclusion, although the possibilities offered by handling simulators are known and proven, their use in the field of inland navigation remains to be developed. Use of this tool could also serve as a catalyst for modernising training and examination. Thus it ought to facilitate access to the profession, increase the level of qualification and competence of skippers, and give them new career prospects. This is particularly important as the sector is currently suffering from a structural shortage of qualified personnel.

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- ABSTRACT 119 -

LNG in inland navigation – a paradigm shift

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LNG (liquefied natural gas) will play an important role in the future energy mix of many countries. Therefore, LNG may become a valuable type of cargo rather than just a niche product for inland water transport. Developing a supply chain for LNG that includes IWT presents a number of serious challenges. But those challenges can be overcome.

LNG also opens up important prospects for inland navigation when used as fuel:
- Introduction of an alternative to diesel oil, at a time when supplies of diesel oil dwindle and it becomes more expensive to buy;
- Significant reduction in emissions of greenhouse gases from vessel operation, and particularly in emissions of pollutants;
- Reduction in fuel costs, compensating for, or even in many cases exceeding, the additional cost of investment.

Thus, the introduction of LNG as a fuel for inland navigation may constitute a change comparable to switching from steam to diesel engines.

The technology and knowledge necessary for using LNG in inland navigation are available, but need to be adapted appropriately. This means that the transmission of knowledge is important so that all parties concerned and also the general public can be informed sufficiently and appropriately on all important aspects, including the ecological benefits of LNG and safety measures for its handling.

Companies need to have regulations established and binding standards laid down. These could be drawn up in a short period of time, as they can be based on a large number of guidelines already published.

Because the LNG chain is international, coordination mechanisms for its development must be international as well. The already existing mechanisms at the national level are necessary, but not sufficient.

The Central Commission for the Navigation of the Rhine (CCNR) is actively supporting the introduction of LNG in inland navigation.

- As the current technical requirements for inland navigation vessels in Europe do not allow the use of LNG as fuel for safety reasons, the CCNR has issued exemptions for four vessels. The first, MTV Argonon, has already been sailing for more than a year. Further exemptions are foreseen. In parallel and based on the experiences with those exemptions, the CCNR is also in the process of drawing up regulations which would make LNG a “normal” fuel for inland navigation.
- Regulations are needed for the bunkering as well as for the loading and unloading of vessels. The CCNR has already issued regulations and guidelines for the handling of other fuels and is therefore well placed to extend those to LNG.

- The CCNR serves also as the platform for the exchange of information with a view of a coordinated development of navigation on the Rhine.

It seems reasonable to conclude that the introduction of LNG as a fuel and as an item of cargo could provide a boost for the navigation industry. Besides international coordination, public support is required in order to reach the critical mass of LNG powered vessels needed for justifying the considerable investments in the bunkering infrastructure as well as the different elements of a LNG supply chain. However, most important will be a sound and comprehensive regulatory framework ensuring a high level of safety and providing a secure basis for the necessary investments.

RUHRCARGO: Proposition for a cost-effective container shuttle on a short-distance link

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RUHRCARGO proposes to connect the container terminals of Duisburg to the port of Dortmund, using an innovative inland waterway ship concept to ensure performance and cost efficiency.

A small fleet of two push boats and a handful of compact barges will be able to transport at least 10.000 TEU per year in a continuous 24/24h service.

RUHRCARGO has developed and tested interesting technical solutions in response to these challenges and offers a novel organisation scheme for the container shuttle service.

The solutions developed by RUHRCARGO can be most important to disencumber the heavily loaded road infrastructure of the Ruhr region and to reduce traffic-induced emissions, namely CO_2.

SMART RIVERS Conference 2013

- ABSTRACT 121 -

Determination of ship impact loads for new and existing bridges

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Ship bridge collisions in German river traffic are very rare events and consequences for the hit bridges are limited to only minor damage such as local damage to bridge piers or superstructures so far. Nevertheless collisions of ships with bridges crossing navigable waterways can reduce the load bearing capacity of bridges and become a threat to the bridge users.

For new bridges, ship collision impact forces as design loads are given by EN 1991-1-7 (2006), Accidental Actions, and the German National Annex DIN EN 1991-1-7/NA (2010-12). These actions are generally based on a certain structural reliability of 0,01 for the bridge element given throughout the design lifetime of 100 years. The background of these accidental actions is the combination of the probability of the impact load, and the probability of a ship bridge collision which results in a ship impact distribution function where the collision design load is referred to as an exceedance probability of 10^{-4} per year, [1]. Analysing a lot of typical waterways dynamic loads had been derived and assigned to waterway classes. For both inland navigation as well as for seagoing navigation, load indentation functions have been updated for the definition of the physical dynamic loads.

The verification of older existing bridges with impact actions using the codes for new structures often fails because of the increase of the load itself and because of some technical deficiencies of the existing structure. Whereas the treatment of new bridges, according to ship collision, represents a certain prognostic approach, the evaluation of existing bridges crossing navigable waterways enables the consideration of experiences with the bridge waterway interaction. Based on the semi-probabilistic design procedure of the EUROCODES which is a reliability-based design procedure a method has been derived to determine ship collision forces as a time-dependent action for the remaining lifetime of an existing bridge. This method, called remaining life expectancy concept, considers the principles of the common maintenance strategies and allows the safe and economic verification of existing bridges considering their past lifetime. The overall reliability is maintained for the remaining lifetime in which the risk has to be covered. Data gathered from observations has been included so as to update the relevant input data for deriving ship collision loads. As a result the dynamic collision loads for frontal and lateral impact are determined with a time dependent lower value. For a typical situation, and as an example, the force for frontal impact and a remaining lifetime of 50 years will be 90 % of the initial value, this for lateral impact 50 %; for the remaining 25 years the values become 85 % for frontal impact and 40 % for lateral impact. By this method the required or socially adequate factor of safety can be ensured for existing bridges when considering ship impact, [2].

[1] KUNZ C.:DIN 1055, Teil 9 und probabilistische Verfahren. In: Der Prüfingenieur, Heft 10, 2006, Berlin, p. 53 – 63.

[2] KUNZ, C.: Bewertung bestehender Brücken hinsichtlich Schiffsanprall. In: Bautechnik 90 (2013), Heft 5. Verlag W. Ernst & Sohn, Berlin.

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- ABSTRACT 122 -

Adaptation of inland waterways to extreme weather events and climate change

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Climate change is neither a new or discontinuous phenomenon, which is expected to change from one day to another one. Extreme weather events have been occurring in the past and today, and the European transport sector has taken and is taking efforts in order to cope with such events to a greater or lesser extent. In the light of a projected accelerated change of the climate it is often assumed that extreme weather events are going to increase in severity and frequency. Similarly to other modes of transport, inland waterway transport has to deal with weather events, affecting navigation conditions and the infrastructure on inland waterways. Most significant extreme weather events result from high precipitation, droughts as well as temperatures below zero Celsius degrees. Heavy rainfall, in particular in association with snow melt, may lead to floods resulting in suspension of navigation and causing damage to the inland waterway infrastructure as well as the property and health of human beings living in areas exposed to flooding. Long periods of drought may lead to reduced discharge and low water levels limiting the cargo carrying capacity of vessels and increasing the specific costs of transportation. Nevertheless, it has to be noted that climate change impacts may have also have positive effects e.g. reduced ice occurrence on certain inland waterways, and the uncertainties of results such conclusions are based on, are still very high due to the complexity of the problem. While many studies focus on mitigation of greenhouse gases in transport, research on the vulnerability of and adaptation to climate driven effects, namely extreme weather events, is still rarel.

Considering the European transportation system, three projects have been carried out and one project has been launched recently, funded by the Seventh Framework Programme of the European Union (EU). The concluded WEATHER and EWENT projects cover several modes of transport. Inland waterway transport is considered mainly by means of literature survey due to the lack of information related to projected changes in hydrology. No hydrological models have been used directly in these two projects in order to evaluate climate change impacts on the navigation conditions and inland waterway transport. Complementing WEATHER and EWENT, the ECCONET project is focussed on climate change impacts on inland waterway transport only, although effects on modal share including road and rail are investigated in addition. The MOWE-IT project, a follow-up of EWENT, started in October 2012, dealing amongst others with measures improving the robustness of inland waterway transport with respect to extreme weather events and climate change by identifying existing best practices and developing methodologies to assist transport operators, authorities and transport system users to mitigate the impact of natural disasters and extreme weather phenomena on transport system performance. Full information on the projects including public reports summarising the results obtained can be found at: www.weather-project.eu, http://ewent.vtt.fiand www.ecconet.eu. The link to MOWE-IT is: www.mowe-it.eu.

The four projects are described briefly, followed by descriptions of the projected climate change impacts on navigation conditions, as well as possible infrastructure adaptation measures.

AIS based monitoring of traffic quality Volkerak Navigation Locks

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The Volkerak Navigation Locks, located in the Rhine-Scheldt corridor, are the busiest and largest inland navigation locks in Europe. Forecasts indicate that in the future, this vital location may develop into a capacity bottleneck. Therefore Rijkswaterstaat, the Dutch authority of the main waterway network, wants to closely monitor the evolution of the traffic conditions. Traditionally, Rijkswaterstaat uses data from the IVS90 system for monitoring the quality of the traffic flow through its navigation locks. IVS90 is the Dutch information and monitoring system for shipping, supporting vessel traffic services, navigation lock planning, calamity abatement and statistics collection.

Although up to now IVS90 has always been the best traffic monitoring system available, it was recognized that this system actually does not fully meet the requirements for the monitoring of the traffic quality at the Volkerak Navigation Locks. The information obtained with IVS90 lacks the required level of detail with regard to the time consumed by the different phases of the locking process. Furthermore, previous studies regarding the Volkerak Navigation Locks have shown that the vessel transit times derived from IVS90 data often do not accurately reflect the true quality of the traffic flow through these locks.

These shortcomings are due to a number of limitations of the IVS90 system, as far as the time registration of the locking process is concerned. First of all, the system relies on manual input by the lock operators. There is no physical connection to the technical control systems. This introduces inaccuracies in the time registration, since other – traffic safety or efficiency related – tasks of operators may obviously have higher priority. Furthermore, the scope of the time registration is only limited. The moments in time at which individual vessels enter or leave the lock are not recorded. Also, the start of the delay of an approaching vessel is not accurately measured. The time begins to run from the moment the shipper reports his upcoming arrival to the lock operators when passing the reporting location at a certain distance upstream of the locks. However, the vessel has not yet arrived at the locks at that moment. This means that besides the delay, also a significant ship dependent amount of non-delayed cruising time is included in the transit times. This is undesirable.

Because of the aforementioned limitations, we decided to look for alternative ways of monitoring. Until recently, monitoring by visual observation was basically the only real alternative. This way of monitoring, however, is very labour intensive (and therefore expensive), and also known to be prone to errors. For these reasons, we looked for solutions of a more technical, automated nature. It was identified that an opportunity for such a solution could be found in the rapid rise of the Automatic Identification System (AIS) in inland navigation. The Automatic Identification System is a (D)GPS based automatic tracking system with electronic data exchange between ships and land stations, used for identifying and locating vessels. AIS originates from the maritime sector, but under the influence of subsidy schemes and the introduction of the AIS

obligation in the Port of Antwerp the system has rapidly emerged in the IWT sector in the past few years, with a current penetration rate of more than 90% already.

Vessels with an AIS transponder on board send a digital message with the coordinates of their current geographical position every 10 seconds. Using these position messages, it is possible to deduce with very high accuracy at which time the ship enters or leaves the lock chamber. Furthermore, it can be determined at which time the ship would have arrived at the location of the lock, if it would not have slowed down already after having been informed by the lock operators that it will have to wait some time for its turn. Based on this virtual moment of arrival, the delay of the ship can be measured in a much accurate way.

Of course, the AIS data provides information only regarding the vessels themselves. It does not provide us with data on the operation of the lock, concerning the moments in time at which the lock gates are opened or closed, and those at which the navigation signals are switched from red to green or vice versa. These data can be obtained from the loggings of the technical operating systems of the locks. Currently, we are working on a data processing tool for integrating the AIS and technical logging data, and computing the desired performance indicators. In 2013 the first results will become available.

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- ABSTRACT 127 -

Research of Inland Water Transportation Dynamic Supervision and Information Service System Based on Smartphone and RFID

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Recently, domestic inland water transportation has achieved considerable progress and its unique advantages of large capacity, low occupation of land, low energy consumption and little pollution are a way of promoting its economic and social development. However, due to the wide distribution of channel, complicated and passing ship size, China's inland water transportation is hard to place under acomprehensive dynamic supervision system and cannot provide a high quality information service.

With the use of computer technology and the development of electronic technology, GPS（Global Positioning System）, AIS（Automatic Identification System）and RFID（Radio Frequency Identification） gradually appearing in inland water transportation regulation and service systems, this kind of technology application is to a certain degree delivering a ship dynamic supervision and/or information service. However, GPS technology and AIS technology ship terminal cost is high and it is difficult to achieve the comprehensive promotion in inland water transportation. The price of RFID is relatively cheap, but it has the limitation of only being a one-way data read on a fixed point and the whole precision positioning for the ship cannot be done. If you need the whole process of ship real-time status information recognition in the inland waterway, it will need to rely on a lot of shore-based equipment and it is a high capital investment, also the maintenance and operation cost will correspondingly increase, so to achieve the comprehensive promotion is more difficult.

At present, the rapid development of the communication industry improves the function of intelligent mobile phones, and mobile phone network coverage will become wider. Considering the existing condition that the high cost of technology for shore-based construction and terminals make the promotion hard. This paper will make full use of intelligent mobile phone's positioning function and RFID Identification function and puts forward an intelligent mobile phone system based on RFID, and the inland water management and service technology combined with the mobile communication network. Completely with the help of the existing network operators' mobile communication network, the technology only need to add a RFID tags and install third party software to acheive the comprehensive dynamic supervision of ships, and can provide an abundant information service. This system will considerably decrease the system of inland waterway regulation and the cost of service system construction, and has a strong practical significance for popular use.

- ABSTRACT 130 -

VELI : VNF online cargo reporting service

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VNF is about to offer to skippers an alternative way of cargo reporting. It has been a legal obligation in France since 1899 for all skippers to declare each of their transport as soon as they carry goods, even on behalf of the fairways network operator (VNF since 1991).

Since Inland Waterways Transport (IWT) has been liberalized (end of the freight burses), all skippers and shipping companies using French inland waterways have been using paper forms to declare their cargo and transports to VNF, which is a very heavy way of working, both for them and for VNF staff to collect and enter those forms into the internal IT system. Because of that, many of the yearly average 90,000 declarations are lost, under-declared or entered with mistakes, about the ship's real origin or destination, the way it has followed on the inland waterways or the type or quantity of cargo. This also results from the fact that this cargo reporting is both designed to feed French official statistics about IWT, but also to invoice and collect navigation duties (based upon the cargo quantity carried, the distance made on the network and its offer range).

Within the 1st quarter of 2013, VNF will launch an electronic cargo reporting service called VELI. This will enable skippers to announce to VNF their voyage before it starts, on 24 hours a day basis, as it will use an online connection, after being granted a login and password.

While entering the voyage key information (origin, date of departure, destination and ETA, type of cargo and quantity carried) under his own liability, the skipper will have access to his own account (past and pending navigation duties invoices, his own activity over a certain period of time, etc.) and may update information regarding his company or ship(s).

As navigation duties are mandatory in France, skippers need information about that cost while quoting to shippers or building their own business plan for certain logistics projects. VELI will also provide them with a reliable estimate of navigation duties, based upon the information entered. Besides, it will become compulsory in France for a skipper to provide information about gas emissions. VELI will also make this information available, based upon the data entered relating to the voyage.

VNF will use VELI in connection with the existing information system already in place at locks ("*cahier de l'Eclusier"*) in order to make statistics of the use of inland waterways as reliable as possible. This system is now installed over about 130 locks out of more or less 2000 in France.

Eventually in a 2nd stage, skippers will also be offered the possibility to pay their navigation duties online. This all goes through a reorganization of skills and work process within VNF, as well as a cleaning of barges' databases, as for the time being many more clients are registered than the number of barges really using French inland waterways.

VELI will right from its launch be available in Dutch, English, German and French, and VNF will study the opportunity and feasibility of connecting it to other existing or forthcoming cargo reporting systems elsewhere on the European IWT network. It may also be connected to some other Fairways Information Systems or River Information Services, such as AIS or seaports cargo reporting systems, especially devoted to dangerous goods or containers' tracking systems.

This dramatic change in cargo reporting implies some training on VNF's side as well as on the skippers' side. Skippers willing to go for the online declaration will be offered 3 months phone assistance if required, and VNF staff, whose working time is now mostly devoted to entering skippers' declarations, will also gradually move to some other tasks.

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- ABSTRACT 131 -

Standardization in Navigation Lock Construction, 50 Locks before 2040

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In the past few years, ageing of waterway infrastructure is receiving more and more attention in the Netherlands. A nationwide assessment of the hydraulic structures revealed that the country is at the dawn of a new construction era. Currently 5 major navigation locks are under construction, but the most is yet to come. Up to 2040 an additional 37 navigation locks are expected to reach the end of their technical lifetimes, and according to economic forecasts 15 locks might run into capacity problems in that same time period. End of lifetime prognoses are a rough estimate, and so are economic forecasts. Nevertheless, one can expect a considerable number of navigation locks to be due for renewal or expansion by that time. This notion certainly brings up the question; do we see any opportunities in this?

With such a series of construction works of the same nature in sight, the idea of seizing the benefits of standardization, where possible, emerged at Rijkswaterstaat.A joint study bymarket, knowledge and public partners has been completed. The results showed that the topic of standardization has many facets and is a promising way to proceed. This recommendation has been adopted by Rijkswaterstaat.An in-depth analysis and perspective is currently being undertaken. This approach takes several angles;

1. Maintenance and operation.The responsible authorities for waterway structures are worried about the diversity of assets they have to operate
2. Engineering and transaction cost. Suppliers stressed the importance of standardization as they are eager to invest in product development and dedicated production lines.
3. Economies of scale. Economies of scale can be exploited if a higher degree of standardisation of elements is applied, engineering costs can be reduced and so can transaction costs (bidding process)
4. Predictability of costs and performance.This is particularly an issue for funding agents in need for stable facts and figures for the decision making process.
5. Learning curve.Stable solutions for known problems create a platform to learn and improve. The learning curve in the constructions sector, public and private, is notoriously flat compared to other sectors.

Obviously there are some serious drawbacks as well. Market interference by government can be a disturbance and could restrain competition. Working with standardized solutions for elements could also hamper major steps in innovation. Therefore the project is not focussing on standardization of constructions elements in locks as something favourable per se. The project is focusing on revealing the tradeoffs in standardization versus design freedom in order to enable Rijkswaterstaat to make well informed and transparent decisions for the challenging way ahead for the Dutch waterways.

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- ABSTRACT 132 -

Four-dimensional acoustic imaging and surveying system

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On canals and/or rivers it is important to keep controlling water depth and to keep maintaining bank protections, especially for waterway safety. For example, iron bank protections are damaged by seawater. These cause a condition known as the facility collapse. However, in many cases, the water in a waterway has low transparency. Therefore, it is difficult to find a damaged part in viewing from land. Sighting underwater, on the other hand, using ultrasonic is not influenced by cloudy water, but it is effective. Moreover, it is sighting underwater, i.e., sounding. A four-dimensional acoustic imaging and surveying system with the technology of both was developed. Although this system was not developed as a canal special-purpose machine, it is thought that its use for an above-mentioned use is possible, and it is introduced here.

Here, 4-DWISS is our new application system, which can show underwater acoustic images of three-dimensional real time (four-dimensional) and convert acoustic data into survey data. Also, it can display arbitrarily-rotated three-dimensional images (birds-eye view), and clip a front-view, side-view and top-view.

The system used the frequency beam steering method, which is a way of transmitting and receiving signals. The system has both land and underwater parts. The underwater part, which has mainly transmitters, an acoustic lens and a receiver array, plays some roles in transmitting and receiving of sounds, amplifying received signals, driving the acoustic lens, and so on. The land part, which has computers, displays, function generators and amplifiers, plays some roles in controlling the underwater part, the generating source of underwater part. The acoustic source is an FM pulse whose frequency is between 0.5 and 1.0 MHz. The source beam width is 33 degrees. vertically and 0.5 degrees. horizontally. The reflected sounds from an object go through the acoustic lens, then converge on the 128 receivers arrayed vertically. The receiver channel number identifies height position of received sound.

In tank experiments, the system achieved three-dimensional images whose fields of view are both horizontal and vertical 33 degrees. The display update rate achieved up to 4 frames per second. Additionally, the system measured a height survey along a mound slope, which the accuracy achieved within 5% at 10 meters of range in a tank measurement.

Field experiments were conducted at Tokyo Bay. The underwater part was fixed on the side of a ship with a crane by using an exclusive-use jig. It measures underwater acoustic images in a four-sided pyramid space enclosed, and the land part shows underwater acoustic images like an optical camera. GPS, direction sensor, TSS and pan and title angles monitor were put on the jig and were connected to a PC.

We surveyed a height of mound slope by 4-DWISS and a multi beam SONAR. Comparison results showed that both are almost equal. If the multi beam SONAR results are true, 4-DWISS results are equal to them within 5 %. We conducted viewing experiments. The targets were sacrificial anodes attached on a jacket, which is a bridge leg of a truss structure pier. 4-DWISS obtained underwater acoustic images of the targets. Recorded acoustic data is corrected by synchronously measured position, direction and sway. The jacket was clearly visible, and the truss structures correspond to the blueprint.

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- ABSTRACT 133 -

Japan's Technical Assistance Activities for Inland Waterway in North Africa: The Suez Canal (Egypt) and the Nile River Ports (South Sudan)

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Japan International Cooperation Agency (JICA), as the Japan's executing agency of the Official Development Assistance (ODA) projects, has implemented various projects in the port and maritime shipping field, including inland waterways such as river and canal. In Africa, JICA has recently launched two projects related to inland waterways in North Africa; the Suez Canal in Egypt and the Nile River Ports in South Sudan. The objectives of both projects are to develop capacity of the local government officers on infrastructure management and operation, while their transport environments and development stages are very different.

In this presentation, we will introduce the features of the above technical assistance projects related to inland waterways and discuss problems that they are now faced with.

Firstly, the Suez Canal in the Arab Republic of Egypt. JICA has conducted many technical assistance (T/A) projects together with the Suez Canal Authority (SCA) over the last thirty years, especially in the field of economic analysis and demand forecasting of the canal transit. Recently, new circumstances in the world maritime transport have been emerging, e.g. the expansion of the Panama Canal, development of the North Arctic route and frequent acts of piracy in the Gulf of Aden off Somalia. These matters could have a drastic impact on the global maritime transport structure. SCA has to cope with these issues in the management, marketing and operation of the Suez Canal. Therefore, JICA and SCA agreed to implement the "Project on Enhancement of Competitive Strategy for Suez Canal" on October 2011, in order to adapt SCA to the drastically fluctuating world maritime market.

The project aims at enhancing the capacity development on

i) analysing the trends of maritime economics and shipping,
ii) developing and handling the maritime traffic model taking the drastically fluctuating world maritime market into account,
iii) setting canal tariff options,
iv) planning the future development,
v) providing value-added service options.

In this presentation, the features of the project and the major challenges that JICA and SCA have to collaboratively tackle with will be illustrated.

Secondly, river transport of the White Nile in the Republic of South Sudan. South Sudan is a very new country seceded from the Republic of the Sudan in July 2011. Since it is a landlocked country which has no coastline, river transport through the White Nile is playing a very significant role for South Sudan. JICA has conducted the “Project for Enhancement of Operation and Management Capacity of Inland Waterway in South Sudan” since before its independence, from March 2011. The purpose of the project is to facilitate the inland water transport in South Sudan and to enhance the management and operational capacity of the river ports in South Sudan through technical transfer activities.

In this presentation, the features of the inland water transportation system and river ports along the White Nile in South Sudan, and the challenges and examination of a new river port act which is aiming at establishing modern river port management and operation will be illustrated. In particular, we will figure out that the White Nile should be placed as an international river connecting South Sudan and the Sudan after the independence of South Sudan, because the main route of river transport in this area is connecting Juba, the capital city of South Sudan, and Kosti, a base river port of the Sudan. The new river port act should be legislated from this viewpoint.

Research on the Development and Application of Chang Jiang Electronic Navigational Chart System

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Nowadays, inland waterway transportation has become more and more popular due to its special advantages such as large capacity, high productivity and low fuel consumption. Known as the Golden Waterway, Chang Jiang River has been playing an important role in the overall transportation system. To meet the rapidly increasing need of inland waterway transportation of Chang Jiang River, besides the regular waterway maintenance, new technology should be adopted to make full use of the established navigation environment, among which the inland ENC is the mostly used and developed throughout the world. In order to make full use of the Chang Jiang natural water resource and provide practical navigational functions and applications for shipping users, Changjiang Waterway Bureau developed an Electronic Navigational Chart (ENC) system.

Furthermore, the Changjiang Electronic Navigational Chart (ENC) system is the core and fundamental part of the whole intelligent waterway system. Changjiang Electronic Navigational Chart (ENC) system is based on computer hardware, IT network infrastructure and basic waterway geographic information data, taking the construction of spatial database as a core work, realizing the integrated production, management, service and application of waterway geographic information data.

The ENC system is composed of three parts, including the ENC data production and editing system, the public service platform and the application system.

With database as the core technology, the Chang Jiang ENC production and editing system was developed based on ArcGIS Nautical solution module. Based on a Nautical Information System (NIS), the system harmonizes all kinds of waterway geographic data, such as underwater topography, aids to navigation and soundings, and is able to produce ENC data conforming to Developing standard for digital hydrographic chart of the Changjiang River automatically.

With Service Oriented Architecture (SOA) as the core technology, spatial database as the support and web service portal as the carrier, Chang Jiang ENC public service platform optimizes the information capturing and publishing process, unifies waterway information service, achieves the centralized management of the resources and enhances the efficiency of waterway information service.

Chang Jiang ENC application system serves as the front-end system for all kinds of users, such as civil society, port and shipping enterprises, and shipping administration departments. The system, on the one hand, develops a complete set of terminal equipment (including software and hardware systems) for vessels and provides them with convenient and practical navigation and/or aids to navigation functions; on the other hand, provides flexible and practical

management, monitoring and other functions for related administrative departments, which can effectively enhance the service capacity and management standards of Chang Jiang waterway.

At present, the Chang Jiang ENC system is fully equipped with large-scale production and updating capability, and the annual production capacity of Chang Jiang ENC system has exceeded 800 ENC cells. The promotion and application of Chang Jiang ENCs are ongoing. In the near future, we will revolve around Chang Jiang ENC system, continually improve and extend ENC functions, integrate digital ship maintenance, internet of things technology, modern communication technology, sensor technology and video monitoring technology etc., realize the instrumentation of waterway resources and information as well as the digitalization of waterway management service. In this way, we will provide our customers with highly accurate and on-the-fly navigational information, thus fastening the speed of digital waterway and smart waterway construction.

The present development and prospect on Yangtze waterway resources

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As a natural river with length of 2688 km, the water-depth resource of Yangtze River is rich. According to statistics, the Yangtze River freight volume was 1.66 billion tons in 2011, for seven years, the freight volume of Yangtze River ranks the first in the world. With factor analysis method, four main driving factors to the Yangtze River waterway resources development and utilization were analyzed in this paper, including China's economic and social development strategy; economic and social structure layout along Yangtze River; science and technology trends which support waterway development; the world economic development guidance, etc.：

(1) With enough advantages, such as less pollution, land saver, lower cost, less energy consumption, long distance transportation, large capacity etc, in a certain period the development of the Yangtze River transportation confirms to our country to build a resource-conserving and environment-friendly economic and social development strategy. Meanwhile as an important part of the national traffic backbone network, its development and construction are concerned by the governments at all levels;
(2) Yangtze River flowed through 7 provinces and 2 cities. As the main waterway through the eastern, central and western regions of our country, waterway transport demands strongly;
(3) The emerging technology, such as integration of 3s cloud computing. Things networking and so on, provides a strong technical support for Yangtze River waterway development;
(4) In recent years, low carbon, environmental protection,.. is a main focus in the world. Due to its obvious advantages; the development of Yangtze River waterway gets a new chance.

Although right now Yangtze River waterway stays the fastest development stage in its lifetime, in order to keep the sustainable development of Yangtze River waterway, combined with present research and construction on waterway regulation, electronic navigational chart, digital waterway and intelligent waterway of Yangtze River. The important direction of the future resources development of Yangtze River waterway was provided：

(1) Speeding up the development of ecological improvement technology to improve the natural conditions of Yangtze River waterway;
(2) Researching and developing equipments for waterway state sense and comprehensive service system to improve the comprehensive service ability of Yangtze River waterway;
(3) Integrating of the software and hardware resources belongs to all units in Yangtze River administration of navigational affairs to achieve the sharing of resources and service based on electronic navigational chart of Yangtze River;
(4) Realizing ship standardization to show the role waterway development of the Yangtze River which is constructing for shipping development.

At last, with system theory, three aspects with the development were comprehensively stated, including water resources comprehensive utilization、the cohesion between main stream and branches, the coordination between service innovation and management system etc. This study will provide powerful guidance to the development of Yangtze River waterway-more unimpeded, more efficient, safer, more green development provide, and promote the harmonious development of Yangtze River shipping.

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- ABSTRACT 142 -

The short-and Mid-term Water Level Forecasting Technique of Chang Jiang

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Chang Jiang, the largest inland water system in China; the river basin has abundant resources and the economy is well developed. However, most parts of Chang Jiang are still in their natural state and the navigation subjected to seasonal stoppages. Due to the special geographical condition, Chang Jiang's water level varies from section to section and time to time, which affects the navigational environment. To guarantee the smooth passage for sailing vessels and make the full use of navigable sections, the paper introduces a short- and mid-term water level prediction method of the navigable trunk, to improve the waterborne transportation's ability.

The hydrological forecasting is an analysis method in accordance with the prophase and realistic hydrological, meteorological and other information and with the use of the weather science, mathematical statistics and etc. Different from traditional water level forecasting method, which primarily focuses on the flood control and hydropower stations operation, the study put more emphasis on the dry season and tries to find a way making full use of the established waterway.

The forecast models is mainly focus on the prediction method of water flow about branch streams, dams and tidal reach, and combined with the forecast data and the water level - flow relationship: Firstly, forecast the annual runoff to judge whether it is a flood year or a dry year and then allocate the monthly runoff according to the statistical figures. Secondly, use the feature of the flow propagation to forecast the flow of the main stations. Thirdly, according to the water level-flow relationship, forecast the water level of the main stations and then forecast the main water levels along Chang Jiang by the correlation. Then, forecast the water level along Chang Jiang with the method of the correlation and the multiple-regression model. Finally, combine with the posteriori analysis as well as the actual situation of the weather, measurement stations and waterway to revise the results. Furthermore, according to the different waterway features, Chang Jiang has been divided into three reaches: the upper (mountainous river), the middle (plain tract) and the lower Chang Jiang (tidal reach). With the analysis of the statistics figures of upper, middle and lower Chang Jiang, different forecast models are put forward.

With the forecasting models above, the water level of the model-based forecasting system has been developed to achieve automatic water level forecast and its error analysis, with which the water lever of Chang Jiang in 7 days can be predicted. At the same time, the actual water depth and 7 days forecast depth of Chang Jiang trunk channel go public through the Chang Jiang ENC, which contains the accurate riverbed terrain data. Therefore, according to the forecast information, ships can carry on the reasonable loading and select the safe and economic course. It not only can lower transport costs but also improve channel efficiency, realize the green, environmental protection and efficient development of inland waterway transport.

In addition, aiming at waterway and period that changing frequently, the measuring frequency has been increased, especially for those frequently changing sections; the riverbed data is more real-time. Therefore, the navigable water depth based on water levels and bed measurement data is more reliable. At present, over 100 ships with Chang Jiang ENC, water level and medium-term prediction technology provides scientific basis for ship travel plans and reasonable configuration, ship transportation is more economic and efficient. Economic and social benefits are more significant.

SMART RIVERS Conference 2013

- ABSTRACT 143 –

The influence of the Yangtze Estuary Deepwater Channel Regulation Project on Ecological Environment Change

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The Yangtze River is the important social and economic pillar in China. In recent years, more and more intensified human activities and exploitation of the water resources of the Yangtze River Basinand estuary area, which make the ecological environment of the estuary change dramatically, mainly including hydrologic sediment conditions, river evolution, salt water intrusion, water quality, biological species and estuary wetland, etc. The most prominent changes are process and regulation of the bifurcation of the Southern and Northern Waterway in the Yangtze River estuary. The North branch continued to atrophy, by the aggravation of salt water encroachment, heavy pollution in the Yangtze River estuary and adjacent sea areas, and as a consequence the biological species seriously reduced. Based on a brief analysis of these changes, the authors put forward the concrete opinions and suggestions focused on the management of the Yangtze River estuary and the construction of Yangtze Estuary Deepwater Channel Regulation Project.

The project adopted a plan which combined regulation and dredging, through the regulation structures exploiting the particular advantages of stabilizing the river regime, river diversions, and by retaining sand and reducing back-silting quantities. Also the project increased deep channel depth to 8.5m, 10.0m and 12.5m in three stages respectively. The topography of the North Channel changed because of the construction of the Yangtze Estuary Deepwater Channel Regulation Project, Also the boundary condition of Yangtze estuary, estuarine circulation and water discharge ratio of the two channels varied after the project.

The water depth in the navigational channels was up to 12.5 meters after the Phase Project. There would be a large amount of sediment to be dredged in order to maintain the depth. Many analyses of the observed data in the recent years indicate that the back-silting quantities of the deepwater channel have reached 60 million m^3 which can exact a large economic toll. The construction of Yangtze estuary deepwater channel regulation project promotes the development of the Yangtze River's shipping greatly, and the development of the shipping industry, effectively supports the economic and social development and achieve good economic and social benefits.

The paper points out that the water conservancy project of the main course of the Yangtze River is related to many fields, such as agriculture, aquatic production, industry, shipping, etc. Therefore, it is necessary to optimize the ecological environment of the Yangtze estuary, especially in navigation, the mechanism of the Yangtze estuary circulation during the deepwater channel regulation project, salt water intrusion and in ecological problems.

So firstly, the authors will describe the changes of the ecological environment in the Yangtze estuary, including hydrologic sediment conditions, river evolution, salt water intrusion, water quality, biological species and estuary wetland, etc. Secondly the important strategy is to promote the social and economic development in the Yangtze River delta region, The Yangtze

estuary deepwater channel regulation project changed the hydrodynamic environment highly, such as the topography of North Channel, boundary condition of Yangtze estuary, and water discharge ratio of the two channels varied after the project. The paper will give a mathematical model to simulate the water environment and estuary circulation during the construction of the project. Finally, combined with the international advanced management experience of estuary regulation, this paper will make some suggestions and discussion on the ecological and environment changes and on river management.

SMART RIVERS Conference 2013

- ABSTRACT 144 -

High Resolution Multibeam Survey and Mobile Laser Scanning – Comprehensive Information for Inland Port and Waterways Infrastructure Management and Maintenance

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The use of professional divers is the most common method used in the inspection of underwater structures nowadays. However, comprehensive dive inspections are very time consuming and the results may consist of not much more than drawings, fuzzy photographs or videos, and written text. In many locations poor visibility and particular environmental conditions can substantially restrict the scope of such inspections or even make them impossible.
This paper presents how high resolution multibeam (MBES) survey, mobile laser scanning and supplementary inspections can be used in an effective way to gather comprehensive information of inland ports and waterways infrastructures above and below the water surface. The benefits compared to other commonly used techniques to gather the information will also be outlined.

MULTIBEAM SURVEY
Multibeam survey is commonly used for hydrographic charting. Technical development with these sensors has been rapid. Nowadays it is possible to collect a huge number of high resolution survey points not only from the natural seabed but also from other kinds of underwater objects. This method also allows smaller targets to be located and identified underwater.
Multibeam survey is a most economic and effective way to get an extensive underwater view of port and waterway structures. Using sideways looking multibeam sonar, underwater 3D data can be collected from the bottom right up to the water surface level. This provides new possibilities and opportunities to inspect port structures and other underwater civil engineering targets more comprehensively.

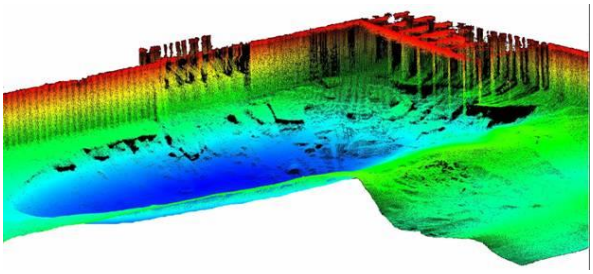

Figure 1: Multibeam survey dataset from Port of Helsinki, basin and quay structures

High resolution multibeam data shows valuable information about possible slope failures, condition of erosion protection in front of quay walls and mass movements due to streams or ships' propeller propulsion. Lost objects such as containers and fenders in addition to possible hazards for safe navigation in the harbour can be located from the data with a high level of

accuracy. The survey results as 3D point clouds are compatible with all modern software for designing, planning and engineering purposes.

MOBILE LASER SCANNING

Laser scanning is a method to collect a 3D point cloud of a certain area of interest in extremely high detail level. When mobile laser scanning is carried out simultaneously with the multibeam survey from a modern hydrographic survey vessel, this makes it a highly cost effective way of working.

Combining a diver's observations and photographs in a paper report is not comparable to what you can achieve by combining mobile laser scanning of coastal infrastructure with multibeam point cloud of underwater structures. All the objects located in the dataset have exact coordinates and are easy to locate for further inspection through a comprehensive view of the area of interest above and below the water surface. This kind of dataset also allows you to document your entire infrastructure for future development needs.

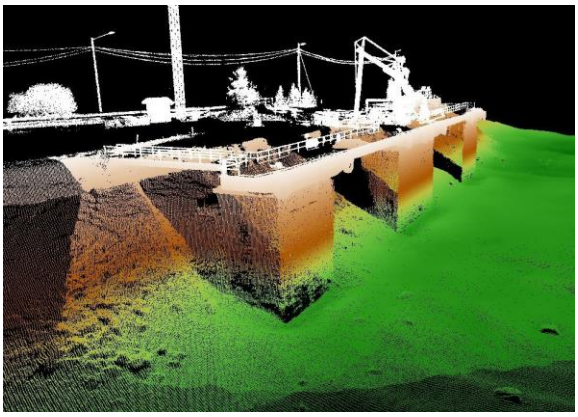

Figure 2: Combined multibeam and laser scanning dataset from Port of Rauma

SUPPLEMENTARY INSPECTIONS

Multibeam and laser scanner data gives good enough information to get an entire picture of your port structures. All the findings can be reported together with images and precise coordinates of the places and targets. This information is an important base to plan local supplementary underwater inspections. Usually these inspections are made by divers. It's possible to use ROV equipment or scanning sonar also for these kinds of inspections.

Supplementary inspections can be limited to the critical areas specified according multibeam dataset. The scanning sonar data is in 3D point cloud format also.

CONCLUSION

Multibeam survey and mobile laser scanning provide a tool to obtain a comprehensive view of a location on a comprehensive scale and to identify potential targets for further inspection. The specific targets can then be inspected more closely for example by professional divers. Alternatively, sonar scanning technology offers the most accurate method to inspect underwater structures without the need to worry about poor visibility or strong currents.

For a professional inspection of port and waterway infrastructures the most effective solution is a combination of multibeam surveying and mobile laser scanning combined with local supplementary inspections. All information in 3D digital format is then usable in modern software for further maintenance planning and engineering purposes. This approach helps to safeguard maritime investments, improve maintenance planning in ports and other waterway infrastructures and supports increased safety of navigation.

SMART RIVERS Conference 2013

- ABSTRACT145 -

Application of Mathematical Modelling in River Bhagirathi and Formulation of River Management Plan

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The Bhagirathi-Hooghly river system commences at the outfall of the feeder canal at Ahiron, a place around 410 km upstream of Kolkata, in the state of West Bengal, India and thereafter traverses downstream for a distance of 630 km before discharging into the sea at Bay of Bengal. The complex river system is non-tidal in its initial part for a distance of 213 km and thereafter falls under the influence of tides. The unique river system in its tidal part encounters semi-diurnal tides resulting in gradually varied flow and critical sediment transport over the governing bars in the shipping channel.

The reach between Ahiron to Swarupganj is known as River Bhagirathi (non tidal part). River Hooghly starts beyond Swarupganj and meets the Bay of Bengal below Sagar Island. The National Waterway-1 (NW-1) of India links India with Bangladesh. The route of the said waterway detours through most of the part of the Bhagirathi-Hooghly river system and thus requires critical examination, monitoring and river management for its maintenance thereby facilitating smooth vessel movement.

The objective of this study is to analyze the one way flow in the Bhagirathi river, a stretch of the river above the Ganga-Bhagirathi-Hooghly inland waterway having length of 213 km, starting from Ahironi.e Feeder canal outfall to Swarupganj (confluence of river Bhagirathi and river Jalangi) and thereby identify the critical stretches in the form of Kalikapur, Plassey, and Natungram, where, often the channel swings from one bank to other and suffers a reduction in depth, thereby requiring either dredging for improvement of depth or implementation of guide vane / deflector for sustenance of flow facilitating the transport of cargo in a hassle free, fuel efficient and environment-friendly mode. Similarly, two stretches where one cutoff has already occurred at the downstream of Plassey (Char-Chakundi-Bishnupur) and that of a situation where a cutoff may occur in near future at the downstream of Baharampur has also been examined by mathematical modelling.

The current study delineates the river behaviour over some critical stretches of the 1620 km long inland waterway between Allahabad(Uttar Pradesh) &Haldia (West Bengal), which in its way is essentially served by Fixed Terminals(FT)as well as Floating Terminals(FLT) at different places.

Mathematical modelling technique is applied over the entire river Bhagirathi for different years under different conditions. The critical stretches, as identified over NW1 for the plying of Inland Water Authority of India's (IWAI) vessels have been critically examined for improvement of depth. Similarly the status of meandering channels from hydraulic consideration has been evaluated from the model result. To contemplate the ossibility, an attempt is made to study the feasibility of laying deflectors in the river banks at Plassey, Natungram&Kalikapur areas and also asses the flow dynamics and the upstream and downstream of the impending cutoff as well as the transitional cutoff by using the MIKE11 Mathematical Model software, developed by DHI, Denmark. Synthesis of satellite data interpretation and model result leads to ascertain the geo-hydro dynamic status and helps to make future River Management Plans (RMP).

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- ABSTRACT 146 -

The Metropolitan Hidroanel of São Paulo

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We use the expression Metropolitan Region of São Paulo, also known as Greater São Paulo, to refer to the continuous urban area formed by the city of São Paulo, the sixth largest city in the world, and over 38 municipalities situated around it.
The region, with 19,956,590 inhabitants, is the fourth largest agglomeration in the world, featuring many typical problems such as pollution, flooding and traffic chaos.
One of the proposals that are being discussed to help improve traffic and pollution in the region is creating a waterway network, approximately 180 km long, linking local rivers and reservoirs, with the construction of dams and channels. This waterway network, for its approximate shape of a circle and similarity to the work of the Beltway (running road works), is being assigned initially as the Metropolitan Hidroanel of São Paulo.
Initial studies conducted by the Waterways Department, subordinate to the Department of Logistics and Transport of the São Paulo Government, indicate that there is great potential for the movement of solid waste, construction debris, sludge from sewage treatment plants, construction materials and deposits caused by erosion areas. Only in the latter segment surveys indicate that the rivers Tietê and Pinheiros receive 500,000 cubic meters of sediment annually.
Early studies indicated that the implementation of a project of this nature and magnitude can not be conceived exclusively for transportation. Other issues related to fighting floods, population relocation, redevelopment, power generation, water supply, tourism and leisure necessarily have to be taken into consideration.
This paper will initially present a history of water resource uses in the region, including proposals and studies for its use in transportation.
It will also present a diagnosis of the current situation and existing difficulties for the implementation of navigation.
Following this there will be a brief presentation of the studies conducted so far, proposals for the Metropolitan Hidroanel, estimated demands and economic outcomes.

From that point three aspects will be discussed:

a) Interference with other issues
   - Fighting floods
   - water supply
   - redevelopment
   - Screening and disposal of solid waste
   - Power generation
b) The start of navigation in the region
   - The first loads to be transported
   - The next stage of deployment
c) further studies

Finally there will be a comparison of the proposals with experiences and situations found elsewhere in the world, especially with the river system in the Paris region.

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- ABSTRACT 147 -

Optimum Design Criteria for Quay walls based on Dynamic Analysis by Considering Water-Structure Interaction

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A Gravity quay wall is made of a caisson or other gravity retaining structure placed on the seabed. They are commonly constructed to prevent landward erosion of shorelines and maintain configuration of the area behind them against wave action. Earthquake waves, acting on the foundation of a quay wall, cause an oscillatory motion of the wall body. The occurrence of a large earthquake near a major city may be a rare event, but its societal and economical impact because of the vital role of the quay walls in protection of the coastal areas, can be so devastating and special attention to design and construction of them is necessary. The earthquake disasters in Los Angeles, USA, in 1994; Kobe, Japan, in 1995; Kocaeli, Turkey, in 1999, are recent examples. In order to mitigate hazards and losses due to earthquakes, seismic design methodologies have been developed and implemented in design practice in many regions.

Present study considers vibration modes and failure criteria of a concrete quay wall during different earthquake excitations. The dynamic response of a quay wall during an earthquake, including water-structure interaction is calculated using a finite element program. A typical concrete quay wall with backfill soil is modelled using a finite element method (FEM), by taking the effects of foundation and sea into account, and several real earthquake records are applied as the base accelerations. According to dynamic equations and applying earthquake motions, the dynamic behaviour of the quay wall is characterized and its failure criteria are investigated. The results demonstrate a great step for the optimum design of quay walls against different loading combinations particularly for earthquake forces.

In this study, the quay wall located in Kobe, Japan, is analyzed for different earthquakes as a case study. The displacements of the crest of the wall are determined using dynamic analysis and compared with the empirical equations. The effects of important parameters such as slenderness on the displacements are also investigated. Investigation of the slenderness of the quay wall (the ratio of the wall height to its width) shows that for a certain range of the slenderness, the stresses and displacements of different locations of the wall for different earthquakes lay within a reasonable range, indicating the optimum stability of the quay wall. As long as the displacements of the crest lay within the elastic limit, by increasing the slenderness of the cross section of the wall, displacements and stresses exceed the allowable limits leading to the instability of the wall; whereas, for higher level earthquakes, while the displacements enter to the plastic limits, the slenderness of the cross section has no significant effect on the stability of the wall.

Finally, based on the numerical results of the dynamic analysis of the quay wall and comparisons with those obtained from the semi-empirical methods, some design curves are presented to be used by designers and researchers for different quay wall design projects. In particular, the empirical horizontal displacements for the crest of the wall are compared with the results of this study which indicate a good agreement.

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- ABSTRACT 148 -

BIVAS, a versatile traffic assignment model for inland navigation

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In the past few years, Rijkswaterstaat has developed a traffic assignment model for inland navigation, called BIVAS. With this model the traffic load on the Dutch inland waterways can be computed for all kinds of user-defined scenarios, relating to aspects like transport volumes, infrastructure availability, cost factors and water conditions. The model offers a wide range of output possibilities. Besides detailed traffic figures (consisting of traffic volumes and compositions on all individual locations in the network), it can also produce travel times on both route and link level, including waiting times at navigation locks. Also, the transport costs associated with the calculated traffic flows can be calculated, as well as the resulting emissions. Because of these comprehensive input and output possibilities, BIVAS can be employed for many different purposes.

Basic principle of the model

BIVAS contains a schematic representation of the whole Dutch waterway network, as well as a dataset with all inland navigation trips over this network in a certain base year. For each trip with given origin, destination, load type, ship type and ship dimensions (including actual depth), BIVAS calculates the most efficient route (in terms of travel time or travel costs), using the Dijkstra shortest path algorithm. Using the method of successive averages, a route choice equilibrium can be computed. If no feasible route is found for a given trip (due to the fluctuating water levels being too low for the given ship depth), the ship will be partially unloaded by BIVAS. In order to compensate for this unloading, additional trips are created, carrying the remaining freight load.

Hindcasts and forecasts

BIVAS is employed for both hindcasting and forecasting. Hindcasts computed with BIVAS are used as a substitute for traffic counts, which are available only for a limited number of locations. Forecasts are computed for explorations of the future usage of the inland waterway network, for example to analyze the possible emergence of new capacity bottlenecks. Except for the prediction of the autonomous developments in inland navigation traffic, BIVAS can also be used for the ex-ante evaluation of policy scenarios or investment decisions (concerning infrastructure realization, or traffic management measures).

Because of the uncertainty associated with forecasts, calculations are performed for different economic scenarios. For each individual economic scenario, BIVAS puts a different set of growth factors on the trips in the input base year database. These growth factors are obtained from a freight transport model. The effects of the increasing ship sizes in inland navigation can be included in the calculations by running the ‘vessel mutation module’ of BIVAS.

Emissions of inland waterway transport
The exhaust emissions of the barges are calculated with a comprehensive model, based on an estimate of the resistance which incorporates an adaptation of the sailing speed to limited fairway width and depth. The future development of emission profiles for each vessel class and the sulphur content of the fuel are specified.

Effects of climate change and water management measures
BIVAS has been applied recently in studies related to the impact of climate change on inland waterway transport, such as “Knowledge for Climate”. Several long term climate scenarios on transportation costs and modal shift have been investigated for the year 2050 and even up to 2100. The outcome of the studies show that transportation costs may increase in periods with low water levels. Depending on the scenario the impact of climate change will be low or result in a temporary modal shift. The results of BIVAS helps to develop a water management policy and the proper measures to prepare the Netherlands on long term climate change.

Applicability not limited to the Netherlands
Although until now the use of BIVAS has been focused on the Netherlands, in fact the model itself is generally applicable. If the required input data (relating to network and traffic) can be constructed, it could also be used for studies in other countries, or for studies in an international context (for example at the European level). Recently a basic European network has been constructed for BIVAS already, in order to improve the results obtained for the Dutch border regions.

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- ABSTRACT 149 -

e-Navigation Geodata Services for Inland Waterways, Ports and their Approaches

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Initiated for maritime shipping by IALA and IMO, e-Navigation has become a major area of activity in the past few years for inland waterway shipping as well. Several test beds in the EU and in North America have been set up to investigate the potential of e-Navigation to enhance safety and efficiency of shipping. While already available to maritime shipping, geodata services for inland waterways other than IENCs are still in an early phase of experimentation and development. The term “geodata” in this context refers to any data on natural environmental conditions relevant to navigation, which may be spot data or area coverage. Inland waterway ECDISes with sufficient IENC coverage are already in use on many rivers in the world. However, as test beds have well established, more up-to-date and in particular high-resolution bathymetry and related applications still belong to the most important and most wanted geodata.

The authors will give more examples of geodata which are relevant to navigation, particularly for route planning and optimisation. However, it does not only count that such services are being provided - it matters how they are implemented and how the data will be presented on an ECDIS system. For example, the simple method of providing data as overlays on the IENC image may not automatically mean more safety or efficiency. In order to avoid overloading and confusing the navigator with too much data, it appears essential to develop and agree basic principles of presenting e-Nav data. One principle should be to keep the conning display free of data layers which are used for voyage planning, and to use a secondary display for planning purposes. Another, related principle is to exercise utmost care in ergonomics both of display and its content, which, also means that related data layers should be processed for integrated information.

The authors will give examples for what this means in practice. The nature of e-Navigation as a means of providing cross-sector and cross-regional harmonisation has far-reaching consequences for inland waterways particularly in the provision of geodata services and on infrastructure requirements; this will be discussed in more detail.

Finally, inland waterway shipping and maritime shipping are intertwined within the transport chain, and there are also hybrid vessels operating both on rivers and coastal seas. Therefore, harmonisation between inland waterway and maritime infrastructure must be achieved as will be shown with examples.

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- ABSTRACT 150 -

Performance Evaluation of Inland Waterways

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Brazil has 40 thousand kilometres of rivers, lakes and ponds potentially navigable in all its territory, of which only 44% is used consistently. Despite the low utilization, in the Brazilian transport matrix, waterways represent an important and significant role and in some cases is determinant for strategic logistical corridors of development and by increasing the country's competiveness. The waterways maintenance program aims to ensure the physical and operational characteristic of inland waterways, by implementing maintenance activities (dredging, signalling, marking, channel clearing and environmental impacts mitigation). However, the maintenance activities are not enough, as they have a shortage of measurement track and deficiency of evaluation mechanisms and performance monitoring. In this research, the objective is propose a mechanism to calculate the Brazilians Waterways Administration performance by considering the maintenance activities carried out by managers and waterway maintenance program keepers. The performance seeks to represent the capacity of the waterway administration in keeping minimal conditions of navigability in its waterways. The proposition uses the Data Envelopment analysis - DEA method, specifically the RCS DEA Classic Model, as known as CCR (Charnes, Cooper and Rhodes, 1978) which considers a constant scale return and assumes proportionality between inputs and outputs. DEA is a method to evaluate the transformation performance of the resources (input) and results (products) by productive units titled Decision Making Unit - DMU's. The DEA methodology consists of a relative efficiency concept, which each DMU is classed as efficient or inefficient by comparison with others. To analyze the selected problem, the CCR model will be used with output orientation, waterways are the DMU's, the input variables are the budget application and the products (output) are navigability and cargo amount flow. As the navigability is expressed by many variables (marking, signalling, others), it used a multivariate statistic method, the Principal Component Analysis – PCS, to arrange those variables, allowing them be represented in a single output and not creating inconsistency on the DEA analysis. The DEA approach is demonstrated by a real study case with 8 (eight) Brazilians Waterways Administrations. The results showed that 50% of the Waterway Administrations has values better than average (1.265) listing them: AHSUL (1.059), AHSFRA (1.011), AHIMOR (1) e AHINOR (1). The Waterway Administrations whose performance were worse than average are: AHIMOC (1.389), AHRANA (1.43), AHIPAR (1.54) e AHITAR (1.694). It is noteworthy the only Waterway Administrations with performance equal to 1 (or 100%) are efficient and are used as benchmark to inefficient Waterway Administrations. Thereby, independently a lack of regular budget transfer to the Waterway Administration AHINOR and AHIMOR, the navigability of their waterways represents performance that matches the investment received and applied, which rank them with maximum efficiency. The performance level achieved by Waterway Administrations was classed and we checked out that 25% as efficient, 25% moderate efficient, 37% bad and 13% really bad. Those results, achieved in the research, serve as an analytic tool to Waterway Administrations, since they allow them to identify deficiencies in each waterway maintenance activities. We conclude that the model can be incorporated as a control instrument for the evaluation and monitoring of the Waterway Maintenance Program.

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- ABSTRACT 152 -

A Mobile Acquisition System for Multipurpose Waterway Management

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The profile of channel beds has been surveyed for a number of years using mobile platforms (i.e. a boat, a positioning system in combination with a multi beam or single beam sensor). However, gathering information on the banks of waterways with high accuracy and precision, used to be the exclusive working domain of inspectors, land surveyors and topographers who conducted their survey on foot with conventional material such as notebooks, total stations and GPS on the river banks themselves. The development of different sensors and measuring equipment recently made it possible to conduct these inspections and precision surveys while navigating along river banks without hindering the waterway traffic. The whole of these techniques is indicated under the common denominator ‘mobile mapping’.

The technique brings along several advantages. First of all, the technique is safer than traditional methods because everything is being filmed and scanned from a boat platform at the normal speed of traffic. Afterwards an operator maps or inspects everything at the office. This reduces the field work to a minimum, meaning there is a substantial reduced risk for accidents at work.. Secondly using mobile mapping means the environment can be inspected or mapped faster and more conscientiously than by traditional methods. At any time, the work of a inspector/cartographer can be monitored based on the recorded source material (geo-referenced images and laser point clouds). Additional surveys, adjustments of existing maps, and the mapping of other objects (such as traffic signs, portals, etc.) can also be executed based on the recorded images and laser scans. While aerial photogrammetry gives a vertical overview of the environment, mobile mapping offers a 360° horizontal overview of the surveyed public domain (e.g. the type of traffic sign can be recognised as well as the text written on it, a view underneath bridges. The images of a mobile mapping survey can be integrated in a viewing application that makes it possible to have an ‘in office’ overview of the field situation which can reduce the number of ‘on site’ visits significantly. Furthermore, a mobile mapping survey can be combined with a multi or single beam campaign on the same vessel at the same time. While the multibeam scans the bottom of the waterway, a laserscanner scans the banks. Combining the data of these two sensors generates a massive pointcloud (a huge set of x,y, z coordinates) of the complete riverbed and banks. This opens the opportunity to get a complete 3D view of the waterway (bottom and banks) which is very useful for generating longitudinal profiles and cross sections.

In the presentation the technique and its applications will be presented by means of several completed real-live projects serving different purposes in one survey, such as mapping of inland ECDIS charts, inspection of river banks, generation of cross section for volume calculations, asset cartography, etc. The presentation will furthermore focus on the advantages and pitfalls of the technique which were researched (achievable accuracy with different positioning systems, visibility of objects and influence of vegetation) as well.

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- ABSTRACT 153 -

Reliable excavation model for smart sanitation

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An innovative method to determine the transition from polluted material to clean substratum has been developed and tested in a large scale sanitation project on the 42 km long River Vecht, The Netherlands. The innovation is the use of high resolution seismics to translate the information from boreholes and chemical analysis into a detailed digital terrain model. A representative detailed model of the transition results in a significant reduction in dredging and deposition costs for polluted materials. During the still ongoing project on the river Vecht, the transition model has been checked by various surveys and tests. First results are presented here.

Present strategies for investigations of polluted water beds are solely based on borehole information and chemical analysis. The Vecht is a natural river in a historically densely populated area. It is characterized by a meandering river course. The river depth and magnitude of sedimentation varied greatly during its history. Consequently, the distribution of the polluted sediments is highly variable. This variation was recognized in the planning phase. Implementation of traditional strategies to create a reliable transition model would require a non realistic amount of boreholes and chemical analysis. This is opposed to the number of boreholes required by following the Dutch normative guidelines for these types of investigations, being only about a minimum of 600 boreholes for the river Vecht.

It was now decided to go for an integrated approach combining various techniques at multiple stages to create the reliable transition model. The project started with two series of high resolution seismic surveys to determine the targeted positions for two borehole campaigns. The transitions obtained from the boreholes were integrated into the digital seismic interpretation system, creating a dtm based on the lateral continuity of bottom layering in the seismic data. This dtm was used to calculate sanitation quantities for the budgetary phase of the project and to define a measurement strategy to optimize the excavation model. To further optimize the lateral resolution of the model, the seismic grid was then densified and combined with an additional borehole campaign. The last step was to tie in the dtm at the river banks to the actual riverbed. The riverbed and -banks were obtained combining multibeam hydrographic survey with land survey.

The accurate definition of the transition has 2 major advantages for the sanitation operation:

- Selective excavation of polluted material results in reduced dredging quantities over all. It also highly reduces the need for (second run) corrective dredging activities as seen in classic projects.
- Reduced dredging quantities result translates into reduction of the use of the limited available deposition volume for these heavy polluted sediments.

The main advantage of the model is the much better description of the lateral variability of the transition layer. A check of calculations in the Vecht project showed that the data density resulted in less model uncertainty, reduced dredging quantities and an increased ‘one pass’ success rate on sanitation. The effort to obtain an improved transition model has already paid back multiple times, considering the costs for dredging and deposition.

SMART RIVERS Conference 2013

- ABSTRACT 154 -

Innovated Design of Jianghan Canal Shiplocks

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The Jianghan Canal is the first artificial one dug in China during the last nearly 100 years, situated in the hinterland of the Jianghan Plain in Hubei province, and 67.22km long in total. It is a new 1000DWT channel connecting the middle reaches of the Yangtze River and the Han River and has active promotion functions for raising shipping efficiency and completing a comprehensive transport system. It has fulfilled the principles of comprehensive use of water resource and sustainable development and is consistent with the requirements of building resource savings and environmentally friendly society and sustainable development. At both ends of the Canal, two shiplocks are built at the Yangtze River and the Han River. In design, the shiplocks have several innovations with consideration of the landform, geological and hydrological conditions of the sites and application features of the shiplocks:

1. Optimizing general layout of the shiplocks and raising throughput of the shiplocks. The general layouts of approach channels of the shiplocks apply the way of curved entrance and straight exit, shortening vessel entrance distance, and raising throughput of the shiplocks.

2. Applying a new delivery system layout to lower the costs of the shiplocks. The locally dispersed delivery system is based on composite gallery double open ditch new energy dissipation technology, applying the energy dissipation principle of dispersed delivery system for concentrated delivery system arrangement, making the water flow similar with dispersed delivery but similar with concentrated delivery in structure, which realizes optimized combination of the advantages of two delivery systems.

3. Applying a sector lock gate at mid-head with flexible operation. Sector lock gate has a small gate opening force, and it can be opened and closed under water pressure and can bear double direction heads, and can also fill water via the gate proper. Sector lock gate normally is applied in low head regions. This project applies it at mid-head with flexible application and convenient maintenance.

4. Applying PHC concrete pipe piles for accelerating construction. PHC concrete pipe piles are applied for lock chamber for the first time in China, accelerating construction and reducing project cost.

SMART RIVERS Conference 2013

- ABSTRACT 155 -

A Case Study on River Navigation System Design with Upstream Control

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Proper design of a river navigation system is based on providing necessary conditions along the reaches of the river concerned such that minimum required flow depth and surface width are satisfied even under worst possible flow conditions. Perennial streams having big discharges throughout a year can be safely utilized for navigational facilities with some adjustments. However, these conditions may not be satisfied naturally for some perennial streams of low discharges. Human intervention is needed, such as river dredging and widening, proper river training and construction of weirs to raise water levels. In rural areas, considering the local conditions, riverbed dredging together with weir construction may be considered as an acceptable solution.

In Turkey, river navigation is not of common use as in USA and Europe. A single urban river navigation system exists in Turkey, where there is not any navigation system mainly because of considerable variation in river discharges throughout a year. This study deals with the design of a rural river navigation system in Turkey. A purpose of the system is recreational; therefore the system will be actively used in the crowded tourism season, during the summer period. However, in summer, very low flows occur in the river. It is inevitable that undesired low flow depths occur in the active season of the system. Therefore, as a starting step, a hydrological study is carried out to determine the low flow design discharge. A frequency analysis is applied to the extreme events of past low flows observed at a nearby stream gauging station on the river, and a conservative design discharge is determined. Minimum flow depth and surface width conditions for the river navigation are specified, considering some candidate boat sizes and their draft depths. Then, hydraulic analyses are carried out to determine the flow depth and width along the river. For this part, MIKE tools from Danish Hydraulic Institute (DHI) are used.

In combination with ArcGIS, Digital Elevation Model (DEM) of the study area and river cross-sections are created in MIKE-GIS. Using MIKE11, 1D river routing calculations are performed and water surface profiles are determined. In the low flow design discharge condition, minimum conditions are not satisfied at most of the cross-sections. Therefore, to increase the flow area, river dredging is applied. To maintain the bank stability, a suitable side slope is specified and a trapezoidal shape is applied to cross-sections. Since the natural riverbed has some adverse slopes in the flow direction, the bed profile is modified to reduce the bed resistance and to maintain smooth hydraulic conditions. To raise the water along the river, gated weirs and locks are to be designed. Miter gates are selected to raise the water level, considering the local conditions of the river.

A series of analyses are carried out and it is decided to design two successive weirs and locks along the river. The locations and gate heights are specified according to allowable upstream/downstream elevation difference in the structure, to satisfy minimum flow depth at every location, and to satisfy a desired minimum water surface elevation at Lake Uluabat. Finally, gate operation rule is defined. While all the gates are closed in the minimum design discharge condition, a gate operation policy is established according to increases in discharge and upstream lake elevation to inhibit sidewise inundation.

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- ABSTRACT 156 –

Design of the loop culvert filling of Ampsin-Neuville Lock, River Meuse

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The waterway axis Rhine/Meuse-Main-Danube crosses Europe transversally from the North Sea at Rotterdam to the Black Sea in Romania. This corridor is one of the longest ones in the Trans-European Transport Network (TEN-T) and crosses both EU countries and non-Member States. In order to increase the transport capacity along this axis, many projects are supported by the Trans-European Transport Network Executive Agency as part of the priority project 18. The increase of the lock capacity of the Meuse River in Belgium to reach class ECMT VIb, allowing the traffic of boats carrying up to 9,000 tons, is one of these projects.

The new lock at Ampsin-Neuville will have a 225m x 25m chamber, with a 4.70m head. This lock will be built between an existing 136m x 16m lock and the weir. As the existing lock is equipped with lateral translation gates, these gates' recesses constrain significantly the location of the new lock. Therefore, a through-the-head filling system has been preferred to the longitudinal culvert system selected for similar locks on the River Meuse. This paper focuses on the design of the upstream head of this new lock, equipped with short culverts and a dissipation chamber.

In order to guide the design of this filling system, a scale model of the lock head has been set up at the Hydraulics Research Laboratory of Walloon waterways administration. The specific aim of this model was to investigate different configurations of the conduit network and of the dissipation chamber in order to limit the hawser forces encountered by vessels in the lock chamber, through a reduction of waves and free-surface slopes in the lock itself, and a sufficient uniformity in flow distribution at the dissipation chamber outlet.

A composite modelling approach has been used in conjunction with this physical model to optimise the design. The key parameter in the design of the dissipation chamber was the placement of energy and momentum dissipation devices. In order to guide this design, and to limit the number of tests in the scale model, 2D numerical simulations of the flow inside the chamber were run in a variety of configurations such as longitudinal walls, square columns in aligned or staggered layout, and round columns in aligned and staggered layouts. The best options were tested in the scale model. Head-losses and velocity distribution at the exit of the dissipation chamber were measured, for different combinations of upstream water level and discharge through the culverts, representative of different stages of the filling process. The measurements were finally compared with the predictions by the numerical models.

The Optimized Design of Hydraulic Synchronous System for Hydro-Floating Ship Lift

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Hydro-floating ship lift is a new type of ship lift proposed by Chinese scientists in the last 10 years. Its working principle is totally different from a traditional ship lift's: by filling/emptying water into/out of shafts through filling and emptying systems, the buoyancy force drives balance-weights in shafts to move up and down which drives the ship's chamber to operate by using connected steel wire rope. Therefore, the appropriate design of a hydraulic synchronous system which can optimize the water flow condition in the shafts and improve the synchronicity of water levels in the shafts is the key technology to keeping safe and stable the operation of the new type ship lift.

At the early stage, the hydraulic synchronous system of hydro-floating ship lift adopted the layout scheme of "equal inertia filling and emptying system and 16 independent shafts". Based on the equal inertia principle, the hydraulic synchronicity of balance weights in shafts is guaranteed theoretically. However, equal inertial hydraulic synchronous has some shortcomings. As shown by physical model tests, each level of branch pipeline cannot distribute flux equally under the condition of unsteady turbulent flow. Furthermore, restricted by ship chamber and tower column structure, the equal inertia filling and emptying system has a constraint layout which influences the uniformity of water flow distribution. Therefore, there is a difference among each independent shaft water level and independent shafts layout further leads to the accumulation of water level difference. Reasons mentioned above result in huge imbalance loads for a mechanical synchronous system. Besides, the layout of vertical branch pipelines for an equal inertia filling and emptying system occupies much space which forces the altitude of the shafts' bottoms to be elevated. Thus, it reduces the initial submerged water depth which goes against the stable operation of balance weights.

Regarding the existing asynchrony of water levels in the shafts, large water level fluctuation and complicated structure problems, the "non-equal inertia filling and emptying system and whole connected shaft" hydraulic synchronous system is proposed for the very first time. Eight independent shafts allocated in each tower column are transformed into "a small lock chamber" which means one-side weights share the same shaft. The filling and emptying system adopts the relatively simple non-equal inertia layout to save vertical space and lower the altitude of the shafts' bottoms. Besides, relying on the Jinghong ship lift on the Lantsang River, the non-equal inertia hydraulic synchronous system is designed. Through mathematical model, the hydrodynamic characteristics of ship lift under the condition of the non-equal inertia hydraulic synchronous system layout are calculated and its advantages are analyzed. Compared with the hydraulic synchronous system based on an equal inertia filling and emptying system, the initial water depth in the shafts can increase by about 10 meters, water flow specific energy in shafts can be reduced by 40% relatively and the water flow condition in the shafts are greatly improved in the new type hydraulic synchronous system proposed in this paper.

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- ABSTRACT 158 -

Research and Practice on Ship Lift Hydrodynamics in China

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This paper gives a comprehensive introduction of the latest achievements and engineering applications in the field of ship Lift hydrodynamics in China.

First, with respect to the hydro-floating ship lift using buoyancy as drive power, the paper expounds the design theory, states its unique operation characteristics and also researches the fluid-solid coupling mechanism of a hydro-lifting system under unsteady flow and solutions to reduce the negative effects on ship lift operation caused by fluid-solid coupling. The main-subsidiary valves control scheme is proposed to resolve the precise docking problem as the ship gets into water.

Secondly, hydraulic problems of ship lift happen when ship chamber dipping in or getting out water in chamber tank and flap gate of ship chamber is opening or closing.

The paper gives the precise calculation formula of vessel squat through multiple physical model tests. The minimal design water depth of the ship chamber and ship's navigation control standards are also proposed. The calculation method of ship mooring force in the ship chamber during the process of flap gate opening and closing is established. In order to resolve the security technical problem in the instance of an extremely dangerous accident using a traditional wire rope hoisting ship lift, measures of safety lock equipment and increasing controllable balance weights are proposed.

For the specific hydraulics problems related to launching type ship lift, computing method of additional hydrodynamic loads during the process of a ship chamber digging in or getting out of water in a chamber tank which is connected to a downstream approach channel is researched and established; the velocity control standard of a ship chamber getting in or out of water is also determined; the velocity limits of a ship chamber getting in or out of water are proposed.

At the end of this paper, the research results of intermediate channel hydraulics in multiple steps ship lift, including the size of the intermediate channel, methods for ships to make way, water level fluctuation characteristics and wave absorption measures, etc. will be summarized.

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- ABSTRACT 160 -

Application of Mathematical Model in Predicting and Optimizing the Hydraulic Characteristics of Navigation Locks

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Filling and emptying system(FES) is the main part of a navigation lock, and the hydraulic characteristics during the levelling courses are the basis for judging the merits or defects of the FES's layout and the rationality of the valves' operation mode. According to the differences in designed vessels, water levels and their combinations, lock chamber dimensions and the geological conditions of the lock site, the type and layout of FES for different navigation locks are quite dissimilar. To guarantee the safety of the vessels passing through the lock and the lock itself, a specific hydraulic physical model test for the FES is often indispensable in the design stage, in which the layout of the FES and the operation mode should be determined. The model test will often prolong the design schedule and increase the design costs. Besides, due to the scale effect between the model and prototype and the construction quality, the prototype hydraulic characteristics will be different from the model to guarantee the safety and efficiency of the lock. The operation mode of the prototype valve should be optimized, and the measures for optimizing are using the similar locks' experiences or redoing model tests. The former measure cannot be easily operated and is not quite accurate, and the latter one will increase the debugging time and costs.

The 1D mathematical model and its computing methods for calculating the hydraulic characteristics are quite mature, but due to the accuracy of the key calculating parameters such as resistant coefficient of the FES and the valve operation mode, the 1D calculation method now is often used in preliminary estimation of the hydraulic characteristics and evaluation of the chosen FES in the feasibility design phase. On the basis of the classic 1D mathematical analysis theory for lock hydraulic characteristics, according to the design and operation experiences from many navigation lock projects home and abroad, the determination methods of the calculating parameters for typical filling and emptying systems have been put forward, and the computational accuracy has also been verified by the model and prototype tests., The results indicate that the 1D mathematical model has many advantages such as easy use, short research period and high accuracy in predicting and optimizing hydraulic characteristics of navigation locks, which can decrease the design lifecycle and cost in lock design, and save the management and maintenance cost.

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- ABSTRACT 161 -

New 225 x 25m lock in Ivoz-Ramet on the Meuse river

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The removal of bottlenecks on the Meuse river in Wallonia, Belgium, is in progress.

This project is a branch of the Trans-European Transport Network on the Rhine/Meuse-Main-Danube axis. This axis crosses Europe transversely and links the North Sea to the Black Sea. The overall European project, including the works on the Meuse river, aims notably – in its northern stretch – at improving the link between the Belgian hinterland and the ports of Rotterdam and Antwerp and is also intended to provide a connection to the "Seine-Nord Europe" canal from the Rhine basin via the Meuse river.

This project involves the construction of a new class Vb - 225 m long and 25 m wide - lock on the Meuse in Belgium in order to meet increasing demand and enable the increase of transport flows.

The project also aims to increase the safety and comfort of users, to improve maintenance devices and to reduce the impacts resulting from the obsolescence of existing structures.

The weir is currently equipped with a medium capacity lock. The waterhead is 4.45 m.

This lock site is the most important in terms of freight transport by inland waterways in Wallonia.

The ongoing and planned investments in the new locks offer significant rates of return from the Walloon perspective, but even more from a European perspective. This project thus received financial support from the EU in the framework of the development of the European inland waterway network.

The new lock is equipped with two longitudinal culverts, an upstream flap gate and a downstream mitre gate.

The construction of this lock began in 2011.

The paper will present two main aspects of the project :

1. Technical specificities of the lock under construction in Ivoz-Ramet in relation to its environmental context and in relation to its operation and maintenance devices.

   The major difficulty of the lock design is its integration in a dense industrial site and close to the existing class Va lock, that has to be kept in service, and a weir. The lock, without expansion joints, is built upon a shale foundation in an enclosure forming an island in the middle of the river. The temporary stabilization works have been optimized. A cell sheet pile guide wall and a prefabricated wall were designed in order to allow navigation during works.

   From an environmental perspective, the design of the lock's guard walls and the special equipment dedicated to fauna - eels pass and fish-friendly Archimedes' screw turbine - are of specific interest.

   To facilitate the operation and maintenance, particular choices were made. For example, the types of doors, the mechanical joints and insulation devices of the lock have been optimized based on actual field experience and on the specific context of this part of the network.

2. The progress of works in Ivoz-Ramet.

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- ABSTRACT 162 -

Research on ship squat calculation method for ships entering and leaving the shiplift chamber

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Shiplift is one of the main types of navigation structures. To reduce the power of a hoisting system, construction costs and difficulty in equipment manufacture, water in the ship chamber is usually very shallow, and the cross-sectional coefficient of the ship chamber is very small. A reasonable water depth in the chamber is required to prevent the ship from grounding the chamber bottom. The ship squat is crucial in determining water depth in the chamber.

In this paper, according to the shiplift projects such as Silin, Three Gorges, Goupitan, Xiangjiaba and others, the impact factors on the ship squat such as navigation direction, velocity, draft and water depth in chamber are systematically researched by different scale models of ship lift chambers and approach channels, using a towing carriage ship model.

The model tests show that under the same conditions, the squat of the vessel leaving the chamber is larger than when it entered the chamber, and the relationship between the maximum squat of vessel and square of the velocity is linear. Tests also show that the ship squat increases with the decrease of the water depth in the chamber and the cross-sectional coefficient of the chamber, but the effect of the chamber water depth and cross-sectional coefficient to ship's squat is less than the velocity, so the chamber water depth should be designed by the vessel's maximum leaving velocity.

Based on the analysis of the main factors impacting the ship squat when ships are entering and leaving the chamber, the dimensionless calculation formula of the ship maximum squat δ（m）by the chamber water depth H（m）, navigation velocity V（m/s）and chamber cross-section coefficient n （$n = F / f$, F represents the cross-section area of the chamber water, f represents ship vertical section area below the water surface ）is put forward: $\frac{\delta}{H} = a \times \frac{V^2}{2gH} \times \left[\left(\frac{n}{n-1} \right)^2 - 1 \right] + b$,

(a and b are coefficients, respectively 2.61, 0.05).

By contrasting calculated results and the model measured data according to several shiplift model tests, the formula can calculate the ship's maximum squat more accurately, and predict the ship squat in the narrow and small water area with one end closed such as that in the shiplift chamber and lock chamber. Therefore, the formula can be a good reference to determine the shiplift chamber water depth and lock chamber initial draft on sill.

Morphological Changes of the Danube River in Serbia

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In 2011, project, fully funded by the EU Delegation to the Republic of Serbia, titled Preparation of Documentation for River Training and Dredging Works on Selected Sectors Along the Danube River started. The goal of the project is the preparation of technical documentation for river training works on the Danube River from the Hungarian border to Belgrade, which would provide fairway conditions for safe navigation as defined by the Danube Commission recommendations. This project is being delivered by the consortium consisting of: Dutch Witteveen+Bos, Danish DHI, and Serbian Energoprojekt. The beneficiary of the project is Plovput, the Serbian Directorate for Inland Waterways.

The project is divided into three phases: Phase 1. Pre-Feasibility Study with General Designs, Phase 2. Feasibility Study with Conceptual Design, and Phase 3. Main Design and Tender Documentation.

The Directorate for Inland Waterways PLOVPUT, as a beneficiary of the Project was intensively involved in the Project from the very beginning. PLOVPUT is performing systematic hydrographic surveys of the Danube River since 1963, and thanks to that has very extensive database on morphological changes.

Systematic hydrographic surveys of the Danube River cross-sections enabled the analysis of morphological changes of the river stretch from the Serbian-Hungarian border to Zemun, over the distance of 260km. This stretch of the Danube River is a free flowing one, characterized by the unstable bed and a number of critical sectors for navigation. The definition of critical sectors, as well as the definition of optimal hydraulic solutions, would provide safe navigation depending, among other things, on the character of morphological changes along the river.

All of the available data was used in order to analyze the dynamic nature of the Danube River. This knowledge was incorporated during the development of 1D and 2D models, and sediment transport simulations. Extensive hydrological and hydrographical databases enabled detailed historical analysis and understanding of basic trends and cycles of morphological changes, serving as valuable tools for the predictions of the future changes and their impact on navigation conditions.

Specific multi-criteria analysis has been developed for the process of evaluation of different design options. Three basic criteria included impact on navigation conditions, impact on the environment, and costs. All options have been carefully evaluated by the project expert team, and also communicated and discussed within the multi-disciplinary Stakeholders' Forum established specifically for this project, in line with the integrated planning approach which is accepted and promoted by Plovput.

Integrated project planning in inland waterway project

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The Directorate for Inland Waterways, Plovput, is the beneficiary of the EU funded project "Preparation of documentation for River Training and Dredging Works on Critical Sectors of the Danube River in Serbia". The goal of the project is the preparation of documentation for works that would enable minimum navigable depth and width of the fairway during the low water periods. Measures which are under consideration include the combination of structural and non-structural interventions. Documentation within this project is being prepared in line with Serbian legislation, as well as in line with the relevant EU and international legislative framework.

The basic approach within the project is to establish conditions which would ensure minimum navigable depth and width of the fairway of the Danube River during the low water periods, while respecting environmental interests. Adopted guidelines for the development of the documentation within this project include: preserving connectivity conditions of the water bodies, preferable application of detached structures, preserving sediment equilibrium, and ensuring mitigation measures.

The Stakeholders' Forum of the project is established in line with the long-term orientation of the Directorate for Inland Waterways Plovput towards the application of the modern concept of integrated inland waterways management. Integrated inland waterways management considers orientation towards harmonization of interests of different stakeholders, respecting national and international legal frameworks, including, among others, the Joint Statement on Guiding Principles on Inland Navigation and Environmental Protection in the Danube River Basin (International Commission for the Protection of the Danube River, Danube Commission, and International Sava River Basin Commission). Basic principles on which this Forum has been established include: voluntary and free of charge membership, mutual acknowledgment and respect of different standpoints of the Forum members, and transparency of work. Those basic principles, together with the rules on organization and work of the Forum, are part of the General rules on organization and work of the Forum.

The Stakeholders' Forum is a multidisciplinary body in which different interests are being represented: navigation, environmental and nature protection, industry, and archaeology. A number of observers (which are all welcomed) is taking part at the Forum meetings, including Delegation of the European Union to the Republic of Serbia, relevant Serbian ministries and other governmental institutions interested in the project, international river commissions, waterway administrations from other Danube countries, as well as NGOs which are not members of the Forum. Having in mind the wider importance of the work of the Forum, all documents are being prepared and distributed in both the Serbian and English languages. All documents from the Forum meetings are available to the general public, at the Plovputs' web site (http://www.plovput.rs/forum-zainteresovanih-strana), ensuring direct insight for all stakeholders of the project and guaranteeing the transparency of the planning process.
Acknowledging and understanding the different interests of different stakeholders is of crucial importance for the implementation of such a complex multidisciplinary project. Reaching a common understanding is possible.

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- ABSTRACT 166 -

Environmental friendly solutions to improve the navigation fairway of the Danube in Serbia

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The Danube between Hungarian Border (km 1,433) and Belgrade (km 1,170) has 24 critical sectors where the navigation fairway has insufficient depth or width. For each of these 24 sectors various environmentally friendly conceptual designs have been developed to comply with the Danube Commission recommendations in order to assure safe and swift navigation on the Danube. The project consists of a Pre-Feasibility Study, Feasibility Study and for 6 sectors the preparation of Detailed Designs and Tender Documentation.

The Danube in the project stretch is a meandering river with straight sections. Many bends have pointbars and significant side channels that cut through the floodplains. At the relatively wide straight sections the flow is divided into multiple flow paths leading to the formation of sand bars and islands which are often dynamic in nature. In both situations this may lead to a navigation fairway which is not wide or deep enough according to the Recommendations of the Danube Commission. The Danube Commission recommends that the navigation fairway in the project stretch should have a minimal width of 180m (200m in bends), 2.5m water depth and a bend radius of at least 1,000m (750m in exceptionally conditions).

The variety of navigation problems in combination with vulnerable wetland areas surrounding the Danube in the project stretch demands sustainable designs that are fit for purpose. Together with the assistance of the beneficiary the options to solve the navigation were developed. Chevrons are proposed as an environmentally friendly structure in the entrance of side channels and at wide river stretches to divert more flow towards the main channel. The chevron structure has been constructed on a number of locations in the Mississippi and Missouri River but is new to the European rivers.

At the start of the project a 1-D hydraulic model (MIKE 11) has been setup to simulate Design Low Navigation Level and to identify critical sectors. Various options were developed and optimised using a 2-D hydrodynamical model (MIKE21C). In addition, an extensive Financial and Economic Analysis was prepared together with a cost benefit analysis to prove the Feasibility of the project. Parallel to the Phase 2 activities the Environmental Impact Assessment has been prepared describing the current status of the river and the possible impact the proposed river training works have on the environment.

The six critical sectors located in Serbia are elaborated into Detailed Designs by using a 2-D morphological model. The Detailed Designs are the basis for the preparation of the Tender Documentation together with the Bill of Quantities and a cost estimate.

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- ABSTRACT 167 -

Widening of the Seine between Bray and Nogent

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While waterway traffic on the wide channel section of the Seine River has experienced strong growth over the past decade, the upstream section, called "Petite Seine" is hampered in its development by the reduced capacity of the infrastructure, limiting the tonnage of ships between the Grande Bosse lock and Nogent-sur-Seine.

Despite this, the Bray-sur-Seine/Nogent-sur-Seine sector appears very dynamic with traffic having tripled over the past ten years. In 2011, more than one million tons were handled in the section. Waterway transport expanded significantly over the period 2006-2011.

VNF launched in 2009, studies on a large-channel waterway connection between Bray and Nogent-sur-Seine. This project is also referred to in the National Scheme of Transport Infrastructure, and VNF has been legally required to bring this project to a public debate in 2011.

The goal of the project is to enhance the channel of the Seine upstream of Paris between Bray and Nogent for class Va vessels (2 500 tons, 110 m long, 11.40 m width). The works include enlargement of the fairway between Bray and Villiers, a new lock in Jaulnes, and a new wide channel canal nearby the BeaulieuCanal.

The project will allow the navigation of 2 500 tons vessels between Nogent and Paris and up to Rouen and Le Havre without cargo transhipment. This project will develop the local economy while increasing the inland waterways transport share. The main expected traffics are construction materials (3 Mt), agricultural products (1.5 Mt), and containers (200 kt).

The project is located in the valley of the Bassée. This valley is one of the 152 most important wetlands in France. This alluvial valley has a dense secondary hydrographic network, composed of many streams, side arms of the Seine and ditches. It hosts a rich and diverse flora and fauna. It is among the few remaining alluvial forests in Europe. Environmental issues of the project are important.

Immediately downstream of this project, a second major project, scheduled by Seine-Grands-Lacs, is also under consideration. It aims to build 10 diked areas for storing 55 million m3 of water pumped from the Seine during floods, and to limit flooding in Paris and Ile-de-France. Cooperation and coordination with this second project are crucial.

Following various feasibility studies (2009-2011) the many challenges of the project (socio-economic, water, environment and cumulative effects) have been integrated and a public debate on the project was held from November 2, 2011 to February 17, 2012. This debate, the first for VNF, was held concurrently with Seine-Grands-Lacs.

Five alternative projects looking a different vessel sizes ranging from 1 000 tons to 4 000 tons, were debated in the different riverside towns :

- scenario 1 : Class Va up to Bray-sur-Seine port (2 500 t–110 m– 130 TEU), class IV (1000 tonnes – 80 m de long – 60 EVP) up to the ports of Nogent-sur-Seine,
- scenario 2 : ClassVa up to Villiers-sur-Seine, class IV up to the ports of Nogent-sur-Seine,
- scenario 3 : ClassVa up to the ports of Nogent-sur-Seine,
- scenario 4 : Class Va+ (3000 t – 135 m – 130 TEU) up to the ports of Nogent-sur-Seine;
- scenario 5 : Class Vb (4000 t – 180 – 190 TEU).

A vast majority has confirmed the choice of scenario 3(2 500 tons up to Nogent).

Following these valuable debates, VNF decided to pursue studies related to the project. A preliminary objective has been set to answer questions raised in the public debate. It should last no longer than one year, and will continue to allow the involvement of local stakeholders before considering the preparatory studies for the public utility.

After a brief description of the project, the presentation will focus on the consultation undertaken throughout the project phases and secondly, on how environment and hydraulic issues have been taken into account in the preparation and conduct of the project.

SMART RIVERS Conference 2013

- ABSTRACT 168 -

Modelling vessel manoeuvring behaviour by optimal control and game theory

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Individual vessel behaviour, vessel interaction, human factors and influences of external conditions are important factors in maritime traffic models. In ports and inland waterways, the geometry of the waterway represents an additional factor. However, most existing vessel simulation models focus on a part of these elements due to the complexity of the maritime traffic system. This paper presents an innovative way to combine all these elements into one new model that is able to simulate vessel behaviour, including vessel speed, course and path, in a given geometry under influence of other vessels and various external conditions, while taking into account the decision making of the bridge team. This way, the new model can be used to describe capacity and safety of the waterway in a balanced manner. The new model reproduces vessel manoeuvring behaviour during encounters by means of game theory, where optimal control algorithms are used to combine the different factors influencing vessel behaviour, such as vessel type and size, fairway geometry, and external factors including wind, current and visibility.

Based on AIS data analysis in the Botlek area in the Port of Rotterdam, it is assumed that the bridge team aims to follow some preferred behaviour, while at the same time reacting on the expected behaviour of other vessels and different external conditions. In the model, vessel behaviour is considered to be a dynamic system, where the bridge team manoeuvres the vessel by accelerating the vessel and changing its direction. For example, the bridge team is assumed to minimize the hinder resulting from the vicinity of other vessels, applying control and straying from the planned speed, course and path. In the model, longitudinal and angular acceleration thus form the control vector for the vessel manoeuvring behaviour, which is used to minimize a so-called navigating cost. The navigating cost describes the effort of the bridge team to counteract the external influences and to follow the preferred behaviour. It consists of several components of manoeuvring costs, which are linearly combined with weight factors. These manoeuvring costs correspond to factors influencing vessel behaviour, such as vessel encounter, external influences and the waterway's geometry.

The new model will be validated for different scenarios, among which are single vessel passing, head-on encounters and overtaking. The simulation model has great potential to describe the individual behaviour of multiple vessels in a large area to assess the safety and capacity of ports and waterways. In future research, more factors influencing vessel behaviour will be included in the model to enhance its accuracy, such as mechanical failures and human error. Furthermore, the model will be tested for different areas, such as ports in other parts of the world and inland waterways.

SMART RIVERS Conference 2013

- ABSTRACT 169 -

The aftermath of river restoration: how to cope with excessive maintenance dredging ?

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In the Netherlands, currently a large number of river intervention works are planned within the Room for the River Program (RfR) and the European Water Framework Directive (WFD). Measures proposed in the RfR scheme are meant to accommodate a larger design flood discharge. It consists of measures to increase the flood conveyance capacity, such as the implementation of secondary channels, lowering groynes and removing obstacles. The main objective of the WFD is improving the ecological value of the river systems. Popular measures in this program are reconnecting side channels and removal of bank defences.

These river intervention works have a strong impact on flow and sediment transport fields, and will induce larger dynamics of the riverbed. This negatively influences the river's navigability. The maintenance costs for navigation, due to a combination of RfR and WFD measures, are expected to rise dramatically as a consequence of the increase in the required dredging works of each individual project. Moreover, the large amount of maintenance dredging to keep the rivers navigable, and the large number of dredging vessels required, will hamper the inland navigation significantly, resulting in large economical impacts and a lower safety of inland navigation.

The lay-out of a river system should be designed in such a way that it keeps itself navigable: so self-supporting. The reduction of dredging amounts can be achieved by structural measures. The goal is to define a self-supporting strategy for the Dutch Rhine branches to improve navigability and to avoid excessive maintenance dredging. The strategy boils down to river regulation works additional to the RfR and WFD measures, to limit the amount of maintenance dredging, and still keep the river navigable, well protected against flooding and attractive with respect to ecology.

SMART RIVERS Conference 2013

- ABSTRACT 170 -

A study on the designed navigational standards for the deepwater channel in the lower stretch of the Changjiang River Between Nantong and Nanjing

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As ports and harbours have been developing rapidly and riverside industrial zones booming in recent years alongside the Changjiang River in Jiangsu Province, it has been urgent to improve the existing navigable channels' ability to handle traffic and adopt severer standards for navigable waterways in the lower stretch of the Changjiang River downstream of Nanjing.

The lower stretch of the river downstream of Nanjing could be divided into two parts at the place where the Jiangyin Bridge is located. This paper demonstrates appropriate design vessel-types for navigation, designed navigational standards and desired geometry and dimensions of channels along the river in connection with physical conditions and engineering restrictions, demands of ports and local economic development and the sailing requirements of larger ships. It proposes the principle of value-taking for desired geometry and dimensions of deep water channels and further gives recommended values in the main sections.

Based on the spatial and temporal changes in hydrographic conditions in the studied river stretch, the paper gives the limited drafts for design vessel-types with different allowable under-keel clearances at different water level guarantee rates, and shows that the seasonal changes in draft limitation of large-scaled vessels should be taken into account in ship operations.

Key Words: Growth in Ship Size, Design Vessel Type for Navigation, Designed Navigational Standards, Dimensions of a Navigable Channel, Allowable Under-keel Clearance.

SMART RIVERS Conference 2013

- ABSTRACT 171-

A Study on the Branch Selection for the 12.5m-deep Main Channel in the Fujiangsha Reach Downstream of the ChangjiangRiver

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In recent years, ports and harbours have been developing rapidly and riverside industrial zones booming alongside the Changjiang River in Jiangsu Province, which poses new challenges for the main channel. As a result, it is proposed to execute a channel regulation project in the Lower Reach of the Changjiang River downstream of Nanjing, to deepen the main channel of the said river reach from 10.5m to 12.5m.

There exist several branched waterways in the Lower Reach downstream of Nanjing, of which the selection of a branch for the main channel will determine the overall pattern of the deepwater channel. Based on technical feasibility studies, harbour suitability, traffic management and others, this paper presents some essential principles on the selection of a branch for the main channel in a branched reach of a river.

The Fujiangsh a Reach is the only section of the Lower Reach which has three branches of waterways. Based on an analysis of the stability of its branches, this paper gives four potential categories of options for branch selection. Also mathematical models and other methods are used to analyse their possible effects and influences so as to obtain one feasible option from each category of options respectively.

According to the proposed principles of the branch selection, two options were selected from the ‘Fuzhong two-way’ options and ‘Fubeione-way+Fuzhong one-way’ options which are recommended for further analysis in the next stage.

Key Words: branch selection, stability of a waterway, technical feasibility, harbour suitability, traffic management.

SMART RIVERS Conference 2013

- ABSTRACT 173 -

The automation of the Thieu lock for operating by bargeman and monitoring by remote control

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The Thieu lock is located in the Walloon Region of Belgium, on the “historical CentreCanal” at the junction with the “Canal du Centre”. This lock is the first to be operated by bargemen in Wallonia. It can also be operated by remote control.

The Centre Canal links the Schelde(Escaut) valley in the west of the country and the Meuse valley in the east.

The “historical CentreCanal” was built at the end of the 19th century to the 300 tons template to pass a fall of 70 m. There are 4 hydraulic lifts able to move the ships through a level difference of 17 m each and is run by the hydrostatic balance of two caissons full of water. Today, the historical CentreCanal and its boat lifts are recorded among the Unesco’s World Heritage Sites.

The “Canal du Centre” is a new waterway of about 8 km in length and goes round the north side of the previous canal. This canal is composed of more modern structures that were completed on 31st August 2002. On this waterway, there is the Strépy-Thieu ship lift to pass the high waterfall.

The Thieu lock which is at the junction of the “historical CentreCanal” and the “Canal du Centre” and allows pleasure boats to go to the Thieu port, is at the 300 tons template. It is mainly used by tourist boats.

At the beginning of 2011, the gates of this lock were still hand operated. The accessibility to the port, and the navigation time of the lock, were insufficient.

That is the reason why the Walloon administration decided to modernise the structure in one step: to install operating machinery and to allow the lock up to be operated by bargemen.

Because this lock is the first to be operated by bargemen in Wallonia, we want to develop the philosophy and the methodology for other structures from this prototype. In acheiving this goal, security is an important aspect and we have also investigated the option of a complete remote operation without any actions from bargemen. The responsibility and ability levels for each type of actor (bargemen, remote lockkeeper, maintenance personnel, ...) have also been studied.

In this modernization, some features have had to be taken into account as follow:

- A wave of 20 to 50 cm coming from the Havré lock and going to the Strépy-Thieu ship lift on the “Canal du Centre” regularly hits the lower gates of the Thieu Lock.

- The Thieu lock with a fall of 6.8 m, a width of 5.2 m and a length of 41.1 m is deep and dark, and thereby the bottom of the structure is difficult to monitor with cameras.

The new specific equipment installed to automate the lock consists mainly in:

- A request operation rod;
- River signalling external, internal and for the gate move;
- Level measurement
- A metering sensor;
- Some laser sensors (detection and counting);
- Some pulling rods for locking and for emergency stops;
- Remote control by radio (equivalent action as request operation rod);
- Remote monitoring from the Strépy-Thieu ship lift;
- A local operation desk;
- Some cameras;
- A fibre optic link.

All these elements and the experience collected by the SPW (Service Public de Wallonie) will be presented in the presentation.

This presentation is proposed for the Smart Rivers conference PIANC'2013 in relation to the topic n° 6. Hydraulic structures.

SMART RIVERS Conference 2013

- ABSTRACT 174 -

Estimating the Economic Impacts and Significance of Recreational Use of Inland Waterways

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Recreational boating and other recreational activities on inland waterways are becoming increasingly more popular at the time when public funding for developing and maintaining recreational facilities and services is generally being reduced. A recent study by the U.S. Coast Guard found that an estimated 73.5 million persons boated in 20l1 and that boating participants logged nearly 3 billion hours aboard recreational boats in the U.S. alone. Americans also own about 22.5 million recreational boats and the majority were used in 2011.

Recreational users, advocate groups and recreation industries are increasingly employing economics (e.g., economic impacts, user values) to gain support ~~of~~ for continued and increased investments in recreation facilities and services. While in some cases, the economic impact associated with alternative water-based recreation use of inland waterways support continued or additional investment, there are other situations where the estimates (e.g., spending, employment, income) being put forward are based on data that is either dated, or was not collected or analyzed in a systematic or consistent manner. Unfortunately, many government agencies responsible for managing waterways and deciding on investments do not have the expertise and funding to either verify or refute these estimates, or produce more valid and reliable ones of their own. Often times the lack of credibility of sound economic impact analyses also reduce the likelihood of gaining additional support to include economic value of recreation use in a navigation project.

In the U.S., federal budgetary funds are allocated based on performance outputs and national economic development benefits and clear priority is given to commercial harbors and navigation channels over recreational harbors. This has created significant difficulties particularly when it comes to dredging during this current period of extremely low water levels. Recreational boating advocates argue that boating is too economically important not to maintain and even enhance these recreational harbors, and even more so because of the economic downturn in many regions.

This paper will provide a review of different techniques for estimating the economic impacts of recreational boating. This will include a review various methods (e.g., surveys) for estimating spending (e.g., annual craft, trip spending) required for use in economic impact assessment models. It will also discuss the importance of, and alternative ways to produce, reliable estimates of boating use (e.g., boating trips) including several recent surveys designed and conducted by the authors. Finally the presentation will include a demonstration of several recently developed web-based tools for conveniently and reliably estimating the economic impacts of boating in a consistent way. These tools can be used to simulate the economic impacts of different levels of boating participation such as might be caused by reduced access or closing facilities. They can be developed and then efficiently updated on a continuing basis so they are available when needed by agencies.

SMART RIVERS Conference 2013

- ABSTRACT 179 -

Hydraulic Structures
Construction of the 2nd Navigation Lock in Zerben

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In the frame work of the delivery of the overall project “Verkehrsprojekte Deutsche Einheit, VDE Nr. 17 (Infrastructure Project German Unity)” it is envisaged to further develop the waterway connection from Hannover to Berlin via Magdeburg.It is planned to extend the Elbe-Havel Canal (EHK) to meet the parameters of Class Vb for European Waterways and so allow for the traffic of long push-tow units and large motorized freighters.

Additionally to the enlargement of the standard canal cross section, a second navigation lock in Zerben, including the upper and lower approaches, and the construction of twonew weir facilities at the “Zerbener Altarm” are envisaged.

The new navigation lock is designed as a single chamber lock made of reinforced concrete. The lock is situated parallel to the existing lock structure at a distance of 45 m, both structures being separated by a middle pier.

The navigation lock facility is composed of the lock chamber, the upper and lower heads, the lock entrances and the upper and lower approaches. The main dimensions of the lock chamber are:

- Serviceable length L = 190 m
- Serviceable width W = 12.50 m
- Height H = 13.35 m

The lifting height of the navigation lock depends on the water level in the Elbe-Havel Canal and varies between 5.15 m and 5.50 m.

The entire navigation lock will be erected within a construction pit protected by diaphragm walls which are supported at the upper part by reinforced concrete struts and a reinforced concrete waling. The construction pit reaches depths up to 17.00 m and is provided with a bottom slab made of underwater concrete which is anchored to the underlying ground by means of micro piles to guarantee sufficient safety against uplift.

The lock chamber and the lock heads are designed as rigid open U-frame structures with a spread foundation and are planned to be erected according to the **innovative monolithic construction method**. Thus the lock chamber, the upper and lower heads will be erected without expansion joints, which are expensive to build, difficult to maintain and very costly to repair. Furthermore this construction method allows for compensation of relative settlements between the different structural elements.

Both lock heads are provided with mitre gates in folded plate design with electromechanical drives. The lock gate located at the lower head is equipped with a rigid beam as protection device against ship impact.

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- ABSTRACT 180 -

Maximizing draught, more efficient sailing and reducing fuel consumption with the Economy Planner

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The Dutch inland waterway network comprises the main navigation routes, so-called corridors, and many smaller canals. It includes terminals and locks where the operating time influences the efficiency of the transport over water. However the air draught of bridges is also important for an efficient, safe and reliable network. The national project “Impulse Dynamic Traffic Management Inland Waterways” (IDVV) aims at delivering a modal shift in favour of inland navigation in order to handle the expected increase of the number of containers due to the Maasvlakte II development. Within the project, tools are developed to create a situation that ships and waterways to be used more optimally. One of the tools is the EconomyPlanner allowing skippers to transport the maximum cargo and to deliver the cargo in time at the required destination meanwhile reducing fuel consumption by energy efficient ship operation. Therefore, the EconomyPlanner contains various modules: prediction module for water depth, flow velocities and air draught, a virtual ship module, and a visualization module.

In essence, the EconomyPlanner makes it possible to determine the draught of a vessel inclusive of the squat, in a way that the vessel can pass the critical location in the route at the moment it will arrive at that very location. This requires accurate low and high water hydrological and morphological models to predict two-dimensional actual and expected local water depths, air draughts and flow velocities. These predictions will be validated by measured water depths by commercial vessels. The EconomyPlanner can also optimize the fuel consumption of a vessel by regulating the number of engine revolutionsby selecting an energy saving track and following this track with a minimum of resistance. Fuel reduction is possible by sailing slower at shallower locations and faster at deeper locations, or by sailing in the deeper parts of a cross-section. These aspects are all implemented in the EconomyPlanner. Finally, all information is put together to make predictions before departure and the optimal track is visualized on the existing navigation charts. The information will be actualized during the trip of the vessel.

Summarizing, the EconomyPlanner will fulfill the following functions: generation of an actual water depth chart, determination of the optimal track with respect to the maximum draught and the fuel reduction, computing before departure an accurate ETA and trip planning, giving advice on reduction of fuel consumption and emissions and the number of engine revolutions. It helps to realize a more efficient use of both the waterway network and the vessels.
A prototype version of the EconomyPlanner has been built and tested successfully recently. Full scale tests made clear that commercial applications of the Economy Planner can be built now by the navigation sector on the basis of the described software architecture which is the result of the studies within the framework of the IDVV project.

Transforming Inland Navigation with Broadband Communications: the Port of Pittsburgh Commission's Wireless Waterways Project

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This presentation reviews how the commercial waterways in the United States, although still critical to economic functioning of a large part of the nation, have come to be generally viewed by the public as yesterday's technology and yesterday's mode of transportation, creating huge impediments to public reinvestment; and, how new broadband communications technologies have the potential to infuse new value into the system with new opportunity to increase public support.

Historically, major navigation projects in the US, like the Erie Canal or the Ohio River Navigations System, were undertaken for geopolitical objectives to economically bind the interior of the nation to its east coast population. Once completed, however, the projects became expected to pay for themselves. This presentation shows how "to pay for itself" in the US has been codified in specific legislation and guidance that precludes the counting of many of the benefits that the system creates; it will show how this differs from European models and why these policies and guidance creates impediments for reinvestment in the waterways of the US.

It explains how and why the Port of Pittsburgh Commission, Carnegie Mellon University, USACE, and the PPC's newly created non-profit affiliate, Pittsburgh Port Technology, Inc, got involved in waterway technology development through the creation of its SmartLock program,a virtual lock entry aid, and the identification of a need for a broadband communications network, why the navigation industry alone could not afford to build the network by itself, how a multiplicity of other beneficiaries were identified and how a business strategy to finance the build out and maintenance of the network was identified, called the "Wireless Waterway".

It explains the "Wireless Waterway Project" (WWP) technical layout, operational concept and business model. This includes a description of the Network System Infrastructure (NSI), an Interoperability Test Bed (ITB), a Navigation Community Portal, Trusted Private Networks (TPN), and layered services. The operational and business model explains how the WWP is scalable and expandable and how it will be able to generate revenues and become self sustaining.

It will show the progress to date with the Interoperability Test Bed, and, working together with academia and industry, the multitude of beneficiaries in navigation, public safety, security, environmental monitoring, and economic development.

It then concludes with an analysis of the problem of reinvestment in US waterways, the possible inclusion of previously classified "externalities" or other beneficiaries that are not currently contributing to the maintenance of the waterway system, and the impending crisis if a new way of recapturing those benefits "for the public" is not found. It presents the WWP as a model to infuse new value into the navigation infrastructure and some of the pitfalls if the infrastructure is not able to recapture the benefits.

SMART RIVERS Conference 2013

- ABSTRACT 182 -

Smart River Management is Sustainable Management

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Our world's rivers are a critical resource that must be sustained. As professionals responsible for managing and maintaining our rivers, we should base our policies and actions on management principles that balance environmental, economic and socially driven perspectives. Smart river management must be based on good science, good policy and good leadership while managing risk. This presentation will focus, with examples, on these three aspects of smart river management.

Starting with the need for good science, both researchers and practitioners, have an ethical responsibility to generate and communicate unbiased science and engineering principles to decision makers. It is critical to transition innovation and emerging concepts into the real design, operation and management of our waterways. Operational organizations that deliver products that impact communities and individuals must reach out to credible sources for the best practices. PIANC Working Group reports are a good example of how best practices are developed and used to inform good design and operations. In the US, independent organizations such as the National Research Council or academic institutions are often employed to support federal agencies in review and development of their tools and policies.

Sustainable river management considers all threats and hazards and is prepared for them. Understanding, assessing and planning for risk is important for sustainable solutions whether these risks are due to droughts, floods, watershed policies related to other sectors such as energy or farming, economic recession, critical water infrastructure threats, failing infrastructure, lack of capital and finances or social vulnerabilities of the people and cultures most impacted. Coastal development and recovery following Hurricane Sandy provides an interesting perspective on how communities perceive and respond to risk. A study by the National Research Council on dam and levee safety programs in the US also highlights the challenges with communicating risk to the public.

Good policy should be driven understanding the issues from the people and organizations who will be most affected. Good policy decisions are not necessarily consensus driven. It means finding the "sweet spot," the place, that regardless of your perspective, you can agree upon action. It means taking action in the absence of a perfect solution and embodies collaboration. The same level of rigor should be given to policy analysis as we give river science and engineering analysis .Examples of policy development including the reform the National Flood Insurance Program and the political process in the US to pass Water Resource legislation will be presented.

Finally, the key to smart river management is leadership. While leadership at the top is important, it is sometime most effective when driven by the individuals, communities and business most impacted. Leadership can be provided by a non-elected community leader who has the respect, vision and passion for their community, non-governmental organizations and/or business leaders in the community. Elected officials can be very effective too, but must have the integrity and political will to take the long view on river management. Several leadership models are emerging. One that will be discussed is the Mississippi River Cities and Towns Initiative.

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- ABSTRACT184 -

Challenges in the Design of Extreme Lock Gates

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From 2009 to 2012 Iv-Groep b.v. (Netherlands), a member of the design joint venture CICP ConsultoresInternacionales, has worked on the design of sixteen steel rolling gates for the Panama Canal Third Set of Locks, the largest contract of the Panama Canal Expansion Program. These services have been performed for the design-build joint venture of GrupoUnidosPor el Canal (GUPC) under contract to the Panama Canal Authority.

The design of unique structures like the new lock gates for the Panama Canal Third Set of Locks has proven to be a truly challenging effort. Bringing multiple technical aspects and disciplines together and moulding them into one consistent design is only part of it. Combining the design parameters while at the same time meeting the Employer's technical requirements and above that those of the code requirements sometimes seemed to be a difficult task. Especially the demand to only use existing concepts, while in fact lock gates of this size and under the proposed circumstances have never been built before seemed to be a paradox at first. The unprecedented combination of the huge dimensions of the gates with relatively high differential heads, a high usage, the accounting for seismicity, and stringent availability requirements simply demands innovative solutions. Fortunately the design team was allowed to use concepts that had been proven to work under comparable circumstances in other industries.

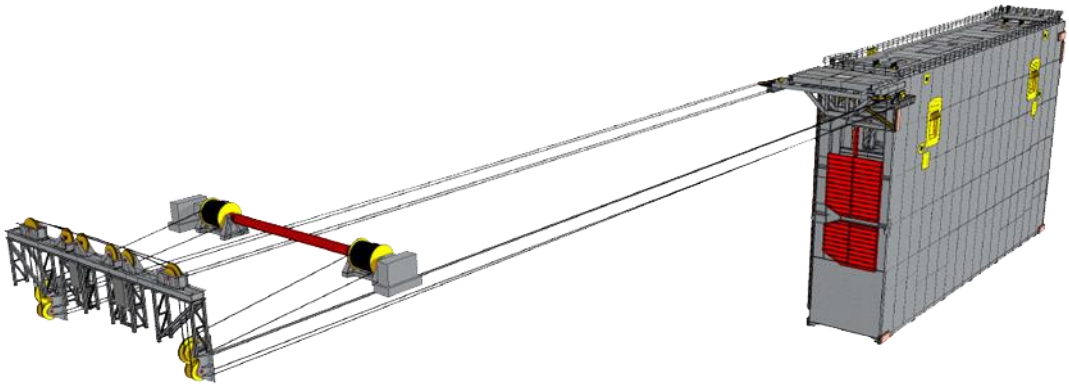
The above described design parameters presented us with a number of technical challenges. Some of these will be described in more detail below:

At a width of 57 m and height varying between 29 and 32 m and a structural weight varying between 2200 and 4000 metric tonnes a piece, the new Panama Canal lock gates will be the largest in the world. It is quite common to reduce the operational weight with buoyancy chambers, located under water. In the Panama Canal, the water level between two adjacent chambers is so large that these buoyancy chambers are required to be located near the bottom of the gates for 12 of the 16 gates. This is no problem in the operational situation, but does create instability when the gate is required to float by itself. The solution was tocreate a watertight space above the buoyancy chambers, called the ´flotation hull´.
Wagon replacement was required to be carried out within eight hours. It was determined that this could not be achieved by the time consuming process of floating up a gate combined with the requirement to have divers in the water. Therefore the lower wagon is connected to a column, which can be released at the top of the gate, after which the wagon-column assembly can be hoisted out and in by a crane within the eight hour time frame. Overloading of the wagons themselves due to seismic action or loss of buoyancy is prevented by a load limiting device consisting of pre-stressed springs located at either rolling wagon.
Optimization of the gate drive mechanism has led to a solution with a double set of steel wires running between the winch system and the gate in such a way that the drive force always acts at the centre of the gate, minimizing skid forces which would lead to friction. Friction forces are also reduced by the choice of materials on the sliders of the gates and on the concrete. The material mounted on the concrete also requires to act as a barrier between the different water levels and therefore requires to be watertight. A specific solution was developed to meet these

requirements while at the same time offering sufficient flexibility to easily and safely mount the panels without gaps and within tolerances.
Interface issues required a lot of discussion between the designing engineers, both internally within the gate design team and with the CICP design centres working on areas interfacing the gate, our client GUPC and the owner, ACP, to achieve consistency in the overall design of the locks.

Apart from the above mentioned technical challenges, the design team faced several other challenges, such as the geographical distances, the communicational difficulty (language barriers not being the only one), cultural differences and the aggressive design/construct schedule. In spite of this, all parties felt bound by the strong common goal of getting the job done.

This paper will present the design process of the Panama Canal Third Set of Locks lock gates and will highlight and illustrate several important design choices that were required to be made. It will also show the alternative solutions that did not make it and explain the reasons why.



SMART RIVERS Conference 2013

- ABSTRACT 185 -

Implementation of e-Navigation on inland waterways

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e-Navigation is defined by the International Maritime Organization (IMO) as:

"the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment."

The development of the e-Navigation concept and implementation plan by the IMO is nearly complete. Much of the focus of e-Navigation has been on coastal and deep-sea shipping, however it has substantial applicability to inland waterways. National efforts in the US as well as international efforts in several other nations have been underway for several years to "build" e-Navigation capability for inland waterways. This presentation will provide an overview of international e-Navigation concepts as the IMO e-Navigation implementation plan is readied for completion in 2014, discuss e-Navigation efforts that are already being implemented through coordinating existing efforts, and review the US e-Navigation strategy, developed under the auspices of the Committee on the Marine Transportation System (CMTS).

International e-Navigation efforts:
The IMO has continued work on the development of an e-Navigation implementation plan, which is scheduled to be completed in 2014. For this presentation, an update will be provided on IMO e-Nav efforts to date, including the completion of an e-Navigation gap analysis that took the user needs previously identified and compared them to current capabilities. From that gap analysis, an initial "solutions matrix" has been developed; once completed it will form the core of the implementation plan, and set priorities for efforts. The presentation will also provide a comparison of the work at the IMO and it's applicability to inland waterway operations.

e-Navigaton efforts in the US:
The US e-Navigation strategy was published in February 2012 and is intended to provide "the coordinated exchange of timely, relevant and accurate information among government and private stakeholders to improve decision-making for safety of navigation, maritime security, protection of the environment and the reliability and efficiency of the marine transportation system."

Since the strategy was published, much work has been progressed to take e-Navigation from concept to implementation, in advance of the IMO implementation plan, but in line with international developments. This portion of the presentation will cover the work of the US Committee on the Marine Transportation System (CMTS) in progressing e-Navigation; in particular on the cooperative efforts required by the various agencies with waterways responsibilities, the efforts completed to date, and details on some of the initial capabilities being developed applicable to inland waterways operations..

SMART RIVERS Conference 2013

- ABSTRACT 186 -

Hydraulic Boundary Conditions for the New Movable Dam in the Julianakanaal near Limmel

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The Julianakanaal in the south of the Netherlands is a lateral, straight canal, which connects at both ends to the river Maas. It is an important canal for IWT, as a route to and from the eastern part of Belgium. Close to the upstream connection, the old lock of Limmel is situated in the canal, which is only used during high river discharges when the target water level on the river Maas and the canal can not be maintained by adjusting the weir at Borgharen in the Maas. Then the lock is operated to maintain the water level in the canal. At even higher discharges the locking process is stopped and the lock only functions as a dam. At the moment Rijkswaterstaat is preparing the replacement of the old lock by a single movable dam without a locking function.

One of the preliminary activities in the new dam project was the working out of the hydraulic boundary conditions which will be a part of the functional requirements in the delivery contract. These boundary conditions are determined by the change in the river discharges, the operation of the river weir at Borgharen and calamities in the neighbouring waterway system.

Concerning the dam, the following five types of operating conditions have been distinguished:

1. Conditions during normal operation; the dam is removed at low river discharges and closed at high discharges, then blocking the shipping traffic. When closed, it has to be possible to sluice a necessary amount of water through the dam into the canal.
2. Conditions during maintenance of dam or canal; e.g. maintenance of a vertical sliding gate.
3. Floating ice conditions; the weirs in the Maas are opened to let through the ice, which means that the movable dam has to be closed to prevent the falling off of the canal water level.
4. Calamities: (A) the dam fails to close at a high discharge of the river Maas, (B) a vessel comes into collision with the closed dam, (C) failure of the canal bank system behind the dam; the dam has to be closed to stop the flow through the canal and the dam has to withstand an extreme positive head, (D) the weir at Borgharen fails to close, is damaged by collision or is operated wrongly; the movable dam has to be closed during flow and the dam has to withstand an extreme negative head.
5. Conditions during construction of the new dam.

For all these operating conditions, the hydraulic conditions have been worked out. The discharges and water levels on the Maas have been determined from statistical data. The water levels for extreme discharges have been calculated with numerical flow models.
Flow conditions during opening or closure of the dam have been estimated from discharge measurements in the canal and the effects of this operation have been calculated analytically.

Due to the widening of the riverbed of the Maas through dredging, the characteristics of this river and the operation of the weir at Borgharen are changing. When this river project will be completed in 2020 (Grensmaasproject), this weir will only be fully opened at a higher discharge, which also means that the movable dam near Limmel will be closed at a higher discharge. Then, the shipping traffic can continue until this higher discharge is reached.

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- ABSTRACT 187 -

"Manoeuvring Models: Does the Ship fit in the inland waterways?"

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In the Netherlands, Europe and the entire world, waterways are classed in certain types, which correspond to the allowed ship size. These names are Class II, Class IV and so on. The classification is based on size, and the allowance to sail on that waterway is dependent on experience with these ship types, and a defined minimum manoeuvrability of every ship.

On the other hand, it is observed that new ship types are entering on the waterways. This is good as these ship types are the result of an innovation process, either from a logistical, a hydrodynamical and (even more) a combined innovation. These ships have unconventional shapes, unconventional main dimensions or unconventional propulsor and steering means. One may think of podded propulsors, ships with air lubrication, and the current trend of wider container vessels. For these ships, we may ask the question of whether they are suitable for a certain class waterway and how we can demonstrate that.

Traditionally, this is demonstrated by simulations with a ship at a certain loading condition in a particular waterway sailing a particular scenario in a range of water conditions. In the Netherlands, the IDVV project is (for a small part) devoted to a new idea: can we make these simulations more easily accessible, i.e. without the need to carry out model tests on a new ship type. This would indicate that it is easier to demonstrate that a ship can enter waterways; it is also easier to investigate the effects of many ship variations, such as the effect of bow rudders and bow thrusters.

The present paper and presentation will illustrate which steps are taken to achieve this and show the results. Part of the research consisted of measurements on a new, not existing hull form, which was equipped as twin screw and single screw version. The model test results on this hull will be made available, and are foreseen as a next international benchmark for future investigation of the manoeuvring behaviour of inland vessels.

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- ABSTRACT 189 -

Inland navigation and Land use planning: A multi-criteria approach

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Land use planning appears to be a key requisite for the long term development of waterways. This is especially the case in North-West Europe given the pressure on land exerted by housing, economic estates and natural conservation demands along waterways. At the same time dominant maritime harbours, like Antwerp or Rotterdam, are in search of larger inland harbours (more than 50 hectares) so as to deploy complimentary logistic projects in their hinterland in the view of facing expected congestion issues. This obviously requires an adequate land provision policy in the short, medium and long term. Finally, in a strongly urbanised context, land use planning has increasingly to address the concerns of local populations in order to minimize expected impacts (noise, dust, carriage) and offer adequate compensationfor facilitating the integration of harbour sites in their local environment.

Considering these challenges, the Walloon Region decided in 2010 to register its inland harbour site offers and to identify potential harbour development sites along its 440 kms of waterways. A three step approach was designed for this purpose.

It consisted of a first step in mapping the adequacy of land for inland harbour developmentusing a quantitative 6 level scale, from largely inadequate (-3) to very adequate (+3). This preliminary screening was based on desktop analysis and used existing land and environmental planning documents, including land use plans, Natura 200 areas, heritage zones etc. It allowed local stakeholders to rapidly identify relevant development zones, considering their field know-how. It was indeed considered that some sites, presently occupied by economic activities, may become available at a 20 to 30 years horizon and should hence be considered as a priority for future logistic projects in the view of recycling existing or future brownfields.

In a second step, those potential sites were classified against a series of 23 criteria, including inland harbour developments criteria (inland waterway capacity, available area of the site, distance from locks etc.), land use criteria (proximity to housing, distance from other economic activities, present allocation in land use plans) and accessibility criteria (rail and road connexions, distance to motorway junction etc.). The classification was based on the *electre* ranking methodology and included sensibility tests so as to check the importance and effects of weighting factors.

In a third step, all those sites were documented so as to propose a coherent and unified system to address the present situation of those sites and to estimate the required investments and efforts in order to develop these sites.

Quite importantly the area of the sites and their present allocation in land use plan was considered as an important dimension in the screening as well as the multi-criteria analysis.

The present structure of harbours in the Walloon region is indeed composed of some 140 scattered sites of some 7.5 hectares. This hardly fits the needs of present logistic developments, especially when one considers that those sites should allow the development of economic activities. At the end of the exercise, some 62 potential sites were identified, whose mean area is 41 hectares. Furthermore a significant amount of these 62 sites, namely 38 of them, were considered as rapidly available, namely in a time horizon of 5 to 10 years. These two aspects, the impact of the area of sites and their availability, which were considered as most debatable during the research, will be more specifically discussed in the paper through a comparison of the efficiency of inland harbour sites in Wallonia and North-West Europe.

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- ABSTRACT 190 -

Navigation Structure Resilience to Overloading

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The goal of this report is to generate enough interest and momentum to form an international group of experts that would develop a "model" building code for a Flood Defense Systems (FDS) while incorporating resiliency, that would incorporate world-wide lessons learned from rare/high consequence catastrophic flood events. The report also ties resiliency as a component of sustainability. Of critical importance is to incorporate the concept of resilience to overloading to a FDS if the flood exceeds the top of the barrier. The features described in the report will ensure resilience to the system by allowing it to survive this overload without catastrophic failure, endure only cosmetic damage, and be capable of withstanding the design loads after the significant flood event passes and returning to normal service. The incremental costs of these features are minor compared to benefits of being resilient by minimizing loss of life. The performance requirement for resilience is to ensure the system does not fail catastrophically if the flood is higher than the design flood. If a FDS does not have resilient features when over topped then the protected community is at greater risks than if the protection had not been built as the potential energy stored behind the wall can be suddenly released with catastrophic consequences when/if it breach occurs. With resilient features a FDS can survive an overtopping flood event higher than the design flood, the FDS performs as designed, with no catastrophic failure and there is time to evacuate the residents and minimal lives are lost. The flooding occurs gradually instead of a sudden failure. Although for the overload event, economic losses for the community will still be significant, these resilient features will allow for the community to survive with less recover time. A small amount of cosmetic damage is acceptable, but the system should still be capable of withstanding the loads after the flood event passes and is capable of being returned to flood protection as soon as reasonably possible.

When these guidelines are followed then FDS will become a sustainable asset. Without resilient features a FDS could fail catastrophically and would probably have to be replaced when first overloaded such as was the case for the Greater New Orleans Area FDS where large portions of the hurricane protection system had to be replaced after the overload from Hurricane Katrina. Any FDS that is disposable after one overload with a sudden failure mode and loss of life is unacceptable. Sustainable systems meet the needs of the present without compromising the ability of future generations to meet their own needs. While this report is not a building code the recommendation is to further develop this relevant information into a comprehensive Model Flood Design Building Code specifying minimum requirements to provide resilient systems to ensure that the human population is not endangered if system capacity is exceeded. As a “model” building code users would make simply edits for their situation when awarding design contracts, i.e., remove coastal but use the river portion of the code for an inland FDS. This code if properly developed would have long reaching impact.

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- ABSTRACT 192 -

VisuRIS – expanding RIS to the MAX !

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1. Background information

Flanders has a lot of waterway and port authorities, with their specific missions and goals. To achieve their missions and goals, they have invested in supporting IT-developments, resulting in a more efficient way of dealing with daily business.

In 2000 all Flemish waterway authorities decided to join forces to promote inland navigation in a user friendly and transparent way and as an efficient and safe transport mode. The development of a single window for inland navigation was a first step to achieve those goals.

By making an inventory of the actual services, a direct link with the PIANC guidelines became visible, making it possible to follow these guidelines and be aligned with a European approach.

Thanks to the publication of the EU Directive 2005/44/EG in 2005, a legal frame work was born and has created a more solid base for the on-going approach of close cooperation, i.e. a single window. This Directive aims at a safer and more efficient use of the inland waterways by harmonising information services, allowing the support of traffic and transport management.

2. Approach towards optimisation

Both waterway authorities, i.e. nv De Scheepvaart en Waterwegen en Zeekanaal NV, realised that almost all information was only available by means of consulting different monolithic applications, thereby missing a lot of synergy. Only by transforming the current RIS IT-architecture to a service based architecture would allow both waterway authorities to fulfil the demands of their customers. The idea of offering RIS based information to a larger scale than only the skippers was born. RIS based information can be made useful to the waterway authorities themselves, to logistic partners, shippers, agents, rescue services, law enforcement, … with respect of the privacy of the individual skipper and with the aim to extend and upgrade the quality of the existing services.

3. VisuRIS – offering RIS based information by means of appropriate tools

The final solution will exist of the following components:

a) Visualisation Tool

This tool will offer our RIS-centres an accurate, correct and user-friendly image of the complete waterway network by displaying position, cargo and voyage information, Notices to Skippers, calamity information, Aids to Navigation (AtoN), waterway levels, Inland ECDIS information, … , inclusive of the possibility to interact with the real time environment.

b) Portal

Based on the same approach as the Visualisation Tool, filtered information can be made accessible by means of an internet portal.

c) Portal Mobile

Information available on the portal will also be offered in an optimized way for mobile devices, allowing rescue services and our own staff to send and receive information to our RIS centres at Hasselt and Evergem.

d) Mobile apps

Mobile apps can use all technical features of a mobile device, thus allowing a better experience than a mobile web version of the portal. Augmented Reality can only be realised by means of an app.

e) Middleware services

Middleware services aren't frontend applications, but services which will process information and return this enriched information to the requesting application. They are inevitable!

4. Conclusion

Starting from a fragmented landscape, waterway authorities in Flanders joined forces to create synergy and use RIS services to make inland shipping a safe and efficient transportation mode, facilitating the modal shift and making inland shipping more or at least equally attractive as road, railway and air transport.

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- ABSTRACT 193 -

Improving Marine Safety with Ship-to-Dock Berthing Impacts and Fatigue Load Monitoring

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This paper is to introduce a new technique for real time monitoring of ship-to-dock berthing impacts (kinetic energy and reaction load) and mooring fatigue load. The BIM technique ("Berthing Impact Monitoring") can be used to improve marine navigational safety standard and provide base data for marine academic studies and researches.

Ship-to-dock impacts are normally transmitted through marine fender systems installed on the quay wall. This transmission process leads to movements on the fender systems correlating to the impacts. The BIM technique monitors ship-to-dock impacts by monitoring the movements of the fender systems, using "Inertial Guidance" principle, or dead reckoning of the position and attitude of a spatial object through integration of its spatial linear and angular acceleration. With the acceleration data collected from 3 axis accelerometers and gyroscopes mounted on actual fender systems, BIM technique creates computer virtual 3D models of the fender systems as they moves in six degrees of freedom. Based on the knowledge about the correlation between ship-to-dock impacts and fender movements, along with known vessel and fender characteristics, BIM technique calculates the kinetic energy amplitude of each impact and interpolate the resultant force / load (which equals to fender reaction force) exerted on the ship and the dock, using measured fender spatial displacement, velocity and rotational angle. Lastly, the impact data is compared with preset thresholds to provide impact warnings during berthing accidents. All impact and load data are recorded in a database for berthing accident analysis, marine fender base design studies, marine structure & vessel design studies, and navigational studies.

For the above concept to reach necessary reliability and practicality, a group of specialty measures were gradually developed, tested and integrated into the BIM technique. To enhance monitoring accuracy, multiple motion sensor units were installed on the same fender system to create redundant data sets; 3 axis magnetic field sensors and other specialty sensors were incorporated into each sensor units to provide external reference; quaternion method was chosen to process sensor data; Kalman filters / fourth-order Runge–Kutta algorisms were incorporated to reduce data noise. Specialty cross platform computer data interpretation software and GUI were developed for data interpretation and warning display. Specialty installation, power supply, and wireless communication schemes were developed for fitting and operating BIM components on mainstream design fender systems under normal harbour environment.

BIM technique also has several other functions important to marine safety. For examples it can be used to detect fender system design deficiency or permanent fender damage, by monitoring fender motions unexpected in fender system design criteria and persistent deformation of stationary fender system geometry from its design geometry. Also accidental drift of moored ship can also be detected by monitoring the "absence" of ship-to-dock fatigue load.

In the near future, BIM technique can be further improved with new technological developments such as superior MEMS sensors and vibration power collection technology.

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- ABSTRACT 194 -

On the use of numerical morphological models for improving navigation channel maintenance – the case of the Rhine Branches in the Netherlands

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The Rhine River is considered to be the backbone of the Northwest European waterways network. The navigation channel of the River Waal, which connects the Port of Rotterdam to the German hinterland, has a depth of 2.8 m and width of 170 m guaranteed for 95% of the time. The draught of the barges and push-tow units determines the depth criterion, whereas the width of the units and the number of required lanes govern the width of the channel. Due to the morphological behaviour of the river, navigation is subject to hindrance in some locations and frequent maintenance as well as improvements to the navigation channel is regularly carried out. It is of a primary interest for the river manager to be able to evaluate different strategies to ensure a sustainable navigation channel. Accordingly, a detailed quasi 3-dimensional morphological model that covers the Rhine branches in the Netherlands was created (the DVR-model, acronym for ***D****uurzame* ***V****aardiepte* ***R****ijndelta,* viz. sustainable navigation channel Rhine delta). Both intermediate and large-scale morphological developments can be evaluated using this model. The intermediate scale concerns the behaviour of a relatively short reach of a few kilometres (spatial distinction), for a relatively short period, weeks to months (temporal distinction). In this way, we provide a tool that enables the river manager to take decisions concerning local effects as well as short term possible dredging activities. The large-scale concerns the behaviour of the entire river (spatial distinction), that takes years to decades to take place (temporal distinction). In this way, we are able to evaluate the response of the river to several interventions that aim to maintain sustainable navigability. The model is also equipped with a novel dredging and dumping functionality that allow analysis of actual channel maintenance by dredging and different sediment management strategies.

Navigation channel maintenance in the Netherlands is rather complex, as there are strict rules for the dredging and dumping actions. Dredged material is required to be dumped back to the river, mostly in the deeper parts of the river. Dredging takes place due to two primary processes, viz. the formation of shallow bars in river bends and the formation of dunes in relatively straight reaches. The model has the capability to capture both processes. Recently, a new functionality has been implemented to simulate ploughing (spreading the dunes out without actual dredging). The model is being used to offer advice to the Rijkswaterstaat (the executive arm of the Dutch Ministry of Infrastructure and the Environment). Herein, we briefly present the model with some selected examples of its application related to navigation channel maintenance. We present a case in which we evaluate the effect of enlarging the navigation channel on the yearly dredging volume by applying a simple dredging scenario. We present another case for assessment of the impact of changing the maintenance strategy from maintaining a minimum local navigation depth (of 2.8 m at low water) to maintaining a cross-section averaged navigation depth (of 4 m deep channel all year long). Moreover, we evaluate the impact of lowering the groynes, to create more room for the river to reduce flood levels, on the navigation channel.

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- ABSTRACT 195 -

Channel improvement of the Upper Scheldt in the city of Tournai

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The priority project n° 30 of the TransEuropean Network of Transport is the development of a large channel fluvial network connecting the Seine and the Scheldt River basin. Within the framework of this global project, Wallonia intends to modernise to class ECMT Va (2000 t) its main waterway network which is currently limited to class IV (1350 t).

The Upper Scheldt connects the French waterway network with the main North Sea ports.
The canalisation of the Upper Scheldt in the 1920s, was designed for class II vessels (600t). In the 1970s, it was decided to upgrade the Upper Scheldt for class IV vessels (1350t). The main problem was the size of the river in the city of Tournai and especially the width of the channel under the bridge "pont des Trous". A system of navigation in alternative directions was established in 1983 on a length of 2.2 kilometers with a green and red signal system controlled by the operator of the lift bridge in Tournai.

In the Seine Scheldt project, it is now proposed to upgrade the Upper Scheldt to class Va (2000t) and preserving the possibility to further upgrade to class Vb (4500t) in the future. The standard width of class V vessels is 11.40 m. The width of the main channel under the "pont des Trous" is 11 m. This bridge is a heritage bridge and a symbol of the city of Tournai. The navigation studies demonstrate also that the width of the river is a problem in the curve of the channel under the bridge "pont à pont". The bridge "pont à pont" must be rebuilt and the river should be widened under the bridge. It is a very sensitive matter because the bridge "pont des Trous" in Tournai is one of the most prestigious vestiges of medieval military architecture in Belgium. The bridge was part of the city wall and protected the entry and the course of the Scheldt through the city. The tower on the left bank was built in 1281, while the right side date from 1304. The bridge himself has been restored in 1948 after being demolished by bombing in World War II. The studies of the new bridge “pont à pont” and the modification to the heritage bridge are now in progress. The consultation of the local authorities and the citizen involvement in the search for the best solution is very important for the success of the project.

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- ABSTRACT 196 -

Generation of PI for Traffic Management using automatically collected RIS

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RIS – River Information Service is one of the most advanced services for traffic supervision and traffic management on inland waterways. It is based on sophisticated automatic data exchange between vehicles (ships) and between vehicles and shore based stations as well as autonomous functions on the ship (e.g. steering, speed). In general this system is called a 'co-operative system' and actually will be applied to all transport modes (road, rail, air transport) in the future. RIS has been installed within the last 10 years on inland waterways in many countries in Europe, China (Yangtse), USA (lower Mississippi) and some other countries. These systems do allow, beyond other functions, to automatically collect positional data of ships, speed, direction and ship ID during their journey with a high resolution (e.g. every 2 sec).

In 2007 PIANC InCom established a workgroup to develop Performance Indicators (PI) for Inland Water Transportation (WG111). Within this WG around 100 PI has been specified covering 9 areas (eg. infrastructure, ports, environment, fleet and vehicles, etc.). The final report was published in 2010 (report 111-2010).The burden to operate the PI's in most of the cases is the continuous (in many cases manual) collection of data over a certain period (e.g. one or more years) to validate them against a defined level as fixed by the administration, or management level of operating units (private and public). This may be the major reason that not many administrations have integrated this scheme into their daily operation.

The paper addresses a new application of PI to automatically calculate delay caused by a lock passage (or a sequence of lock passages – like on the Austrian stretch of the Danube) against an unrestricted fairway without locks using the automatically collected position and speed data (from the RIS system) of an individual ship in all phases like approach to lock, lock passage, after lock acceleration up to regular speed. Additional influencing factors like water level, weather conditions, etc. need to be analysed in further studies.

The advantage of this approach is to avoid burdening the operating staff of locks with data collection. Data from a selected number of passages (ships) have been collected to analyse the different phases when passing a lock with different ship configuration up-stream and down-stream. First analyses show a different behaviour in the different phases and also the capability for some improvement to better co-ordinate sequencing ships through locks as well as manoeuvring actions. A more extended collection and analyse of data seems to be necessary to validate the results and necessary actions to be taken.

Resume: When finally data from all ships will be available e.g. over a period of one year, PI's in this area can be used to compare the performance of operation in inland navigation between different river systems on a very detailed level. This can finally improve safety (e.g. in areas above locks), energy consumption by better guided approach to locks, efficiency in lock passage (e.g. utilisation of lock capacity), and lock operation. Finally the effective delay due to lock passage against the (virtual) unrestricted passage in this section can be precisely calculated and in a later stage maybe minimised.

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- ABSTRACT 197 -

Technical Navigation Improvements in the waterway Santa Fe – Confluence (Parana River, Argentina)

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The objective of this paper is to describe the characteristics of the 650 km Santa Fe – Confluence waterway and also the navigation improvements that have been carried out since 2010, regarding the aids to navigation that were installed and the dredging operations performed in the area. Finally, types, figures and projections on the transported freights and types of barges in the area are detailed.

The importance of the work for the future development of the hinterland with its huge economic potential if adequate freight costs are assured will be highlighted.

1. DEEPENING OF THE WATERWAY

The project requires a final navigable channel of 12 ft draft (including 2 feet of underkeel clearance) that was achieved in 2011 and has been maintained since that year.

Capital dredging has required the mobilization of approximately 1.6 M cu. m of sediment. Due to the presence of very shallow areas at the time of dredging, sidecasting with small TSHD was required. The AtoN system comprises 330 lighted buoys and beacons, all of them designed according to IALA guidelines.

The river is very wide and its braided pattern provokes very frequent changes of position of the most adequate branch for navigating in shallow areas. These changes are produced by the effect of variations in river discharges and the existence of loose soils on the bottom. To follow these changes in position frequent bathymetric surveys have to be performed. With the information obtained from the surveys a new path for the portion of the river studied is proposed to the Client that has to approve it before actions can be taken on the field. The realization of these special bathymetries added to a general annual bathymetric survey of the whole river is a byproduct of the project because previously this information was not available. To solve the problem Aids to Navigation has to be moved from the original path to the new path for the channel and eventually maintenance dredging has to be done to guarantee the project depths.
As natural changes in the riverbed are frequent surveys, maintenance dredging and operations in aids to navigation are carried out all year round by dredgers and buoy tenders.

2. ENVIRONMENTAL IMPACT

The Parana – Paraguay Waterway is a project that been in the news for several decades. One important objection presented by ecological groups in the 90's was the eventual effects on the Pantanal region in Brazil where the Paraguay River begins. These discussions produced important delays in decisions and loans that retarded the project.

Therefore, an important part of the project was the elaboration of an Environmental Impact Assessment (EIA) that considered the fluvial ecosystems and floodplain, aquatic biota, water and sediment quality and nature conservation taking in consideration that this waterway has 14 natural protected areas, 2 RAMSAR Sites (The Convention on Wetlands of International Importance), 2 bird conservation areas and fish reserves. To this end, an annual survey of water samples and bottom sediments with the corresponding laboratory analysis is performed. In the same manner, the place of disposition of dredged sediments is discussed to avoid any interference with other activities or sensitive areas such as water intakes, recreational beaches, fisheries, low islands, etc. These activities are followed by an Environmental Management Plan approved and supervised by the Client.

3. NAVIGATION AND COMMERCE THROUGH THE WATERWAY

The Santa Fe–Confluence waterway handles both domestic and international commercial river traffic to and from Uruguay, Paraguay, Bolivia and south of Brazil.

Barge convoys navigating this sector of the Paraná River range from 16 to 42 units. Mississippi type barges (L=60 m x B=11 m x D=3 m – DWT=1500 ton) were the most common in past years. The appearance some years ago of a new type of barge with higher capacity (L=60 m x B=15 m x D=3 m – DWT=2500 ton) have started the replacement of them. These barges are conformed in convoys demanding high power pushers and navigating skills. Information will be given on national flags under which barges and pushers are registered. This is a problem deriving from countries having different policies on aspects such as labor, investments and others.

Nowadays, very big barge convoys with a maximum of 36 barges each are navigating this part of the river. Details about convoys will be given. Also, the problems which arise when these convoys during the trip get broken and the special procedures that has to be taken to reorganize them will be explained

The hinterland of the waterway has agriculture potential as well as reserves of iron ore and manganese that are of worldwide importance.

Soybean and by-products, iron ore and fuels gather 85% of total freight. In 2011, 17.6 M tons were transported and for 2016 a projection of 22.3 M tons is forecasted. Information on the type and volumes of cargo both present and future will be presented.

5. MESSAGE AND INNOVATIVE CONCEPTS

This waterway, even though it is 640 km long, is only a minor part of the whole Parana Paraguay River waterway and others waterways of the region. The message of the paper intends to be that the improvement of the waterway is possible applying the appropriate working methodologies and that the results are worth the money required to do the job because there are ways of solving the problems to make inland navigation more effective and efficient.

Innovative concepts could be found in some dredging methodologies in very shallow stretches, the continuous following of the deepest parts of the shallow stretches to avoid excessive dredging, the conformation of big convoys with high power pushers for the transportation of cargo and associated navigating problems.

The presentation will try to transmit experiences than can serve the audience for the evaluation of similar problems in their own countries.

SMART RIVERS Conference 2013

- ABSTRACT 198 -

Assessment and optimization of RAMS-performance of hydraulic structures

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The Dutch Ministry of Infrastructure and the Environment operates and maintains over 600 hydraulic structures (storm surge barriers, locks, weirs, dams, outlet sluices and pumping stations) for maritime navigation, water management and flood protection. Most of these were designed and built between 1930 and 1950 with a life expectancy of about 80 years using the then-current standards and regulations. Conditions and utilization have changed over the years, resulting in different loads on the structures. Signs of aging are becoming more and more apparent. Some recent (near) accidents have already occurred, risking vessels and crew and causing significant economic losses due to long-lasting unavailability of the structures.

In order to prevent future incidents and to enable proactive risk-based and performance-driven asset management, comprehensive and integrated reliability, availability, maintainability and safety (RAMS) analyses of the structures were executed. These RAMS analyses comprise three main parts which are elaborated in full coherence:

1. On-site inspections and measurements (including underwater inspections);
2. Technical analyses of all civil, geo-technical, hydraulic, mechanical and electrical parts of the structures;
3. Failure mode and effect analysis (FMEA) and quantitative Fault Tree analysis.

Additionally, the effects of possible upgrade measures on the expected RAMS performance are determined, as well as the costs of these measures, enabling risk and performance based decision making on upgrades and refurbishments.

In our presentation we will describe the methodology of the comprehensive integrated RAMS-analysis and illustrate its application using a case study, covering the following unique aspects:

- Translation of on-site inspection results into quantitative RAM data using a.o. Weibull-analysis.
- Translation of technical analyses (unity checks) into quantitative RAM data using probabilistic techniques.
- Determination of the quantitative relation between costs of future upgrades and refurbishments and the quantitative RAM-performance of the structure enabling life cycle optimization.

SMART RIVERS Conference 2013

- ABSTRACT 200 -

InCom WG 155: Ship behaviour in locks and lock approaches

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During the transit of a ship through a lock, and even during normal navigation, ships can be significantly affected by the interaction with the processes induced by a lock. It is relevant to have an idea about the governing processes, as they have an impact both on the design and operation of navigation locks.

The aim of InCom WG 155 “Ship behaviour in locks and lock approaches” is to give designers of locks, and organizations that operate locks, more insight into the troubles they might encounter and what to do about them. It should be made clear which factors are important for safe locking and lock transits. To do so, the following points should be evaluated:

- What are the relevant physical processes?
- How to evaluate the forces on the vessel?
- What is the vessels’ reaction?
- What does the shipper think on this?
- What to do to prevent misery?

The goal of the working group is to give designers and operators an idea, why the above questions are important and to combine this with the experience from completed lock projects.

The working group has been set up in 2011 and currently consists of 14 senior and 4 young professional members from 9 countries. After the inaugural kick-off meeting New Orleans in 2011 (at the PIANC Smart-Rivers Conference), further work group meetings in Delft, Lyon and Panama City followed. During the meetings, a structure for the report was developed. This follows a “timeline of events” from point of view of a vessel that transits a lock. This structure has been infilled with content in the meantime and parts of it will be presented as a feedback from the working group to the public in a workshop on locks. The workshop will be held directly before the Smart-Rivers 2013 conference. This will give an insight in the work of the group and furthermore gives the public an opportunity to interact with the group. Thus, it is expected that the workshop rocket fuels the remaining work of the group. In this presentation both the work of the working group and results from the workshop will be presented.

SMART RIVERS Conference 2013

- ABSTRACT 201 -

Design Guidelines for Inland Waterways (PIANC-INCOM WG 141)

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Over the years PIANC and other navigation organizations have performed research and published papers and guidelines on the design of inland waterway channels. Information identified in the past has related to the size of fairways in canals and rivers, sweep of bends, lock and bridge approaches and size of bridge openings. With the development in new technologies and the development of new waterways, it is essential that this information should be reviewed and presented in a comprehensive publication to help designers and operators with their preliminary tasks.

For this purpose a PIANC INCOM WG was founded on the occasion of the 32nd PIANC Congress in Liverpool in May 2010. Following from seven meetings, two interim meetings on special questions and several internal workshops the group finished the review of existing guidelines. It analysed several best practice examples, especially concerning fairway design in rivers, the dimensions of lock approaches and bridge openings.

The group members discussed three approaches to find appropriate waterway dimensions:

- First the common “ConceptDesign Method”, basing on experience, existing guidelines and using additional information e.g. for wind or curve increments, e.g. to define minimum fairway widths and depths in straight canals;
- second the“Best Practice Approach”, providing and commenting existing dimensions to be able to choose appropriate data for the case to be considered;
- and third the “Case by Case Design” using simulation software as in ship handling simulators.

Because in all design cases it is necessary to find an appropriate safety and ease standard, depending especially on the ship type, the ship speed and traffic density and the special boundary conditions to be considered, the group proposed an approach to account for this essential aspect in waterway design.

The paper shows selected results of the findings of WG 141. It gives also a summary of the workshop “Inland Waterway Design” from the same conference two days before.

SMART RIVERS Conference 2013

- ABSTRACT 202 -

Tools for Asset Management of Hydraulic Structures

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The European hydraulic infrastructure is becoming of age whilst at the same time maintenance funding is under pressure and requirements concerning reliability, availability and safety are getting more and more stringent. Therefore the Dutch Ministry of Public Works commissioned, amongst others, ARCADIS to conduct studies into the use of Reliability Centered Maintenance (performance based maintenance planning) and the RAMS-methodology (analysis of Reliability, Availability, Maintainability and Safety of infrastructure). Both methodologies have proven to be highly powerful tools for rational decision making in asset management. This paper addresses our experiences with both tools and propagates a wider use of these tools.

RINK is an acronym for Risk Assessment of Hydraulic Structures. The RINK-project comprises a full inspection, technical analysis and RAMS-analysis of a number of hydraulic structures ranging from relatively small historic navigation locks to large discharge sluices and pumping stations. While traditionally inspection, technical analysis and RAMS analysis are more or less uncoupled disciplines, the RINK project aims at actually linking them. This requires flexibility from the different disciplines but results in high quality insights into the performance and required maintenance of hydraulic structures. Because the technical analysis is performed according to current regulations and guidelines, and uses the actual condition as input, the RAMS-analysis provides insight into the *current* performance and safety levels. In addition measures to increase availability and reliability are defined for each structure.

Through a RINK-analysis the Asset Manager gains insight into the actual performance of hydraulic structures and obtains budget estimates for performance improvement measures.

While the RINK-project focusses on the RAMS-performance, regular maintenance is analysed and optimised through the use of performance based maintenance plans (acronym PIHP). Performance based maintenance is an application of the RCMII methodology, specifically developed for hydraulic structures. It provides insight into the long term maintenance of hydraulic structures and aims at the delivery of an optimal balance between availability and maintenance costs. Using RCM-based software the Life Cycle Costs, Reliability and Availability are computed for different maintenance strategies (e.g. corrective, proactive). The methodology provides for the asset manager an insight into the actual relationship between maintenance costs and possible performance (Reliability and Availability).

Both the RINK-methodology and performance based maintenance planning are powerful tools available to the asset manager of hydraulic structures. When combined they provide an ultimate insight into both the actual RAMS-performance and in the long term, the availability based maintenance budgets and activities that are required.

TRILOGIPORT – A new Multimodal Platform in Liege

NIVELLES Stephan

- ABSTRACT 203 -

Mechanical & Electrical Engineering, Lessons Learnt: MAINTENANCE in PIANC WG-138 Report

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Maintenance of navigation structures is an issue of great significance for the performances of waterways. Several (if not most) failures and malfunctions of those structures are caused by improper or insufficient maintenance. There are many lessons learnt in support of this statement. Moreover, the awareness of it will likely grow in the future due to:

- growing number of existing navigation structures;
- globalization and the resulting growing significance of reliable and safe navigation.

Therefore, lessons learnt from the maintenance of navigation structures comprised a significant part of the PIANC WG-138 proceedings. As a matter of fact, nearly every lesson learnt can be related to maintenance. In this sense, maintenance is an issue in all the lessons presented in the 9 chapters of the PIANC WG-138 report. In Chapter 7, “Maintenance”, the focus has been laid on the general concerns of this field, such as:

- the choice of appropriate maintenance strategy;
- approach to contracting versus in-house maintenance;
- condition monitoring and inspections, diagnosis of malfunctions;
- concepts of service levels and remote maintenance;
- expected future developments in the field of maintenance.

As there exist diverse maintenance strategies, one will obviously seek the best strategy for a particular structure or group of structures. The existing maintenance strategies of navigation structures can globally be classified in three groups:

- Corrective maintenance (defined as “fix as fail”);
- Preventive maintenance (defined as “change before fail”);
- Combined and other maintenance.

In terms of asset management, the corrective maintenance is presumed to be variable, and the preventive maintenance – regular. This is disputable, as some corrective maintenance activities (e.g. replacements of stock-hold items “as failed”) are often performed on regularly basis, but it can usually be accepted. The division into corrective and preventive maintenance, as well as the definitions of both, reflect some compromising within the Working Group. Some professionals also distinguish “predictive maintenance” as a separate group. Some others preferably speak in terms of “scheduled” and “unscheduled” maintenance. Still others define the “corrective” and “preventive” maintenance in a slightly different way than presented here. As the readers of the report may also have different views, it is advisable to keep the presented definitions in mind.

The WG report gives recommendations for choosing the maintenance strategy. In general, this choice should be taken on component level and result in a combination of both strategies on the level of entire systems. The report presents experience based choices for the maintenance of mechanical, hydraulic and electrical components as practiced in the countries of WG members. The discussed lessons learnt cover different aspects of maintenance management, including the application of modern technologies, risk assessment and asset management methods.

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