



PIANC
The World Association
for Waterborne
Transport Infrastructure



SMART RIVERS 2015

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ABSTRACT BOOKLET

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The world association for waterborne transport infrastructure

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Edited by Lucía Torija

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- ABSTRACT 02 -

The State and Perspectives of Waterborne Transport Infrastructure Worldwide

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The World Association for Waterborne Transport Infrastructure (PIANC) has provided global guidance on waterborne transportation issues since its founding in 1885. PIANC's mission recognizes the importance of waterborne transport infrastructure to international trade and the global economy. Investments in environmentally-sound, sustainable inland and maritime facilities support stable and secure nations, stimulate economic development, and promote the well-being of communities worldwide.

Waterborne transport has never been more important than it is today. Major projects with worldwide impacts - such as the expansion of the Panama Canal - are expected to have notable impacts on global trade patterns. Emerging trends in global transport, including use of alternative fuels, institutional reforms, and new approaches to the construction, operation, and maintenance of waterborne transport infrastructure, have the potential to transform the industry. Technological advances in ship design and port operations, and the introduction of larger and more efficient vessels to the world fleet, increase the demand for port infrastructure modernization, expansion, resilience, and operational efficiencies. Yet waterborne transport infrastructure faces increasing challenges of world population growth, a changing climate, and limited funding.

At the 33rd PIANC World Congress in San Francisco, 31 May 2014, the Annual General Assembly formed a task force on the "State and Perspectives of Waterborne Transport Infrastructure Worldwide." PIANC Working Group 181 is charged with gathering relevant information on the current state of global waterborne transport infrastructure and assessing needs for new, expanded or rehabilitated facilities. WG 181 will investigate investment in new assets, expenditures on asset management (operation & maintenance costs), and emerging trends and technologies driving change in the system. The working group will then assimilate and interpret this information to provide expert guidance to industry stakeholders, policy- and decision-makers, and system end-users and beneficiaries, on the future state of the system.

It is anticipated that the work of WG 181 will lead to an ongoing dialogue (via electronic media, workshops, conferences, etc) that will inform, educate, and facilitate meaningful adaptations of the system to address fundamental challenges and future uncertainties. WG 181 kicked-off in February 2015, and will complete its work by August 2016. This paper provides a status report on the initial findings of the group, with a particular focus on factors most affecting inland waterways.

- ABSTRACT 03 -

P3/P4 Solutions for Inland Waterways

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Public private partnerships (P3) have been important for executing surface and water transportation projects in the United States (US) since 1792. The US Army Corps of Engineers (UNITED STATESCE) has begun to explore the application of the P3 delivery tool to coastal and inland navigation projects in the US through its alternative finance program as a result of its existing authorities. The US Congress authorized a water infrastructure P3 pilot program in Section 5014 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014), which was enacted on June 10, 2014. This 5-year pilot program requires identification and execution of at least 15 previously-authorized, coastal harbor improvement, inland navigation, flood damage reduction, or hurricane and storm damage reduction projects with private sector participation via the P3 project delivery tool. This program would enable innovative agreements with the private sector for projects from planning and design through construction and possibly operations and maintenance, but requires subsequent appropriations and/or new authorities to fully implement. Hence, the UNITED STATESCE has moved forward on the P3/P4 demonstration program under its existing project authorities.

Since the overall goal of the UNITED STATESCE P3/P4 program is to dramatically increase investment in US water resources infrastructure, the UNITED STATESCE is currently working on prospective public-public-private partnerships (P4s) with non-federal sponsors to engage private investment for the construction of federally authorized water resources development projects. WRDA 1986 formalized cost-sharing agreements with non-federal sponsors, which provided an authority for public-public partnerships. UNITED STATESCE may enter into P4s (WRDA 1986) but not traditional P3s because its authorities for the formation of direct relationships with the private sector are limited primarily by the Federal Acquisition Regulations (FAR). P4 participation would be accomplished by applying real property instruments and/or cooperative agreements with the US Federal Government retaining ownership of water resources assets. WRRDA 2014 legislation was passed in recognition of the declining state of waterway infrastructure assets in the US to identify cost-savings and accelerate project delivery alternatives to reduce the backlog of authorized, unfunded, federal projects and increase private investment to improve the reliability of waterway infrastructure. For existing infrastructure, UNITED STATESCE stated intent to apply the P3/P4s delivery tool to sustain performance, extend service life, and/or buy down risk for the nation. For new infrastructure, UNITED STATESCE stated intent to apply P3/P4s to accelerate delivery, reduce life cycle costs, and achieve earlier accrual of project benefits to the nation.

The Waterways Committee of the Coasts, Oceans, Ports and Rivers Institute (COPRI) of ASCE studies and reports on methods and problems of planning, design, construction, maintenance, and operation of waterways, including dredging,

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stabilization, navigation, flood control and regulation, with consideration of their effects on the environment. The Waterways Committee coordinates with the Ports and Harbors Committee. The P3 Subcommittee of the Waterways Committee was created to provide expertise and support in educating, advocating and facilitating water infrastructure public-private partnerships, in support of inland waterways programs. UNITED STATESCE has identified major challenges to implementing P3/P4s through its demonstration program. Legislative and/or policy changes are required to address implementation impediments to include OMB Scoring, payment mechanisms and availability payments, revenue generation and ring fencing, and budgetability. P4 project development is the path forward to immediately and fully leverage existing federal authorities and mitigate some of the most perplexing challenges and limitations in adopting the P3/P4 delivery tool for US navigation projects.

Internationally, the US is ranked 24th out of the top 25 for using public-private-partnerships overall infrastructure verses global competitors. The US is viewed as a high potential growth market for this type of "Alternative Delivery Method" with the quickest pathway to success being through a partnership with the UNITED STATESCE and its non-federal sponsors.

Panama Canal Third Set of Locks Operations and Maintenance Strategy for the Civil Works

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The new Third Set of Locks for the Panama Canal has been designed to optimize reliability, availability, maintainability, and safety (RAMS) of operation. To achieve this goal, operational requirements have been integrated with risk-based maintenance management techniques including fault tree analysis (FTA), failure mode effects and criticality analysis (FMECA), and application of reliability-centered maintenance (RCM) principles. Because the civil works components comprise the major water-retaining structures of the lock and canal system, it is a challenge to devise a comprehensive maintenance program - considering both planned and unplanned actions - that achieves the RAMS objectives without disrupting vessel transit operations or compromising personnel and vessel safety. This paper presents a unique approach to developing a comprehensive maintenance management program employing RAMS principles for the civil works components of the Third Set of Locks. The approach can serve as a template for other civil and structural systems where optimizing life-cycle performance is paramount.



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- ABSTRACT 06 -

The Panama Canal Expansion Project Complexities and Lessons Learned

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One of the world's greatest engineering achievements, the Panama Canal celebrated its 100th anniversary while preparing to meet the challenges of growing traffic demand, particularly by containerships, LNG and bulk carriers, plying the route between Northeast Asia and the U.S. East Coast, and also to accommodate post-Panamax ships by means of the Panama Canal Expansion Program. The program includes two new lock complexes that have established a new size standard, the Neo-Panamax class. This paper explores the complexities of the studies, decision-making process, integration of multidisciplinary expertise and program execution. At present, with most civil works near completion, the commissioning of electrical, mechanical and control systems are being carried out by the ACP to ensure successful operations once the waterway opens to commercial traffic in April 2016.

GATEWAY TO EUROPE MULTI-PORT GATEWAY REGION BLACK SEA Cooperation of the ports on the western coast of the Black Sea and the ports on the River Danube

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The European Commission has set up in 2010 in preparation for the revision of the TEN-T (Trans-European Transport Networks), an expert group (WG # 4), which was mandated to investigate the "Ten-T extension outside the EU," and to develop proposals on the basis of the developed methodology of TINA Vienna. A considerable part of the work took the themes of the roles of the ports as the "Gateways to Europe". WG 4 has identified a series of seaport agglomerations based on the definition of the European Seaport Organization.

Of these "multi-port gateway regions - MPGR" that are to be regarded as a node of the EU core network have been called three as particularly important for access to the EU - TEN-T:

The ports of the North European region, the western Black Sea area,
The northern Adriatic Sea.

The northern Adriatic responded the fastest. Four ports in the three neighbouring countries (Italy, Slovenia and Croatia) came together for the North Adriatic Ports Association NAPA.

NAPA is the best practice for the other MPGRs. At the western Black Sea there is a similar situation: 3 countries - 6 ports:

Ukraine Odessa
Illichivsk
Romania Galai
Constana
Bulgaria Varna
Burgas

The benefits of a cooperation between the ports of the multi-port gateway Black Sea can be defined as follows:

- Joint international presence in the region and the ports
- Common strategic goals in international competition
- Development of common technical standards
- Joint procurement
- Joint presence at Trade Fairs
- Through these activities results in high savings potential
- Expansion of the specific strengths of each partner
- Response of the funding for joint activities EUSDR
- Common organization of the land and river transport links (Hinterland connections)
- MPBS supports the development plans of its individual members

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A strong partner for the surrounding regions

The project covers two topics based on a concept of the working community of the Danube Regions: first a cooperation of the ports on the Black Sea with each other and on the other hand the economic cooperation of the Danube regions with the Black Sea regions, focusing on the Danube ports.

A major impetus for the project was set by the EU Danube region strategy EUSDR which has enshrined this objective in its basic documents and offers also the chance, to apply for subsidies. It should be noted that only intermodal projects can be funded under the CEF (Central Europe facilities) however.

What are the benefits of cooperation to be expected?

The "multi-port gateway Black Sea West" is an opportunity for the regions, towns and ports, to better connect with the major economies in Europe and the Danube River basin, to integrate better in international networks and to strengthen the ports as main players of the regional economies. The expected benefits are added value both the economies of the countries of the Danube region and the Western Black Sea territory.

World's largest Fiber Reinforced Polymer composite Mitre Gates for a new Lock in the Netherlands.

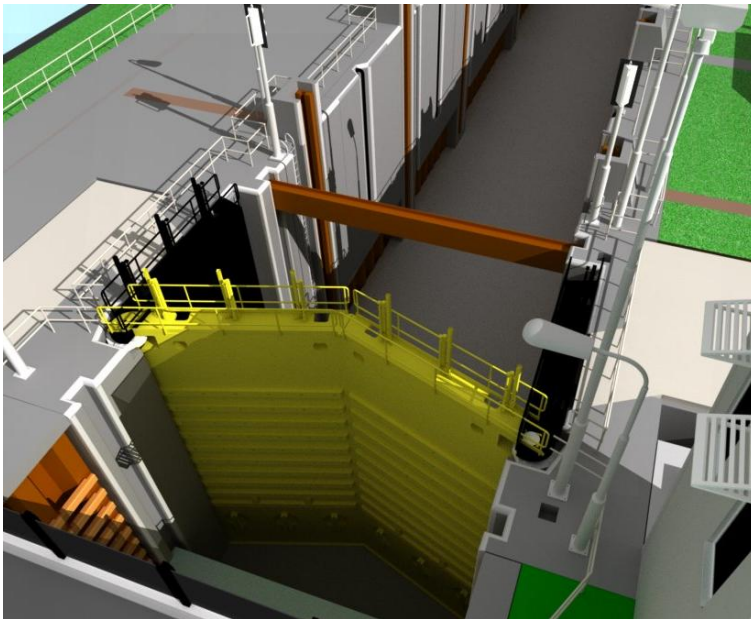
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Rijkswaterstaat the Netherlands is investing heavily in the wet infrastructure by increasing the navigational capacity of the main waterways, therewith reducing road traffic congestion and CO₂ emission.

One of these projects is the upgrading of the Wilhelmina Canal in Tilburg, the Netherlands to accommodate CEMT class IV ships. A new lock (named Lock III) will be built in 2015 replacing the two existing ones (Locks II and III).



Impression of the new Lock III in the Wilhelmina Canal, the Netherlands.

The new Lock III will be equipped with the world largest Fiber Reinforced Polymer composite mitre gates in the world today.

A single leaf of the upper gates will have the dimensions of 6.2 x 4.8 meters.

The leaves of the bottom gates will have the dimensions of 6.3 x 12.3 meters and are designed to resist a hydraulic head of 7.8 meters.

Rijkswaterstaat stimulates the use of Fiber Reinforced Polymer composites in civil waterway works in cases where there is a material property advantage.

As Fiber Reinforced Polymer composite material is strong, durable, lightweight, low-maintenance, and easily fitted; the use of Fiber Reinforced Polymer composite instead of classic steel or wood was chosen because of the less intensive maintenance regime,

which also results in low hindrance for water traffic during the 100 years of the intended design life.

Also the use of tropical wood will be avoided, which contributes to one of the Rijkswaterstaat general environmental objectives.

This paper describes aspects of implementing these Fiber Reinforced Polymer composite mitre gates in the Netherlands.

A short review of the experiences with smaller Fiber Reinforced Polymer composite mitre gates is given, which are already in use for several years.

The design approach for the new Lock III is discussed, based on the functional requirements in conjunction with the hinges, the quoin blocks, gate paddles and the sealing requirements.

Also the perceptual and general mental barriers for using Fiber Reinforced Polymer composites for this relatively large navigational structure are discussed.

Apart from design codes, specific requirements for the design approach and for ensuring structural safety and durable performance have been prescribed by Rijkswaterstaat:

- Additional requirements on stiffness
- Continuous fiber arrangement and build up
- Damage tolerance in the structural design
- Design for 100 years of operation including effects of creep, humidity and fatigue
- Conservative design approach regarding the theoretical forces on the leaves
- Additional testing on every final product
- Real time and continuous deflection monitoring during operation
- Reparability of local damage

These specific requirements ensure structural safety and durable performance, and also create consensus among designers, operators and users to accept the use of Fiber Reinforced Polymer composite as an innovative and reliable material for this relatively large structure in the Dutch civil waterway.

- ABSTRACT 12 -

Rapid Construction of Locks

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This paper explores the possibility of building future locks using tested technologies while simultaneously using engineering and contracting innovations to deliver such projects ahead of schedule and below budget.

In 1905, John Stevens - the foremost civil engineer of his day and second chief engineer to head the United States' effort to build the canal and locks in Panama - drew up logical plans for the canal's construction. One of the first things he recognized was that the project was largely the logistics problem of efficiently moving the excavated material out of the project footprint. To accomplish this, he set up a railroad to move the materials and supplies throughout the project.

During construction, the method of placing concrete was by using large buckets suspended from truss-frame cranes that rolled on rails parallel to the lock chamber alignment. What is striking is the similarity of these cranes to the modern container crane in their basic configuration.

Using the same logic as John Stevens of rolling cranes along the alignment, this paper proposes a project delivery method for design and construction of locks using conventional quayside container cranes as the primary construction crane, rather than tower cranes as are being used to build the third set of locks today. The basic difference between what was done originally and what is proposed herein is that the walls would be made from precast elements rather than from poured-in-place concrete. As such, the methodology incorporates rapidly erectable precast concrete block units (CBU), a structural precast system that works well with the container cranes. The CBU is an oversized hollow-core precast concrete block. The blocks nominally measure 16 feet long by 8 feet wide by 8 feet high and volumetrically represent 38 cubic yards. The CBUs weigh approximately 40 LT which will allow the use of top-picks, reach stackers and straddle carrier. This unit is, by design, dimensionally similar to a one-TEU shipping container, except that CBUs are 16 feet long rather than 20 feet long.

These blocks can be stacked and offset, and the system allows for the placement of horizontal as well as vertical post-tensioning. The inclusion of post-tensioning ducts in each of the three planes is the method of tying the blocks, both to each other and to the foundation.

The CBUs have "container" handling fittings on top and bottom that assist in handling and that enable the CBUs to be stacked in terminals and on barges or ships using conventional container handling equipment. These fittings consist primarily of embedded steel plate with oval-shaped holes at the lift points.

Design of the Magdalena River Training Works for Navigation Improvement (Colombia)

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The work described in this article was carried out between 2006 and 2013, along a 456 km river reach, to improve the Magdalena river navigation.

The type of structures proposed consists of bank revetments, channeling dikes, and partial closure structures, to reduce maintenance dredging. These works should stabilize the river to prevent flows from going through various side channels.

Studies made since 1993 on transportation demand showed the need to reactivate navigation upstream Barrancabermeja, an oil port located 630 km from the ocean, and recommended revitalizing the river transportation system with a terminal port in Salgar as an economically important inter-modal center only 180 km from Bogotá, the country's main cargo origin and destination center.

The first design study in 2006 established the methodology for the project, according to guidelines provided by 3 ex-UNITED STATESCE consultants who had participated in the planning, design, construction, and maintenance of similar works done in various rivers in the United States. Their experience was instrumental, as the works designed for the Magdalena River are similar to works successfully done by UNITED STATESCE in the Mississippi River system, especially along tributaries similar to the Magdalena.

In October 2009 detailed designs of training works were presented for the Berrío-Barrancabermeja sector (100 km), in October 2011 for the Salgar-Berrío sector (155 km). By the end of 2011 the Colombian Government had the detailed designs required for opening an international tender and contracting process to extend navigation on the Magdalena River.

However, the Berrío-Barrancabermeja sector had to be adjusted on account of significant morphologic changes brought by the devastating floods of 2010 and 2011, caused by La Niña phenomenon. The adjusted report was submitted in October 2012. Finally, the designs of the last sector downstream Barrancabermeja (205 km) were presented in October 2013.

After 20 months of bid process, the tender was awarded in September 2014. It is a 13.5-year Public-Private Association concession responsible for the training works between Salgar and Barrancabermeja (256 km), including river maintenance and dredging from Salgar to Barranquilla (908 km). The contract value is US \$2.3 billion, including financing.

Technical characteristics of the project:

-Design vessel is a barge tow in a 2x3 formation. Barges are 65m overall length, 13m beam, 1.80m draft (6 feet), with a 1,200 tons cargo capacity.
-Design tow transportation capacity is 7,200 tons, with length 240m, beam 26m, draft 1.8m.

-Design process was divided into two components: i) the design of the proposed navigable channel layout, and ii) the design of the training structures to stabilize the channel.

-The navigable channel layout was defined based on geomorphology along river valley, river dynamics of the last 36 years, and river thalweg location during the last years. These natural conditions lead to divide the work area into 23 reaches, separated by lithological controls.

-The channel layout complies with navigation standards (widths, radii of curvature, and depths), as defined by UNITED STATESCE.

-The navigable channel will have the following characteristics for the design tow:

- ✓ Summer river channel stabilized width = 300 to 500 m.
- ✓ Navigable channel width (two-way) = 150 m.
- ✓ Minimum radius of curvature = 900 m.
- ✓ Available summer channel depth = 7 feet (2.10 m).
- ✓ Summer vessel draft = 6 feet (1.83 m).

-Stabilized summer width was determined by hydraulic conveyance analysis of cross sections along significant reaches. This analysis lead to determine the top elevation of the training structures to be approximately at water level exceeded 75% of the time in most cases.

-Available depths were established under a water level exceeded 90% of the time for the uppermost works reach, and 95% for the rest.

-Typical structures proposed are bank revetments, channeling dikes, and partial closure structures, designed to withstand floods up to $T_r=10$ years with parallel and transverse flows.

-Main material for the structures is quarry rock. An overall volume of nearly 7 million m³ was estimated. Twenty possible quarry areas were studied, with more than enough volume for the requirements of the project.

-For the 456 km river length, 265 structures were designed and 697 detailed plates were drawn.

“Lessons to be learned by Mercosur countries from River Management and collaboration of the River Rhine”

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The “River Plate Basin” reaches the center of the South American continent. It is of great importance for the economies of Argentina, Bolivia, Brazil, Paraguay and Uruguay, but most of all to Argentina. It is a well-known fact that “transport by water” inherently is the cheapest mode of transport and almost all regions in the world are making more and better use of their waterways. But the potential of this river-system is scarcely used. In Europe the Convention of Mannheim of the River Rhine is seen as a ‘logistics backbone’ of the European inland waterway network. Therefore efforts must be made to ascertain if herein lessons can be found.

Economising mooring and guiding constructions at lock approaches in inland waterways - the Dutch experience

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As a result of diminishing budgets for maintenance, the Dutch waterway authority Rijkswaterstaat is amongst others in search for economizing infrastructural facilities for commercial inland vessels along its waterways. One type of those facilities are the mooring constructions for line up and waiting areas at lock approaches. Another type are the guiding constructions for entering the lock chamber, the so called funnels. The mooring and guiding constructions basically exist of piles, connected by crossbeams. The traditional lay out seen from the lock chamber is a guiding construction, leading under an angle to the shore where it is connected with a mooring construction, which lays parallel with the lock chamber and which consists of a line up and waiting area. Research was carried out in 2011 by Rijkswaterstaat in the SW part of the Netherlands (Zeeland), where several locks are situated. Those lock approaches are provided by approximately 10.000 meters mooring and guiding constructions. The main question was if a reduction was possible in the length of those constructions.

Based on observations of the use of funnel, line up area and waiting area in situations with strong cross winds it was concluded that the line up area was the most essential part. Concepts for alternative lay outs were given, in which there was a 100 m gap between line up area and funnel. It was recommended to try these concepts out in a pilot, e.g. in the new 3rd lock of the Beatrix complex.

Regarding some doubts to introduce this revolutionary concept right away, the Marin Institute in the Netherlands was asked for a second opinion by Rijkswaterstaat in 2013. Marin narrowed down that a connection between funnel and line up area is still necessary at strong cross winds for some categories of vessels (empty push convoys Vb resp. motorvessels without bowthruster) to slide along the guiding construction into the lock chamber. Placing piles instead of an ongoing connection between funnel and line up would run the risk for the vessels mentioned of their bow being blown away in a waiting situation.

In a workshop experienced skippers stretched that a way to anticipate is to navigate to the upper windside of the lock approach. However, this has an effect on the traffic pattern and can subsequently diminish traffic safety, especially in a situation with a number of parallel lock chambers.

Reliable Height Determination for an Efficient Bridge Collision Warning System on Inland Waterways

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In recent years, much effort has been devoted to the development of strategies to monitor and mitigate the risk of collision on inland waterways. In particular, collision avoidance of inland water vessels with bridges has been widely recognized as a threat to the efficiency on river transportation systems. However, few initiatives have succeeded in implementing reliable collision detection schemes which are able to improve the safe crossing of bridges. These laser-based systems require either line of sight to the bridge, or radar-based solutions installed at the bow of the vessel to measure the clearance when crossing the bridge. This includes a significant residual risk of possible collisions if line of sight is not available or the remaining time for stopping maneuvers to avoid the collision is too short. Therefore, the German Federal Waterways and Shipping Administration (WSV) has commissioned the German SME "in -innovative navigation GmbH" a feasibility study to identify, develop and assess solutions and methods towards the avoidance and reduction of collisions during bridge passages. The investigated solutions are based on land systems (using optical sensors), on ship systems or a combination of both. One of the most promising solutions uses the integration of shipborne sensors with present and future GNSS technologies.

GNSS-based solutions can be used to determine the height and the movement of the vessel - both in the horizontal and the vertical planes - to determine clearances or potential collision risks early before entering the safety space of the bridge. However, achievable accuracies of a few meters of the Stand-alone Point Positioning (SPP) technique may not be sufficient for the determination of the height within the required accuracy. Therefore, additional augmentation techniques such as the code-based IALA Beacon DGNSS, the phase-based Real Time Kinematic (RTK) or the Precise Point Positioning (PPP) can be used to increase the horizontal positioning and height accuracy. As each technique has its specific characteristics, a performance analysis has to be carried out to evaluate their capabilities. With American Global Positioning System (GPS), the Russian Globalnaja Navigazionnaja Sputnikowaja Sistema (GLONASS) or Galileo in the future, further GNSS are available to be used for positioning. The combination of the available systems may also increase the positional accuracy due to a larger number of satellites used for position determination.

In consequence, this work investigates the performance evaluation of selected GNSS-based techniques for the accurate height determination with inland water traffic purposes. The performance of different techniques is discussed in relation to the availability of data provided by augmentation systems and under consideration of the available infrastructure. Technical challenges are also investigated. Evaluated on a large set of measurement data, which has been collected in a challenging area located

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on the river Moselle comprising three bridges, the capability of the considered techniques is discussed.

Recent developments in the application of shallow water ship hydrodynamics in inland waterway design

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Changing boundary conditions in inland waterway transport demand for an optimized use of existing waterway infrastructure. Examples for such changes in boundary conditions are the more extensive United States of existing waterways by generally larger and deeper draught vessels - as on the German Neckar River, which is currently being adapted to be navigable for 135m large vessels (before: 105m max. ship length), staying in general with the same fairway width - or the planned restrictions concerning fuel consumption and pollutant emissions by the European Union. This and the general trend to consider the possibility of self-driving vessels generate a demand for the development of fast-time simulation software for ship behavior in shallow and confined water which is fitted for optimization purposes. The aims of such an optimization could be e.g. minimizing fuel consumption with respect to aimed arrival times, the minimization of loads on river bed and banks to save maintenance costs, the reduction of pollutant emissions and the increase of the capacity utilization for existing waterway infrastructure.

The validity of such a fast-time simulator is limited by the quality of the mathematical model it is based on. Besides the basic momentum equations, several effects have to be taken into account that can be neglected for ships in open water, e.g. the varying flow velocity and depth along the ship length and the resulting hull forces or ship-ship-interaction.

This paper introduces the fast-time simulation program 'FaRAO' (German: Fahrdynamische RoutenAnalyse und -Optimierung) developed within the Hydraulic Engineering Department at the Federal Waterways Engineering and Research Institute (BAW, German: Bundesanstalt für Wasserbau). The focus will be on two aspects: The shallow water ship hydrodynamic system has been further refined and validated with physical models and real life measurements. The resulting ordinary differential equation (ODE) model can be solved by standard numerical integration methods. This dynamic model will be presented in detail. Secondly, a new software design based on modular blocks has been introduced. Besides better code maintainability, it enables the use of the fast-time simulation program with optimization algorithms to find optimal ship controls in terms of fuel consumption, safety concerns and arrival time.

To be able to apply optimization algorithms it was necessary to reduce the computational times significantly below real time. The resulting software framework will be documented and numerical results for a convergence analysis and two benchmark problems - a lateral offset maneuver and a ship passing a cross flow - will be presented.

LNG propulsion for push-tugs

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Shipyard Gebr. Kooiman BV is part of The Kooiman Group, a family owned group of three shipyards, a design office and an electro technical company, all based around Rotterdam in the Netherlands.

At the shipyard Gebr. Kooiman BV in close collaboration with its Design office, recently four new 5550 hp inland navigation pushers were built for ThyssenKrupp Veerhaven BV, to serve the Rhine river with push convoys for the upstream transportation of ore and coal from Rotterdam seaport to Duisburg (Germany) .

To be able to meet the coming and demanding environmental regulations for emissions on the European inland waters, The Kooiman Group developed a LNG fueled push boat that not only meets the latest emissions limits, but also will be more efficient in propulsion and power management than the existing vessels in operation.

Above the “bare” fuel costs savings, (LNG over diesel) , which will be around 20% of the diesel price, the innovative technical solutions for efficient power management together with an innovative hull, propulsion and maneuvering tools make it possible to save around 36% on total fuel costs.

As per regulations, LNG was not allowed as fuel for inland navigation in Europe . the CCNR and AND safety committee (these are European organizations of Flag states and Class societies) need to give Recommendations (permissions) on a case to case base for sailing with the LNG fueled vessels as pilot projects on European inland waters.

Shipyard Gebr. Kooiman BV, in 2014 obtained all necessary Recommendations to be able to build the first LNG propelled 5750 hp push boat. Moreover the LNG pusher project was rewarded as a beneficiary in an EU Ten-T funded in the Rhine -Main - Danube LNG Master plan.

In our presentation we not only want to explain how the LNG push boat was designed, the difficulties regarding legislation and regulations faced and the technical details of layout and (LNG) installation of the pusher. We also will explain about the innovations and our design philosophy and how we believe we can realize 16 % fuel savings above the 20% bare fuel cost savings by using LNG.

Based upon thorough study of South American rivers and inland waterway operations, since 2012 Shipyard Gebr. Kooiman and its Design office made a number of designs and proposals to suit the South American market by way of low draught pushers in the range of 4500 to 6500 hp.

These design concepts obtained from the proven designs and pushers operating in European waters and from the LNG fueled concept offering ship owners the opportunities to operate these pushers in rivers of 6 ft. water depth and gain fuel savings. For low water depth rivers and delta's all over the world, this might be an advantage against traditional high draught North American designs. In this paper we will explain about the naval architectural principles and how we proved these principles to work in real life operations.

- ABSTRACT 25 -

Rehabilitation of Canal del Dique, Colombia

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Paper is related to following topics of the conference:

- Inland waterway transport and the environment (including climate change);
- Multi-purpose use of river systems (e.g. transport, energy, etcetera);
- Hydraulic structures.

Canal del Dique is a 115 km long waterway, constructed in the XVI century, connecting the Magdalena River with Cartagena, Colombia's major Caribbean port. For navigational purposes the canal has been enlarged in different phases, with the last reconstruction in 1984. These large scale rectification and enlargements of the cross section have resulted in a gradual enlargement of the flow capacity of the canal, leading to major environmental and social problems. In December 2010, dikes along the Canal did breach resulting in an inundation of 35,000 ha of land and rendering the United States and thousands of people homeless. This disaster forms the trigger for this project and is one of the objectives for development of an integral solution.

In August 2013, Fondo Adaptación Colombia has assigned this project to rehabilitate Canal del Dique (reducing of flood risk and ecological restoration of the system Canal del Dique). Fondo Adaptación is the public institution founded by the Colombian President, Juan Manuel Santos, for construction and restoration of infrastructure affected by La Niña 2010-2011. The paper 'Rehabilitation of Canal del Dique, Colombia' presents the integral solution for the environmental restoration of the eco-system of Canal del Dique. The following elements are taken into consideration: historical development of the canal (chapter 1); ecological restoration (chapter 2); multi-purpose use of the canal (chapter 3); strategy to rehabilitate the system (chapter 4); the integral solution (chapter 5); the required regulation structures and river training works (chapter 6) and a detailed description of the navigation lock at Calamar (chapter 7).

International and transboundary collaboration in inland waterway transport in Europe and the Danube region with special focus on communication, dissemination and image by inland waterway infrastructure operators

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Europe's freight transport system leaves much room for improvement. Whether congestions, delays or capacity problems, the need to shift to less-energy intensive, cleaner and safer transport modes has become a top priority in the European Transport Policy agenda. Inland waterway transport (IWT) which compared to other transport modes has the lowest energy consumption and external costs coupled with a high transport capacity is an obvious choice for achieving the targets of the modal shift towards more environmentally-friendly transport modes.

Although being an attractive mode for many transport scenarios, inland navigation is rarely perceived as an innovative transport mode and suffers from a lack of visibility. Whether because communication is not perceived as an important tool or because if resources are allocated to communication measures these are far too limited or because these measures are not sufficient are among the topics we will be addressing here. The reality shows that in local and regional planning processes, public authorities, the transport and logistics industry and the wider public are often unaware of the advantages of inland waterway transport and leave it out of their agenda. This calls for coordinated efforts by all actors to promote collaboration on international and transboundary level in order to reflect a joint stronger image of this important mode of transportation. Creating communication tools for the promotion of the image of IWT and to increase its functionality is no easy task.

A first step will be to describe the situation. Our ultimate goal is to increase the share of IWT in the modal split. We want to unveil the many unexplored potentials of inland navigation and show our stakeholders that the sector has more to offer than one may think. Instruments have been created in the past 5 years which have contributed to increase the attractiveness of inland waterway transport. Infrastructure, markets, fleet, River Information Services (RIS), but also ?image?, have been the focus of these measures. With image we mean positioning, communication and promotion actions. It is during this phase that we have understood how important a common approach is in our sector. We have a limited business sector and only a joint approach makes sense to achieve common objectives. Our stakeholders do not have the time and resources to listen to us when lobbying on their behalf at frequent meetings. IWT likes to think in term of efficiency, this much has become clear. Stakeholder workshops, Business to Business meetings such as Danube Business Dating have a proven track of efficiency and are being adapted throughout the European IWT landscape.



In a second step, we will show how working on communication and promotion can increase awareness and change the opinion and behaviour of people and users of the IWT sector. The levels of communication have changed with time and we have moved from a situation where communication on behalf of IWT was almost non-existent to a situation today where while stakeholders react to our messages and understand the importance of communication, our resources remain limited. In this part we will advocate a better distribution of resources to increase the share of communication resources.

In a third step, we will look very closely at today's image of IWT in Europe with best practice examples and communication tools such as Communication Toolboxes that have changed the landscape of communication on behalf of IWT.

To illustrate our argumentation we will look at pan-European and European transnational approaches.

SIMULATION OF A CONTAINER TERMINAL AND IT'S REFLECT ON PORT ECONOMY

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The combination between the design and project of container terminals and the reflect on port's economy may be carried out through two main approaches: optimization or simulation. Although the approaches based on optimization models allow a more elegant and compact formulation of the problem, simulation models are mainly based on *discrete event simulation* (DES) models and help to achieve several aims: then measure this impact on port economy before and after implemented this updating overcome mathematical limitations of optimization approaches, support and make computer-generated strategies/policies more understandable, and support decision makers in daily decision processes through a "what if" approach. Several applications of DES models have been proposed and simulation results confirm that such an approach is quite effective at simulating container terminal operations. Most of the contributions in the literature develop object oriented simulation models and pursue a macroscopic approach which gathers elementary handling activities (e.g. using cranes, reach stackers, shuttles) into a few macro-activities (e.g. unloading vessels: crane-dock-reach stacker-shuttle-yard), simulate the movement of an "aggregation" of containers and therefore do not take into account the effects of container types (e.g. 20' vs 40', full vs empty), the incidence of different handling activities that may seem similar but show different time duration and variability/dispersion (e.g. crane unloading a container to dock or to a shuttle) and the differences within the same handling activity (e.g. stacking/loading/unloading time with respect to the tier number). Such contributions primarily focus on modeling architecture, on software implementation issues and on simulating design/real scenarios. Activity duration is often assumed to be deterministic, and those few authors that estimate specific stochastic handling equipment models do not clearly state how they were calibrated, what data were used and what the parameter Values are. Finally, no one investigates the effects of different modeling hypotheses on the simulation of container terminal performances. The focus of this paper is on the effects that different hypotheses on handling equipment models calibration may have on the simulation (discrete event) of container terminal performances. Such effects could not be negligible and should be investigated with respect to different planning horizons, such as strategic or tactical. The aim is to propose to analysts, modelers and practitioners a sort of a guideline useful to point out the strengths or weaknesses of different approaches. Drawing on the model architecture which will be affected on port economics.

Development of a Simulation Procedure for the 3D Modelling of the Filling Process in a Navigation Lock Including Fluid Structure Interaction

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A good compromise between a smooth and safe filling and emptying procedure on the one hand as well as small construction and maintenance costs on the other hand is the ultimate goal, when designing a ship lock. For the smooth and safe filling, the forces acting on the ship hawsers are the critical design criteria. Due to the difficulties and uncertainties in measuring them, typically the hydrodynamic forces on the ship hull are measured in a physical model. To do so complex measurement structures are installed on top of the ship for analysing the acting longitudinal and transversal forces resulting from the tilting of the water surface in the ship lock chamber during the filling. However, high construction costs, long construction times, the restriction to very few measuring points and especially unavoidable scale effects make the physical models disadvantageous in some cases and strengthen the need for alternative investigation methods like numerical models. Yet, the analysis of the forces on the ship with the means of numerical modelling is still a big challenge, since the lifted ship requires special numerical methods for performing the fluid structure interaction. Necessary mesh motion and adaption for large lifting heights and small space between the ship and the lock chamber walls complicate the simulation. In the scope of our study we developed a procedure for modelling the locking process with a movable ship hull on basis of the CFD toolbox OpenFOAM-extend, combining mesh generation and manipulation steps and special solving algorithms. In particular, the mesh consists of a movable and a non-movable cell zone. The movable zone includes the main parts of the ship lock chamber and the boundaries of the ship hull defined as a rigid body with two degrees of motion freedom. The upstream water and the filling system underneath the lock chamber belong to the static region. Both cell zones are connected through two interfaces: one vertical interface in front of the ship and another horizontal interface underneath the ship. The first allows the sliding of the moving mesh region inside the lock chamber. The latter was constructed for defining the location for layer addition and removal during the simulation. The cells in the movable region are deformed as a function of the ship's motion, when a certain aspect ratio is exceeded a new layer of cells is added below the ship. For the calculation of the multiphase problem a Volume-of-Fluid approach was used, which was extended for improving stability and enabling the fluid structure interaction. The case was calculated on the in-house high performance computer. For the computation of 200 seconds approximately 14 days with several restarts were required on 16 cores. Special care is taken to ensure



computational load balancing in the presence of topological change i.e. layer addition or removal. For validation, the results of the simulation were compared to measurements from a physical scale model. The results showed acceptable agreement and suggest that the methods utilized provide a milestone for the development of the numerical investigations of forces on ships during the lockage. In the framework of the paper the methods used for the grid generation and manipulation will be described in detail. Further, the developed approach for enabling the lifting of the ship will be explained including details about the numerical solution procedure. For showing the practicability, the transferability of the modelling procedure to other examples, the computation time and other challenges of the study will be discussed. Possible sources of error will be listed and an outlook for future studies will be given.



- ABSTRACT 29 -

Waterways Management in Bahía Blanca Estuary

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In 1993 the Bahia Blanca Port Management Consortium (CGPBB in Spanish) became the first self-governing Port of the Argentine Republic. Self-finance has provided the funds to undertake port expansion, not only of the infrastructure in land (roads and services) but also in waterways and berths which received a remarkable boost. The combination of natural advantages and efficient administration has contributed to present success. Great efforts have been made to improve the conditions for navigation in Argentina's deep water port, to maintain a competitive breach and bolster future development

Pilot Project Bad Deutsch-Altenburg - impact-orientation and impact-assessment in the development process of river engineering measures

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The about 48 km-long section of the Danube River between Vienna and the Austrian-Slovakian border constitutes the most significant weak point for inland navigation in the West-East transport corridor. Furthermore, continuous riverbed degradation in this section of the Danube of up to 3.5 cm per year jeopardises the ecological balance of the Donau-Auen National Park.

In order to remove the bottleneck East of Vienna for the benefit of navigation, to counteract riverbed degradation and, at the same time, to give adequate consideration to the ecological requirements in the project area, the so-called Integrated River Engineering Project to the East of Vienna has been conceived as an integrative project; It combines and unites the interests of navigation with the ecological needs of the Donau-Auen National Park on the basis of the technological possibilities offered by hydrologic engineering measures. To attain these objectives, a combination of various river engineering measures was developed in an integrative planning approach. Despite using cutting-edge hydrodynamic models and running physical model tests at the hydro engineering laboratory of the Technical University of Vienna, it was decided to realise additional field tests.

Within the scope of the Pilot Project Bad Deutsch-Altenburg, practical experience has been gained on river-engineering measures to be employed on the entire Danube stretch. These measures include

- the restoration and lowering of river banks,
- the re-connection of a cut-off side-arm and
- the optimisation of low-water regulation along the project stretch.

Adding somewhat coarser Danube gravel is expected to equip the riverbed with a better protection against further deepening.

For the first time, all measures developed for the Danube East of Vienna were realised together in an approximately 3 km long river stretch. The construction works took place between February 2012 and July 2014. Since then the post-monitoring phase of has been carried out.

Although the project will only be fully evaluated in the next few years, it is clear that the pilot project has proven to be a beneficial method for an impact-orientated investigation of the effectiveness of the developed collection of measures before realizing them on the entire stretch. Furthermore, practical experiences were gained for the technical implementation of the innovative river engineering measures to reduce potential technical and financial risks.

The Pilot Project Bad Deutsch-Altenburg was not only designed to test river engineering solutions and construction processes. It was also necessary to develop



and test the required technological and ecological impact assessment procedures. In a pilot project, suitable impact assessment is a particularly critical success factor. The project was therefore accompanied by an extensive monitoring programme which contributed to adequate documentation and interpretation of the test results. After monitoring the situation before the realisation of the works and the second phase to accompany the construction works, the post-monitoring is running since the finalization of the works and for the years to come. Part of phase 2 and 3 is a tailored research facility under the framework of the Christian Doppler Society - an Austrian research institution responsible for scientifically evaluating particularly demanding hydro morphological aspects of the project.

The realisation of a pilot project will also contribute to a higher acceptance for the need and the measures of the global project. A participative stakeholder model ensured that affected groups and stakeholders, for example the navigation sector, scientists and environmental protection organizations would be informed and collaborate effectively in the project from the start until the final implementation. Within this model, stakeholders were involved in the project on a decision-influencing level, had the opportunity to receive detailed insights into the project, to accompany the construction works and could discuss the interim project results. In this case, personal observation and live demonstration of the progress replaced complex plans and computer models. The participation model proved to lead to a better understanding of the deficits in the river section, explained the need for action and contributed to a better understanding of the requirements of the situation.

- ABSTRACT 32 -

How to maintain (the potential of) an international waterway?

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With 10 riparian states and 2.414 navigable river-kilometres, the Danube is not only the most international river in the world but also shows a large variety in nautical, hydrological and hydro-morphological characteristics. Some parts are compounded stretches and large parts of the Danube are free-flowing. These circumstances have far-reaching impacts on the maintenance activities required by the Danube's different countries. The Danube river has a long tradition as an inland waterway for freight transport, whereas nowadays it still offers significant free capacity for additional waterborne freight transport.

Major historic events and subsequent political changes during the last century and beyond have changed the political scene along the Danube: two world wars, the period of the cold war, the dissolution of the Eastern Bloc, the establishment of the European Union and its enlargement still in progress to name just a few. Together with the technical and economic development, in particular of road transport, this led to major changes in transport flows and market conditions, so that Danube navigation was severely restricted and lost many of its competitive advantages.

Around twenty years ago, new interest in Inland Waterway Transport arose in Europe. Initiatives for promotion and development of inland waterway transport were taken, triggering action in various relevant domains: infrastructure, market, fleet, jobs & skills, telematics and communication. Together with the growing consciousness for the need of greening in the transport business, waterways came again in the general focus. Whereas European Union's transport policy puts its emphasis on modal shift towards rail and inland waterways, only very few national governments give policy priority to Inland Waterway Transport. As a consequence, on many Danube stretches, maintenance of the navigable channel has been neglected for a while, therefore further development of Danube waterway transport being limited.

In spite of these difficulties, the cooperation between waterway administrations along the river has grown through several dedicated joint projects in the framework of several initiatives of the European Union for infrastructure, cooperation, transport and innovation: Framework Programmes for Research and Technological Development, Trans-European Network for Transport, European Territorial Cooperation, Macro-Regional Strategies etc. The presentation will show the development path towards the recently adopted "Fairway Rehabilitation and Maintenance Master Plan" for the Danube and its navigable tributaries which describes the preconditions for sustainable

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waterway maintenance in the coming years through which the reliability of the transport infrastructure will be significantly improved.

The Masterplan identifies major needs for investment in dredging equipment, riverbed surveying and fairway marking. These and all other related needs are identified in the Masterplan per riparian country. In addition, all critical locations are identified in the Masterplan and are currently under classification with regard to their priority for rehabilitation of the Danube waterway.

This success story of international and trans-boundary collaboration for inland waterway management builds the agreed basis for significant improvements for the United States ability of the Danube as a transport infrastructure during the next years and it shall encourage the rehabilitation and further development of international inland waterways worldwide.

Workshop on DESIGN GUIDELINES FOR INLAND WATERWAYS

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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 in May 2010. In so far 11 meetings, 2 interim meetings on special questions and several internal workshops, the group developed an approach to account for different safety and ease demands for waterway design, reviewed existing guidelines, analysed practice examples, especially concerning fairways in rivers and discussed the use of ship handling simulators for waterway design purposes. As a result, three approaches or steps to find appropriate waterway dimensions, depending on necessary ease demands will be recommended:

- The Concept Design Method, basing on existing experience and guidelines, delivering concrete design values e.g. concerning minimum fairway widths and depths in straight canals, if necessary extended by using additional information e.g. for wind or curve increments or safety distances.
- The Practice Approach, providing data from existing waterway dimensions and corresponding boundary conditions to be compared to the specific design problem considered.
- The Case by Case Design, using field investigations or ship handling simulations with special respect to quantify the easiness of a special driving situation.

Within the workshop the recommended approach of WG 141 will be presented in detail and demonstrated by examples. They latter show how the approach works in practice. Our first workshop in the framework of the last Smart Rivers Conference in Maastricht two years ago showed that we are generally on the right way, especially concerning the recommended three steps design and the safety and ease approach. But because the report of WG 141 should not be published before its practicability will be examined, we hope to get feedback from the audience especially concerning this point.

- ABSTRACT 38 -

METHODOLOGY FOR LINKING EXTREME FLOOD EVENTS AND THE COST OF DAMAGE TO WATER SECURITY INFRASTRUCTURE

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The possibility of collapses of some of the small dams and reservoirs, as a result of extreme flood events, is likely to increase due to climate change effects (Mason et.al,1999:241-257). The risk of damage to infrastructure from extreme rainfall and flood events is greater in drier areas than areas that usually receive high rainfall (World Bank, 2001a:1-14). Much of Southern Africa lies within arid to semi-arid climatic regions. This research paper examines both the scientific and financial approaches for linking extreme flood events and the cost of damage to water security infrastructure in the Vaal River Water Management Area, Gauteng Province, Republic of South Africa. Key parameters driving the relationship between extreme flood events and the cost of damage are identified. Theoretical and simulated extreme flood events from three separate sub-catchments in the Vaal River Water Management Area are used to determine the cost of damage to water security infrastructure in the catchments. The outputs are then compared with actual cost of damage to water security infrastructure as a result of recorded extreme flood events. Reliability of the results or findings is achieved by comparing outputs from amongst selected catchments. The outcomes of the analysis are then used to determine the risk factor which should be taken into account when designing the water security infrastructure. In addition to the risk factor, the researcher develops a process framework for linking extreme flood events and the cost of damage to water security infrastructure.

The Rhine - a small river that became a successful multinational transport system

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With a length of 1300 km, of which 850 are navigable, the Rhine is not among the largest 100 rivers of the world and only number 12 in Europe. In terms of transport however, it is one of the most important rivers, with 330 million tons of cargo and 2 million containers (TEU) carried on inland navigation vessels each year, equalling 45 billion tkm. What sets the Rhine apart from most other large fluvial navigation systems, in particular from those in China, Russia and the UNITED STATES, is its multinational character. The navigable part of the Rhine runs through four countries and inland navigation counts for more than 50% of the cross border freight traffic along the Rhine corridor. This makes the Rhine probably the most important *multinational* inland water transport system. Furthermore, the Rhine forms the backbone of an even larger navigation system that connects a number of the most significant industrial centres, urban areas and seaports of six western European countries. This larger system provides for almost 2000 km of highly developed inland waterways.

In addition to its geographical location, which provides a high demand for transport services, what has made the Rhine such an important multinational fluvial navigation system? And what are the critical success factors that guarantee its sustainable development?

1) A very good infrastructure for navigation

The Rhine waterway maintains high standards for effective navigation. It has guaranteed fairway dimensions for large vessels and convoys. Modern technologies and River Information Services (RIS) are employed to ensure safe and economical navigation around the clock throughout the year.

2) A well-organised industry with a long-term interest in inland navigation

It has been decisive for the development of the Rhine to have competent and progressive industry representatives engaged in a structured dialogue with public authorities in defining policies for the development of Rhine navigation. Since the 19th century, strong links have existed between ship owners, skippers, bankers, technical and legal experts and other professionals, forming a cluster to support a competitive industry. The Rhine fleet is continuously developed according to logistical needs and technological progress by entrepreneurs who drive this industry.

3) Integration in logistical chains

Numerous public and private ports and terminals constitute the link between Rhine navigation and the surrounding economy. They are inter-modal platforms providing a great variety of services. The large seaports are the gateways of Western Europe to the world, and the Rhine connects these seaports most efficiently with the hinterland beyond.

4) A dedicated supranational organisation

Since 1815, the Central Commission for the Navigation of the Rhine (CCNR) has been the forum for coordination and decision-making in all international matters concerning Rhine navigation. Freedom of navigation, equal treatment of waterway users and prosperity for the navigation industry are its guiding principles. The CCNR was given legal powers, which it has used to develop a comprehensive and continuously updated set of regulations for Rhine navigation. These regulations have become the blueprint for the regulation of inland navigation in Europe and beyond.

5) Protection of the environment

The Rhine's navigable waterway system is to a large extent the result of human actions. In the past, development has often been ecologically blind and as a result, caused severe damage. Today, decisions concerning the management and improvement of the infrastructure are preceded by careful environmental impact assessments. These are carried out in close cooperation with all stakeholders. The shipping industry is well aware that inland navigation is only one of several water uses and all of them must engage in the protection of the fluvial ecosystems and the environment in general.

These five factors are more than an explanation of the enduring success of Rhine navigation. They are central elements of a strong economic system, as the Rhine is more than just a waterway. They can also be used as guiding principles for effective development of other multinational fluvial navigation systems.

LNG Masterplan for Rhine-Main-Danube corridor - Lessons learned from a highly innovative and complex transport innovation project to facilitate LNG as fuel and as a cargo on Europe's main inland waterway artery

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The LNG Masterplan for Rhine/Meuse-Main-Danube (2013 - 2015) functions as cooperation platform for authorities and industry stakeholders for facilitating the use of Liquefied Natural Gas (LNG) as fuel for inland vessels as well as a cargo. The project is coordinated by Pro Danube Management and Port of Rotterdam Authority and brings together 33 project partners from 12 EU Member States and one associated partner from Switzerland. Due to its high innovative character and its relevance for major objectives of the European transport policy, the project is co-financed by the European Union from the Trans-European Network for Transport Programme. It receives a grant of more than € 24 million.

The LNG Masterplan will provide the basis for turning LNG into a major fuel for inland vessel as well as paving the way for LNG to be transported by barge on the most important European waterway axis, the Rhine/Meuse-Main-Danube corridor. The project actively contributes with innovative concepts and deployments for vessels and on-shore LNG infrastructure and ensures the environmental competitiveness of the inland navigation sector together with improved efficiency of vessel operations. The project not only provides important inputs to a concise regulatory framework but delivers a high number of innovative concepts and concrete investments in LNG fuelled vessels and on-shore infrastructure.

Together with key industry stakeholders, the project partners elaborate a comprehensive strategy for the deployment of LNG. This strategy encompasses an Action Plan with concrete measures in identified areas, such as market & financing, vessels & equipment, jobs & skills, infrastructure and governance aiming to provide guidance for future policy actions on national and EU level. All in all, the LNG Masterplan project plays an important role in reaching a wide spread use of LNG in inland shipping on a mid to long term perspective

AIS next generation - the development of the VHF Data Exchange System (VDES) for maritime and inland navigation

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The Automatic Identification System (AIS) has been successfully introduced by the International Maritime Organization (IMO) for maritime navigation in 2002. Since then, more than 100 000 commercial ships and recreational vessels have been equipped with AIS. AIS is widely used in many applications in maritime and inland navigation: AIS Class A is an IMO carriage requirement for maritime shipping; AIS Class B for pleasure craft and smaller vessels; AIS Search And Rescue Transmitter (SART) and AIS Man Over Board Device (MOB) are used for search and rescue purposes; AIS AtoN stations are used to equip aids to navigation (AtoN). AIS base stations and AIS repeater on shore provide the infrastructure for shore based applications like Vessel Traffic Services (VTS), River Information Services (RIS), traffic surveillance and ship reporting systems. Via satellite detection AIS is also used for global tracking of ships. In European inland waterways Inland AIS is used, which serves the specific needs for inland navigation while maintaining interoperability to maritime AIS.

Further, AIS has some capability for the exchange of safety and navigation related data between ships and between ship and shore. This functionality is known as Application Specific Messages (ASM) and can be used to send - for example - meteorological and hydrographic data, area notice, safety messages, route information or lock information. However, recognizing the potential of ASM and considering the development of e-Navigation and River Information Services, additional possibilities for data exchange between ships and between ship and shore are required beyond the capability provided by AIS.

The next generation of AIS - the VHF Data Exchange System (VDES) - will take into consideration the requirements for more data exchange capabilities while protecting the AIS radio channels (VHF Data Link VDL) from overload as AIS populations increase. First signs of AIS channel overload were seen in some busy areas like big seaports or areas with a high amount of recreational vessels using AIS.

International organizations like the International Telecommunication Union (ITU), the International Maritime Organization (IMO) and the International Association of Maritime Aids to Navigation and Lighthouse Authorities (IALA) have recognized the growing use of AIS as well as the increasing need for data communication and started the development of the next generation of AIS - the VHF Data Exchange System (VDES). VDES will include the original function of AIS, it will provide extra channels for Application Specific Messages as well as additional functions of higher data exchange capability considering requirements for data communication like data protection or the guarantee of data delivery. The VDES will provide terrestrial data communication as well as satellite components using VHF radio channels.

DUKC[®] Chart Overlay - An operational tool for vessel navigation

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While developments in positioning technologies have led to great advances in relation to the horizontal position of a vessel, with AIS, VTS, ECDIS as prime examples, technologies relating to vertical position have not advanced to the same extent.

Until recently no Aids To Navigation could provide spatial, predictive information about anticipated UKC for vessels in transit. Existing charting packages allow tides and draft requirements to be entered, but have the disadvantage of being static, spatially constant and limited to the resolution of the navigational chart.

DUKC[®] Chart Overlay (DCO) technology is designed to meet this need of providing predictive spatial UKC information to pilots. Functionally the information is displayed as a Marine Information Overlay (MIO) that can be displayed on a suitable Electronic Charting System (ECS) such as installed on a Portable Pilot Unit (PPU). The DCO displays the UKC information as a semi-transparent image with each pixel representing an area on a high resolution grid. Where UKC requirements are not met at a particular point on the grid, its pixel is displayed red.

The benefits of a DCO are accrued through allowing rapid identification of channel areas that must be avoided, which allow pilots to make informed tactical navigational decisions about a vessel's route as well as fine-tuning or optimising of passage plans for long or complex passages while already underway. In emergency conditions the information from DCO could inform pilots and decision makers of escape options and by doing so lower the risk of channel blockages.

The DCO implementation and operation requires the coordination of a number of partners. The predictive UKC requirements for a planned route require an operational DUKC[®] system (described in a companion paper) with transit monitoring enabled. Transit monitoring combines AIS information of a vessel's position with the latest environmental and passage plan information (which can be modified while underway by the pilot to adapt to changing conditions).

The overlay is produced by combining the DUKC[®] forecasts with the latest high resolution (sub metre) bathymetry surveyed by the Waterway Agency. By projecting the bathymetric data onto a grid with a resolution of metres, a more detailed seabed surface results than is usually available from a navigational chart. The DCO is created by identifying areas on the detailed surface where the predicted UKC will be insufficient, and flagging them.

The DCO generation is a land based process. Transferring the DCO to the transiting vessel is done by an electronic charting partner who publishes the overlay on a server for the ECS on board to download. Each DCO is vessel specific, and needs to be

regularly updated, as the passage plan and environmental conditions on which the UKC information is dependent changes.

The DCO has been successfully implemented for vessels transiting through Torres Straits, a shallow and narrow body of water, between Australia and Papua New Guinea. Torres Strait connects the Pacific Ocean via the Coral Sea with the Indian Ocean via the Arafura Sea, and consequently has dynamic and complex tidal movements. The transit through Torres Straits is approximately 6 hours, which gives ample time for the changes in passage planning adapting to changes in predicted environmental conditions as well as traffic conditions in the waterway.

One of the rationales for introduce DCO in Torres Strait was the increased safety that the additional navigational information would provide pilots by providing enhanced situational awareness of UKC restrictive areas.

While DCO is a new technology, there are a number of characteristics of riverine environments suggests that its adoption could be valuable. River transits are generally of long duration, and pilots often need to adopt passage plans due to traffic congestion or other issues that were not present when transit commenced. Mobile beds caused by migrating sand waves means that the bathymetry is constantly varying. As the DCO uses the latest available high resolution bathymetry, the UKC implications of sand wave migration can be more easily detected and route corrections adopted. Finally, in estuarine environments where tidal influences are present, the DCO allow changes in UKC conditions, due to changing environmental conditions, to be quickly transmitted to the vessel and their implications immediately assessed.

Proposals for a bridge collision warning system

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Collisions between inland vessels and bridges due to insufficient vertical clearance are a major part of accidents in inland waterway transport in Germany. On inland vessels, several parts like the wheelhouse or a radar antenna can be lifted to improve visibility to the skipper. Furthermore, cargo may be of varying height from trip to trip. When the vessel approaches a low bridge, it has to be checked whether a safe passage is possible, and, eventually, these parts have to be lowered again to enable a safe passage. Otherwise, a collision of e.g. the wheelhouse with the bridge superstructure will cause serious damage to the vessel and possible injury to persons in the wheelhouse. At the same time, light bridge constructions like bridges for pedestrians or bikers are in danger to be severely damaged in case of a collision with an inland vessel.

In this paper different approaches to realize a bridge collision warning system shall be presented. They are the result of a feasibility study of the German Waterways and Shipping Administration on this subject which has been finalized recently. A bridge collision warning system shall warn the skipper in time, as soon as parts of the vessel are too high to pass under a bridge. To solve this task, four different solutions have been identified. Components of the systems are onboard equipment, measurement units in the area of the bridges as well as further land based infrastructure and services. This approach makes use of several RIS components. At the same time, extensions to several RIS components are proposed.

One approach uses onboard measurements of the height above water level combined with actual bridge clearance data computed in a central service based on water level models. As an alternative, direct clearance measurements at a bridge can be used. Different approaches to model the clearance of a bridge are taken into account. Bridge clearances from the Inland ECDIS chart are used as basic clearance data. In addition, the United Statesge of exact bridge profiles has been considered. To take into account temporary restrictions of bridge clearance, notices to skippers have to be processed by the system. For the transmission of bridge clearances from shore to the vessel a mobile internet connection as well as the United Statesge of AIS has been considered. A second approach bases on onboard DGNSS processing combined with information about the geodetic height of the bridge superstructure. For application of a bridge clearance warning system, high precision multi frequency GNSS is required. The provision of suitable correction data (based on RTK and PPP methods) with high availability is a crucial point in this approach.

The third approach is based on laser scanners installed near the bridge. Here an alarm would be generated on shore. It has to be signaled by installations on the bridge or by transmitting it to a suited system on the vessel.

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The fourth approach makes use of thermal cameras monitoring the area in front of the bridge.

The different approaches are compared regarding different criteria and requirements like accuracy, availability with respect to weather or lighting conditions and costs. For the cost estimations, scenarios for one bridge, a regional roll out as well as a nationwide coverage in Germany is taken into account.

The full paper and presentation is based on the findings of final report of the feasibility study including a description and assessment of the mentioned solutions. In addition the paper will provide information about unsolved problems and which may require future investigations in these fields.

Numerical modelling of hydrodynamic interaction forces during entering of a sea lock for Real Time Simulations

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In order to be able to receive seagoing vessels of ever increasing size in the port of Amsterdam, Rijkswaterstaat (the executive body of the Dutch Ministry of Infrastructure and the Environment) plans to build a new large sea lock at IJmuiden that is capable of doing so. The new lock will be situated in between two existing locks, which leads to an asymmetric approach on the sea side of the new lock. To assess the minimal required nautical space at the sea side approach of the new lock, Real Time Simulations have been performed at MARIN.

During a lock entry, large vessels experience high forces and moments caused by the induced hydrodynamics. In general, the hydrodynamic models underlying a Real Time Simulator (RTS) only account for (undisturbed) time-varying hydrodynamic influences, like currents, but do not account for the hydrodynamic phenomena induced by the presence of a vessel (i.e. vessel and geometry induced currents, translation waves and their reflections). As there is a strong coupling between the (longitudinal) propulsion forces of the entering vessel and the rudder forces (lateral forces and turning moments), longitudinal forces, as well as lateral forces and turning moments due to hydrodynamic interaction, play an important role.

To account for the longitudinal forces on a vessel caused by the aforementioned phenomena and to realise a proper nautical safety assessment of the new lock design, Deltares coupled the 1D numerical model WAROS (Vrijburcht, 1991) to the RTS. Since WAROS is a 1D model it does not account for the lateral forces and turning moments working on a ship. To account for these the potential flow model DELPASS (Pinkster, 2004, Pinkster and Bhawsinka, 2013), developed by PMH, was coupled to the RTS as well by MARIN. Since DELPASS is a potential flow model, it does not account for viscous effects and can thus not be used to calculate the longitudinal forces working on a ship. The combination of two separate models therefore enhances the hydrodynamic modelling of the RTS significantly.

WAROS has been developed in the eighties to calculate ship and water movements during entering, leaving or sailing through symmetrical locks by inland vessels. The model is an extended version of the mathematical model of Vrijburcht (1986). During the studies for the new sea lock, WAROS has been validated with scale model tests of seagoing vessels entering asymmetrical locks performed by Flanders Hydraulics Research.

The present paper mainly focusses on the validation of WAROS for seagoing vessels, the conceptual functioning of the coupling of WAROS to the RTS and the verification of



the coupling. Additionally, this paper also describes briefly the coupling of the potential flow model DELPASS to the RTS to account for the lateral forces on a vessel due to the asymmetrical approach of the new lock design. Results of the coupled simulations with the RTS of the IJmuiden sea lock are not presented due to confidentiality of the project.

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- ABSTRACT 52 -

The St Lawrence River DUKC[®] System Implementation

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The Port of Montreal is one of the largest inland ports in the world, handling around 1.5M TEU and 17.8MT of bulk cargo in 2014. The Port of Montreal is connected to the Atlantic Ocean through the St Lawrence River. Drafts to Montreal vary seasonally with the river levels. When the river is at its highest the maximum drafts are about 11 m.

To safely make use of the full water column on the St Lawrence River, the Montreal Port Authority, in conjunction with the Canadian Coast Guard, contracted OMC International to deploy a DUKC[®] system to provide sailing advice for vessels transiting between Montreal and Quebec. DUKC[®], or Dynamic Under-Keel Clearance (UKC), is a web-enabled navigational aid that dynamically calculates the UKC requirements of vessels transiting a waterway.

The DUKC[®] system provides two principle benefits of safety and economic efficiency. Safety is delivered by ensuring that planned passages have sufficient UKC throughout the entire transit. Economic efficiency is achieved by allowing vessels to load more cargo, or sail at times that would not be possible under previous static rules.

While the DUKC[®] has previously been installed in waterways as an extension of marine areas, this is the first installation in a purely river based environment. This paper will cover the technologies implemented, particularly focusing on In Transit sailing advice, speed optimisation and air draft features.

From a hydraulic perspective the river section between Montreal and Quebec City can be understood as two separate systems. The section from Montreal to Trois-Riviers (~70 NM) is a riverine system, with water levels controlled by upstream flows from Lake Ontario. From Trois-Riviers to Quebec City (~70 NM) the river is tidal. Strong currents are a feature of both sections of the river and transits last from about 12 to 20 hours, with vessels sometimes anchoring midway through the transit. These features of mixed regimes, strong currents and long transits present a challenge to producing accurate sailing advice.

The DUKC[®] needs to ensure that UKC requirements are met throughout the duration of a transit and therefore forecasts of river conditions need to cover the duration of any planned passage. As squat is one of the major UKC components in the waterway, accurate predictions of currents are needed to assess speed through water and times at locations. The St Lawrence DUKC[®] system requires forecasts of water levels and currents. Official 30-day forecasts of water levels and currents are provided by the Canadian Hydrographic Service for hundreds of locations along the river and these are directly integrated into the system.



The In Transit feature of DUKC[®] is particularly useful for the St Lawrence system because the UKC requirements of an underway transit are continuously monitored and the UKC implication of changes to passage plans or of changing environmental conditions can quickly be assessed. Vessel positions are monitored through an AIS feed. This positional information is combined with any revised forecast and the UKC for the remainder of the passage recalculated. This updated passage plan UKC information can be viewed on any web enabled device, on board or ashore.

The pilots were interested in optimising their speeds to reduce the overall transit time. This functionality was introduced into the DUKC[®] through a new speed optimisation feature that calculates the speeds of a planned passage or an underway transit to find the fastest route, while maintaining sufficient UKC.

Overhead power lines and bridges provide a particular challenge for waterways that are not often present in marine environments. As vessels transiting the St Lawrence River pass under a number of significant bridges and major power lines, the ability to assess the air draft as well as UKC was an additional feature requested by the DUKC[®] users. In collaboration with stakeholders an initial implementation of air draft has been configured which will be refined as feedback is received.

The DUKC[®] has provided sailing advice to marine ports for over 20 years. The implementation of the DUKC[®] in the St Lawrence River shows that the DUKC[®] technology can be successfully implemented in a riverine environment, allowing riverine users to benefit from the UKC planning and monitoring advice that the DUKC[®] provides.



- ABSTRACT 53 -

Traffic and Cargo Trends on U.S. Inland Waterways

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The demand for surface freight transportation is growing in the U.S. and worldwide, yet traffic on U.S. inland waterways has been slowly declining for decades. Recent data shows that in some parts of the system the decline is accelerating. In the U.S., waterways are the most underutilized mode of freight transport. Freight movements by rail have increased dramatically, and we have increasing congestion on highways. What is driving the decline in waterway traffic, and how might it be reversed? Could the waterways attract new cargos? Would better intermodal connections increase traffic? Is the reliability of infrastructure (or lack of it) a significant factor? This presentation will present the latest data on both tonnage and cargo and discuss the forces and factors which drive freight movement on the waterways now and in the future.

Review of existing solutions and presentation of a simplified method for the crashworthiness of lock gates

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This paper presents a review of existing solutions to analyze lock gates subjected to vessel collisions. In the first part of this article, a brief review of national and international guidelines is performed. Some examples of existing protection devices are also provided. The second part of this paper is devoted to the presentation of a simplified analytical method that could be used to quickly evaluate the impact resistance of plane lock gates. To validate this new approach, some comparisons with finite element simulations are presented.

Computational Fluid Dynamics simulations of the effects of density differences during the filling process in a sea lock

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A variety of forces are exerted on a ship during a lock leveling process. The following force components can be identified: forces due to translating waves, momentum decrease, friction, from the filling jet, but also due to differences in density along the length of the ship. Numerical methods, in this case often 1D or 2D models, like LOCKFILL, to predict these forces often schematize each individual type of force and superpose them to get a net force. The schematization involves a simplification, especially for the forces due to the filling jet and the density difference, which requires calibration to experimental results and is therefore not always generally applicable for a wide range of leveling systems. The application of a generic model would be a useful tool in lock leveling system design.

This paper reports results from the application of Computational Fluid Dynamic (CFD) simulations of a leveling process in a sea lock using a fully 3D finite volume code (Star-CCM+). The model incorporates a free surface in the lock, saltwater density effects by means of a transport equation for salt, a turbulence model validated for negatively buoyant jet flows and a fixed ship. Mesh deformation with overset meshing is used for the moving door valves. The leveling system incorporates door openings with breaking bars. The lift head of the leveling process has a maximum of approximately 4.5m.

Firstly the resistance and discharge coefficients of the leveling system are calculated by means of a permanency test with a constant flow. For a given discharge, the drop in water level characterizes the total resistance of the system when the door valves are fully open. Good agreement is seen with the experimental measurements showing that CFD can be used to characterize resistances in this way. These CFD simulations are relatively short in duration.

Secondly a leveling process without a ship is simulated. The leveling system is steered by means of moving valves in the door which are simulated in the CFD model by means of an overset mesh algorithm in Star-CCM+. The discharge curve is a result of the CFD simulations. Comparison measurements of velocities in the lock chamber from the scale model tests are not available. Finally a leveling process with a ship present and a density difference is simulated.

The results show that CFD can be used in an early stage of lock design to make assessments of a design's viability but that a fully functioning virtual prototype of a lock in CFD needs more validation data of the complex flow fields in the lock chamber.

- ABSTRACT 56 -

Contribution of channel lighting to the safety of navigation as seen from the pilots perspective

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Inland channels in the Netherlands with combined inland waterway and sea going traffic have channel lighting comparable to streetlights in normal road traffic. Considering that all vessels are equipped with radar and most vessels nowadays are equipped with electronic chart devices, it is questioned if an expensive and energy consuming system of channel lighting still is necessary for safe navigation. A study was started using a manoeuvring simulator to determine the contribution of the channel lighting to the safety of navigation. In a first phase of the study inland skippers sailed a bended channel with a four barge push convoy during night handling meetings with sea going traffic. During the simulations distances to banks, distances to other traffic and the swept path were measured together with physiological (workload) measurements like heartbeat and the capability to perform an additional secondary task. The results of the first phase showed for tight situations (160 m channel width) a strong correlation between the availability of channel lighting and the performance in terms of distances to banks, distances to other traffic and workload of the skippers. For wide channels no correlation was found between the availability of channel lighting and the performance. It was concluded that from the perspective of the inland skipper channel lighting is only necessary in tight situations.

The first phase focussed on the necessity of lighting for the inland skippers and studied only the availability of channel lighting and the distance between the lights. In a second phase of the study also river pilots sailed the same bended channel during night with a large bulk carrier and handled meetings with inland vessels and other sea going traffic. In this second phase also design aspects like the colour and flash pattern of the lights were studied. The methodology for the second phase was identical to the first phase and was based on measuring performance in terms of workload and distances to banks and other traffic during a navigation task with and without channel lighting. In case of channel lighting the following design aspects were varied:

- Distance between the lights;
- Colour of the lights;
- Flash pattern of the lights.

Based on a comparison of the performance measures it was concluded that from the perspective of the river pilot channel lighting contributes to safer navigation in all circumstances. A row of lights on each bank with a fixed separation distance between the lights provides very fast information on the rate of turn of the own vessel and the relative position of the own vessel to other traffic and to the banks. E.g. the river pilots indicated that in most cases a small rate of turn is detected earlier from a row of lights

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than from the instruments like a rate of turn indicator or the ECDIS. It was recommended to use yellow lights on both banks at a separation distance of 200 m. The paper describes the set-up, the results and conclusions of the second phase of the study in relation to the above mentioned design aspects and as seen from the pilots perspective.

The Seine-Scheldt project Challenges renewing 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 tonnes). In order to achieve this, the Belgian region of Flanders is preparing navigability enhancements of the river Lys, which currently allows vessels up to 2000 tonnes.

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 contract demands the continuity of navigation during the execution of the works, apart from a small period 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.

Due to the lack of space of the project area, lying in the city centre of Harelbeke between several building projects, building a temporary lock and temporary weir showed to be the best solution to guarantee flood management and traffic on the river during the works. Innovative thinking in the building sequence, re-use of building components and very detailed study was needed to cope with this challenge.

To solve the problem of fish migration along the river Lys, a fish ladder is provided to bypass the weir. Next to it, a pumping station will compensate water losses during dry periods. Most of the time though, this installation will be used as a generator creating energy from the natural water flow on the river Lys. On an average basis, this lock will be energy-neutral.

To accommodate vessels with 3 layers of containers, the road bridge in the city centre will be renewed at a higher level. The design is a state-of-the-art steel bow bridge, adapted to the scale of the surroundings and designed as a recreational area with view on the lock.

To connect the two river banks for slower traffic, a cycle path will also be built across the mill island, will lead over the fish ladder and over the river by a moveable bridge upstream of the lock. Although this additional bridge is a very useful connection for pedestrians and cyclists, reliability and operation times are very important issues to avoid impact on vessel traffic.

- ABSTRACT 60 -

Challenges and lessons learned from ten years of RIS operation in Austria

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In 2004 PIANC has set a major milestone for the implementation of River Information Services (RIS) by publishing the first edition of the “PIANC RIS Guidelines”. In Europe the “EU RIS Directive” was published in 2005 setting the frame for implementation of RIS in the European Union.

Austria was among the first countries to implement RIS after several years of preparation in parallel to the development of the PIANC RIS Guidelines and the EU RIS Directive. Based on the special properties of the Austrian Danube stretch with many river bends and nine locks on 350 river kilometers, the Austrian Navigation Authority took a European leadership position in RIS implementation in order to increase safety and efficiency of navigation by providing new tools for skippers and lock managers. The Austrian “DoRIS” system started operation in 2006.

Among the first services were a complete AIS-based vessel tracking and tracing (VTT) system, electronic navigational charts and an online system providing Notices to Skippers (NtS). DoRIS was extended later by other modules, namely the national RIS Index, an electronic reporting system (ERI), a lock management system (LMS), the national vessel certification database and several complementary value-added services.

Being among the first worldwide to deploy RIS, previous experience was neither available for specification and system implementation nor for RIS operations - therefore, many lessons were learnt during the development and the first ten years of DoRIS operation.

The presentation will summarize the main challenges and experiences of this process in various areas: technical aspects organizational and procedural questions, legal and financial topics. Special emphasis will be laid on the interaction with RIS users, as well during requirement collection as during pilot operations and associated United Statesability improvements. This shall provide valuable input for countries which are planning to implement or to extend RIS. They can draw from available experience and overcome more easily the existing gaps in standards and guidelines which still exist today, more than ten years after the publication of the PIANC RIS Guidelines and the EU RIS Directive.

- ABSTRACT 61 -

Discussion about the low-carbon conservation mode of inland waterways in Jiangsu Province

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Conservation is an important part of protecting waterway resources, continuing waterway's life, and achieving waterway's sustainable development. According to the definition of international standard for low carbon concept, this paper researched the concept of low-carbon mode in waterway conservation, and analyzed the connotation of low-carbon waterway conservation mode. From technical and management levels, this paper put forward low-carbon maintenance modes of routine maintenance observation, navigation mark and signage maintenance. Low-carbon mode of routine maintenance observation includes low-carbon mode based on field observation and low-carbon mode based on informationized observation. Low-carbon mode of navigation mark and signage maintenance includes low-carbon mode of informationized navigation mark observation and low-carbon mode of navigation mark repair. Based on carbon emission model, this paper calculated carbon emissions of various modes of routine maintenance observation, navigation mark and signage maintenance in waterway conservation. As the results shown, after introducing the low-carbon modes, carbon emissions of routine maintenance observation, navigation mark and signage maintenance will reduce obviously. Regarding the routine maintenance observation, low-carbon mode based on field observation can reduce carbon emissions by 44.1% at most, and low-carbon mode based on informationized observation can reduce carbon emissions by 72.1% at most. Regarding the navigation mark maintenance, carbon emissions can reduce 50% at least. Through concept innovation, technological improvement and so on, the traditional waterway conservation way is changed to low-carbon way, helping to reduce carbon emissions of waterway conservation and to build ecological low-carbon waterway.

- ABSTRACT 64 -

Infrastructure for inland waterways: Sustainable solutions

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Although shipping is labeled as a sustainable transport mode, future societies will not be able to sustain, maintain and keep in operation, inland navigation forever, the way contemporary societies do so today. Studying the reasons why contemporary societies will not be able to sustain inland navigation, for a prolonged period of time, without compromising the environment, indicates important points on which one needs to focus, if one wants to improve the sustainability of waterborne transportation.

A widely accepted definition of sustainability comes from the 1987 Brundtland-commission. It states: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Inland navigation is sustainable according to the Brundtland definition. Still it does impact the environment negatively (emissions, land use, water use, ...), but it impacts people positively on both the individual and the societal level. Taking planetary boundaries into account, it is clear though, contemporary inland navigation is obviously not truly sustainable. The paper discusses the availability of energy resources as a planetary limit to growth. Furthermore the paper argues most of the mature economies in the world, the Eurozone, the OECD and the G7, have already reached this limit a decade ago. Many countries are being confronted with this limit to growth nowadays: Egypt and Argentina, among others, but apparently China as well. Other countries will encounter this limit in the not too far future, like India.

Just like the modern economy it's embedded in, waterborne transportation relies entirely on fossil fuels. Ships sail on oil, electricity, often generated by coal or gas fired power plants, is needed to operate locks, bridges, communication appliances and water management systems. Construction of infrastructure is a very energy intensive business too, not only in the construction phase, but equally in the production of building materials. Therefore constrained energy resources pose a significant threat to waterborne transportation and to the way contemporary infrastructure for waterborne transportation is conceived, because, within the projected lifespan of new infrastructure, energy will become scarce.

Examples of locks, dams, ship lifts, movable and fixed bridges, water management and bank protection, both in Europa and the UNITED STATES are investigated and judged on their merits concerning sustainability. It turns out infrastructure, designed with low energy use as the prime design parameter, has beneficial effects on cost and on other aspects of sustainability, such as wildlife and air quality.

With careful design of its infrastructure, inland waterways will serve future generations. To do so, engineers should take the following principles into account:

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- 1) The larger the infrastructure, the higher its contribution may be to the exhaustion of limited resources. Upscaling infrastructure is a policy that needs careful consideration, counting in future energy scarcity.
- 2) Heavy moving parts are to be avoided, unless careful design, so the parts can be operated, or can easily be made operable, without large amounts of external energy.
- 3) Concrete and steel are to be avoided, if possible, because of their dependency on fossil fuels during their fabrication, because high levels of CO₂ emissions and because they do not support ecosystems.

Shipborne Information Services

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The intricate fairway network in the Netherlands with hundreds of locks, bridges, weirs and thousands of vessels transporting people and (dangerous) goods every day necessitates constant vigilance from waterway authorities, especially in densely populated countries as in Western Europe.

In addition to Vessel Traffic Centers, Rijkswaterstaat (part of the Dutch Ministry of Infrastructure and the Environment) has a fleet of patrol vessels at its disposal to keep the fairways safe and waterborne transport flowing. To provide the crews of these ships with the information they need and to enable them to report irregularities with pinpoint accuracy, a new and innovative Ship borne Information Services system was developed which allows detailed monitoring and management of inland shipping in the Netherlands.

Integrated system to support the mobile traffic manager

Based on RIS key technologies implemented in the Netherlands in previous years, such as European standardized technology Automatic Identification System (AIS), electronic Reporting International (ERI) and Notices to Skippers (NtS), a new central collection and integration platform was created to supply the fleet with information services.

This set of information services integrates vessel position and cargo information with fairway information, displayed on an electronic chart, whilst allowing the mobile traffic manager to easily enter reports and messages directly linked to a geographical position. Additional vessel and fairway information can be retrieved through these services as needed.

As vessel position information is gathered from a central AIS receiving infrastructure and the cargo information from the national lock management system, patrol vessels are provided with all vessel information within a specified radius from their ship or any specified geographical location in the Netherlands, thus enabling the mobile traffic manager to make his preparations based on the actual operational picture of an area while the patrol vessel is departing for or still moving toward this area, which is crucial for effective emergency response. Events which occurred up to 15 minutes in the past can be recorded to aid incident analysis.

This ability to extend the situational awareness of the mobile traffic manager not just to the area around his vessel but to any area covered by an AIS monitoring infrastructure offers the unique ability to perform monitoring and traffic management as needed without having to rely on voice communication with shore based Vessel Traffic Centers.

Lessons learned

Since wireless communication cannot be relied upon to deliver an uninterrupted data link on the fairway, the system uses local storage and processing in order to continuously provide the user with the most actual data available, even when the data link is temporarily down. A robust store-and-forward mechanism in addition to careful



antenna configuration and placement aboard the vessels to optimize reception was implemented to deal with intermittent reception.

Extensive study and testing led to creation of the optimal geographic background charts onto which the relevant information is projected in order to manage performance issues when processing and displaying the information. Limiting the amount of zoom levels and layers solved this problem.

From an organizational perspective, getting a user population with years of nautical experience and seniority but a somewhat conservative attitude towards innovative Information Technology to adopt and fully exploit its possibilities requires considerable attention from the project organization.

Future developments

In the near future it will be possible to enhance the accuracy of position information even more by integrating Radar images using the Inter VTS Exchange Format (IVEF) protocol developed by the International Association of Lighthouse Authorities (IALA). As developments are progressing towards cross-border exchange of AIS and integration of the Dutch Coast Guard AIS monitoring system, the areas of interest available to the mobile traffic manager will be extended even further.

Another subject currently under investigation is the use of Electronic Nautical Charts (ENC). While ENC's are used for navigational purposes they could also be used as a selectable layer of the geographical background (for information purposes) to supply the mobile traffic manager with an image closer to the skipper's point of view.

To gain the most from the system an E-learning module is under development, allowing user-training when it is most convenient.

Sustainable Marinas - Institutional Framework of Sustainability

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The Sustainability is a guiding principle for the planning, design, and operation of waterfront infrastructure in general, and specifically for recreational boating infrastructure and marinas.

This study was triggered by the observation of organizational behavior by private and public promoters in waterfront development, which suggests that the most difficult challenge for the successful implementation of sustainability strategies is working with the local community to integrate its needs and perceptions, allow positive involvement, and increase positive impacts. After analyzing organizational factors that negatively impact sustainability, we found that environmental impacts of coastal resort projects and the regulatory environmental impact assessment process are also affected by organizational behaviors. The awareness of this challenge highlights the importance of addressing organizational issues and considering a comprehensive institutional framework in order to improve conditions for sustainable marina development.

The traditional environmental impact assessment process, which is the basis of most environmental regulatory frameworks, has shown to have deficiencies. The problems are magnified in places where the regulatory framework and enforcement are weak and when project promoters have a confrontational approach to environmental permitting. A change in attitude by developers towards the design and entitlement process, rooted in fundamental objectives of hospitality design and enhancement of guest experience, is proposed as a path forward to improving the environmental sustainability of marina projects.

Social sustainability criteria for marina planning is considered necessary to achieve sustainability. However, it is not sufficient. While the business case for experience-oriented marina planning may be strong and the benefits to sustainability are apparent, the implementation of an approach to include the local community faces significant challenges in practice. The implementation of a social sustainability strategy that enhances guest experience and benefits the local community requires a long-term commitment, resources and institutional capabilities.

This paper summarizes case studies of private development and operation hospitality organizations that have implemented successful sustainability programs that demonstrate the feasibility of this approach. This analysis results in recommendations for private marina developers and operators. A comprehensive approach for sustainable development of recreational boating infrastructure should consider the net benefits of embedding environmental and social dimensions of sustainability in the design and operation of marinas.

The Berlin Landwehrkanal: Public Participation in an Urban Area

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The Berlin Landwehrkanal (LWK) is an approximately 10 km long, inner-city inland waterway, operated and maintained by the German Federal waterway administration. The canal runs through a densely populated area, passing five inner-city districts with around 1.5 million people living nearby. At the present time, the canal is important for tourism and for recreational navigation. Apart from its role as a navigable waterway, the LWK provides some more purposes: as part of the Spree River system, the canal drains floods coming from the upper river stretches. With the green areas along it, the canal provides opportunities for public recreation and leisure activities, and it promotes favourable ecological effects, especially by creating habitats for fauna and flora and as a cooling zone.

The Landwehrkanal was built in the second half of the 19th century, planned and realised by the Prussian landscape architect Peter J. Lenne'. Despite the constructional measures and modifications, especially during the last five decades, more than 50 % of the canal stretches are still in their original and so historic shape. For these reasons, the canal is a protected structure, according to the Berlin list of protected monuments. In 2007, an approximately 50 m long stretch of the historic canal bank, located in Berlin-Kreuzberg, lost its constructional stability and collapsed. Subsequent security measures to protect the canal bank were taken by the waterway administration, which also included removing a large number of trees. These actions prompted harsh controversies as well as disagreements with the Berlin authorities, and protest campaigns were initiated by citizen and environmental groups. In order to resolve the escalating public conflict and to find acceptable technical solutions for the bank renovation, the waterway administration decided to conduct a mediation procedure that would involve all interested public groups and organisations. The mediation procedure, called "Future of the Landwehrkanal", started at the end of 2007 with representatives from action and environmental groups and from the Berlin State and District authorities. The mediation procedure was chaired by an external, independent mediation team organised and financed by the waterway administration. Through the mediation procedure, technical solutions for reconditioning the canal banks were developed in cooperation with all members of the mediation procedure, addressing their manifold interests and criteria. Rules for sharing mutual information and for involving the public into the future were negotiated, concluding with the final Mediation Agreement at the end of 2013.

After a short overall canal description and the specification of the relevant static and constructional details of the canal bank walls, including their failures in 2007, the

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presentation will focus on the above mentioned conflict and on the performance of the mediation procedure. It will be shown how such a mediation procedure works, and how the involvement of the public in planning and developing a construction project leads to mutually acceptable, but nevertheless economically reasonable results. An outlook into the canal renovation, and how is it intended to provide for future public participation will be given.

Waterways improvement of the Red River Delta (Vietnam): Design and construction of the Lach Giang River mouth

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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. Within this program, the PMU NIW is in charge of the waterway aspects of The Northern Delta Transport Development Project (NDTDP). This project covers two of the three main waterway corridors in the Northern Delta Region:

The navigation at the mouth of the Ninh Co River, Lach Giang area, has been identified as a critical sector for navigation mainly due to the lack of minimum depth and the dynamic morphological changes happening in the area that require to change the navigation channel regularly.

The starting point for the detailed design of the access channel at Lach Giang Mouth is the alternative proposed in the Feasibility Study (SMEC et al., 2008). The implemented alternative in the detailed design, performed by CNR and IMDC, comprises two breakwaters 1200 and 1400 m long, three groins parallel to the breakwaters and a fourth groin parallel to the Ninh Co River mouth. The aim is to allow navigation through an access channel of 2.3 km, lateral to the high morphological dynamic mouth of the Ninh Co River. The river outlet is constantly changing the shape of the sand bars and would make it difficult to predict their evolution.

The design of the breakwaters followed the Vietnamese and international standards. The final design of the structures was done with 2 layers of HARO units in the armour layer, based on an economical comparison with rock and other type of prefabricated concrete units. Furthermore, the orientation of the structures and their amount and length was optimized with the assistance of the numerical modelling

During the detailed design phase of the project, the location of the structures proposed in the feasibility study has been moved 400m to the north, after learning from the new bathymetry survey (November 2011) that the area at the original location has been eroded and is deeper today than was originally thought. The new location of the structures is still through a sand pit which gives stability to the structures in such a morphodynamic area.

The design has been submitted in 2012 and approved by the client in 2013. During that time, the client has organized tenders, and the construction has been divided in 8

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packages with 12 different contractors. The packages have been assigned by the end of 2013. After a period of preparation, the works effectively started during summer 2014 and are planned to be completed by the end of 2015. This 70 M USD project is the largest waterways structure currently build in Vietnam

The paper will present the different aspects of the design, the progress of the construction of the 2 breakwaters and the coactivity of the different contractors for a site which will open a strategic waterway access to the 3000T sea river units in the northern delta.



- ABSTRACT 75-

The threats and challenges in navigating the Magdalena river

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The threats and challenges in navigating facing the granting by the Magdalena River in Colombia, where they are treated problems, that if not mitigated in time, does not fulfill the objectives of maintaining the waterway as a major axis of multimodal logistics focus and analyzes the problematic in the context of competitiveness and improvement of the waterway with a major impact on navigation and safety.



- ABSTRACT 77-

Performance Measures for the Marine Transportation System of the UNITED STATES

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This paper describes an initial assessment of the U.S. Marine Transportation System (MTS) using publicly available data from authoritative sources. Seventeen measures across five categories of assessment were identified (economic benefits, capacity and reliability, safety and security, environmental stewardship, resilience). Graphs for ten measures are included in this report. In conclusion, it is possible to make a high-level assessment of U.S. MTS performance, but gaps in data reporting and analytical capacity still exist. Suggestions for future research include identifying sources of intermodal freight data and the development of improved measures for environmental stewardship and security.

- ABSTRACT 79 -

A future proof design alternative of the Upper Sea Scheldt, combining navigation with sustainable nature development

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The Upper Sea Scheldt is the upper tidal branch of the Scheldt Estuary (Flanders, Belgium). Apart from its ecological and recreational functions, the Upper Sea Scheldt is an important inland waterway linking the Port of Antwerp with the Port of Ghent and the Seine-Scheldt network.

Although, geometrical bottlenecks limit navigability in the upper stretch of the Sea Scheldt to CEMT class IV, navigation was not considered in the 2000s when reshaping the Scheldt valley in the so-called Sigma plan. The Sigma plan aims at protecting the Scheldt valley against flooding, and includes ecosystem restoration as a requirement to make investments in flood protection both socially and economically acceptable.

Today, also the improvement of navigability and the integration of the waterway into the CEMT class Va network is taken into account, but the measures required to improve navigability may affect both nature and flood risk.

Other evolutions may however also affect these functions: apart from sea level rise (due to climate change), there is also a growing awareness of morphological effects due to historic measures and maintenance practices that may amplify undesired changes to boundary conditions (tide, sediment concentration, ...) for navigation, safety and nature.

Therefore, in its mission to promote navigation and sustainable management of the river Waterwegen en Zeekanaal NV launched an integrated study to investigate the requirements of a design that both accommodates class Va navigation and resists such changes.

The study aims at improving the design of alternatives including measures to improve the hydrodynamic, morphological and ecological functioning of the estuary. The effect evaluation is based on the results of a tailor made, state of the art modeling instrument, consisting of interdependent hydrodynamic, sediment transport, higher trophic level

and ecosystem models. Real time navigation simulations are included to evaluate and improve the navigation conditions of the different alternatives.

The models will be used to investigate different design alternatives of the future tidal branch, combining the design requirements of a class Va channel, with measures that tackle both undesired effects of the autonomous and morphological evolution, and including ecological requirements and potentials existing along this tidal river. The modeling, but also effect evaluation, is closely monitored by a group of independent international experts, which criticism on the used methods and assumptions are taken into account to improve the modeling and evaluation methodology.

The modeling and effect evaluation, including a strategic environmental assessment (SEA), should finally lead to the definition of a future proof design alternative for navigation, and nature and safety against flooding. The design will be accompanied by a monitoring programme, allowing for adaptive maintenance and management, as it already is being implemented in the Western Scheldt, and is introduced in the Upper Sea Scheldt for the current class IV navigation in 2015.

As such the project will, apart from improving navigation, serve multiple social objectives:

- to preserve the safety function of the floodplains (Sigma plan),
- to hold off undesired morphological effects,
- to intercept mud from the system, and
- to improve the conditions for fresh water estuarine nature development.

The paper will be focusing on the integrated approach for modeling and the method to evaluate the different alternatives.

- ABSTRACT 81 -

Navigation Channels Design in Argentine Inland Waterway

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The Parana - Paraguay waterways in Argentina, has characteristics of an unregulated alluvial river with low slopes, significant morphological changes and an extensive floodplain in their middle and lower reaches. The constant erosion and sediment depositions force the relocation of the navigation channel axis to coincide with the thalweg of the river, looking for natural depths navigation. However, there are places called "critical zone" where the dredging works are necessary and inevitable. This usually occurs in the presence of bifurcations of two or more branches, widening of the river, bends and crossings. In the latter case, the axis of the navigation channel has a significant difference respect to the direction of flow, which implies contemplate widening the channel to avoid the contact of the ship with the lateral side of the channel. The curves also require higher width due to sharp angles and small radii. Design methodologies must consider the peculiarities of these rivers. The existing and available methods in the international literature to design widening navigation channels have been obtained for different waterway worldwide systems. The particularities of Paraná, Paraguay, and Uruguay waterways, are not common to those presented in regulated rivers. Our navigable river systems are characterized by generous natural width and deep; but, in the critical zones, the hydrodynamic of the river and the route of the ships, looking for deeper zones, requiring to the ship perform specific maneuvers. In these inland waterways, is important to consider the criterion of maximizing the natural conditions to match the trace of the navigation channel with naturally deeper zones, and in the case of critical zones, procure channel designs that involve smaller volumes of dredging. This approach seeks to improve costs, as well as minimize the environmental impact of works. From a navigation channel design made for the Uruguay River, between Concepción del Uruguay - Fray Bentos, has been performed a comparative analysis of the channels wide using some of the methods generated for other inland navigation systems. Moreover, in this waterway is common to find large bed forms (dunes), whose crests restrict the navigation, therefore, they need a special consideration. This paper presents and analyzes the results, and gives conclusions for the inland waterway design, in Argentina. Also makes methodological contributions on design for navigation channels in an unregulated lowland river, with significant main channel widths and the alternating presence of banks, islands, crossings and curves that presents Argentina Inland Waterway.

- ABSTRACT 83 -

Development of Utility Functions and Aspiration Levels for Multi-Purpose Inland Navigation Projects

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Many navigation projects in the United States Inland Marine Transportation System (IMTS) are composed of projects that have multiple purposes as part of their successful operation. The U.S. Army Corps of Engineers (UNITED STATESCE) inland navigation projects are primarily utilized for their navigation benefits but these structures provide other critical UNITED STATESCE mission requirements such as flood control, hydropower, water supply, recreation and environmental benefits. With the ever increasing age and deterioration of the UNITED STATESCE IMTS and increasing United Statesge, there is a strong need to prioritize investments and make robust funding decisions over the entire portfolio of inland navigation projects. These decisions must reflect the benefits or value contributed by each of the critical purposes that a project provides to maintain a sufficient utility above currently established aspiration levels for UNITED STATESCE projects.

As part of the UNITED STATESCE Asset Management Program, a methodology that encompasses utility functions for multi-purpose projects is currently under development and being piloted at piloted at several UNITED STATESCE inland navigation facilities. The use of utility functions over multiple critical mission areas allows for a simple scale of comparing the value of the structure to meet the minimum mission requirements through defined aspiration levels. The utility functions under development focus on the current operational condition assessment (OCA) for system level components at UNITED STATESCE facilities. The OCA ranking combined with system level fault trees develop the availability or utility at the system or project level to meet a minimum requirement of operational reliability required. The presentation will focus on the utility function methodology and how that can be applied to any multi-purpose project and a complete demonstration of the utility functions will be highlighted for UNITED STATESCE inland navigation projects.

INTERNATIONAL COLLABORATION CONCERNING THE USE OF THE DANUBE RIVER IN ROMANIA

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Transportation is one of the main components of social and economic life of any society.

Romania is geographically located with the Danube River to the South and the Black Sea to South-East. This position enabled over time the construction of sea and river ports which currently ensure the performance of a major traffic of import and export goods. Danube is navigable from Ulm (Germany) to the Black Sea, measuring 2,588 km, out of which 1,075 km are in Romania. Along its course the Danube and Rhine - Main - Danube Corridor cross the territory of eleven countries and it represents an important historical waterway. The Danube flows into the Black Sea.

As a consequence to the fact that Danube is an international river, all the aspects must be agreed upon by all the countries crossed by it.

After a series of modifications the "Convention regarding the rules governing the navigation on the Danube" was signed by the countries having direct access to the Danube, in Belgrade. The Danube Commission was found in 1954 with the headquarters at Budapest, with the purpose of standardizing the regulations for navigation, establishing the manner for performing the maintenance works, signalling, for collecting the fees charged, for ensuring that all the payment services are mandatory and so on. D.C. cooperates with CEE, with the International Committee regarding the protection of Danube Convention and Rhine Commission in order to be in line with the regulations, due to the fact that the navigation takes place both on the Danube and Rhine. Government agreements that took into consideration the D.C. regulations enacted between Romania and its neighbours Conventions. As a result, Mixed Committees were found.

The members of these committees meet periodically to discuss all issues at stake along the common sections of the Danube.

The cooperation between Danube riparian countries refers to: navigation rules, assignment of the sections of the Danube to be maintained by each country, performance of the appropriate signalling operations in the summer and winter and regular measurements to establish the depths and volumes of dredging to maintain the necessary depth, execution, exploitation and studies. In addition, the countries inform each other about the potential outcomes that may adversely affect the navigation, such as: floods, pollution and formation of ice blocks, in order to establish the appropriate measures.

Through an active international collaboration, the Danube River can be used for navigation while respecting environmental requirements.

St-Lawrence Seaway Modernization

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The Seaway is undergoing a substantial overhaul in how it used to process vessels compared to how it will process vessels through our locks. The Modernization multi-year program includes the implementation of Vessel Self-Spotting, Hands Free Mooring, and Remote Control of our locks.

Vessel Self Spotting has been developed internally and is currently deployed and being used at all our deep locks.

Hands Free Mooring has also been developed internally and is currently being deployed to all of our deep locks.

We are currently in the process of re-designing our central Traffic Control Centre to enable remote operation of our locks.

The topic covered would be titled "Modernization of the St-Lawrence Seaway, an Investment in Sustainability", and would cover the technical development of the tools which will be part of the new Seaway.

The passage of a vessel through a lock normally involves the deployment of four mooring wires from the vessels onto the bollards fixed on the lock walls. Vessels needs to be equipped with steel wires and rollers in order to be allowed into the Seaway system. This task is labour intensive, slow and hazardous.

It is labour intensive because the steel wires are 1.5 inch in diameter, heavy, and difficult to handle. Each vessel requires the handling of four wires over sometimes long distances. The use of Hands Free Mooring, which uses vacuum technology, only requires the push of buttons in order to secure and detach vessels, without any manual labour. This eliminates the need for vessels to equip themselves with steel wires and rollers in order to come into the Seaway, therefore allowing more vessels into the system without the need for costly conversions.

The tying up of vessels is time consuming, with the use of HFM, we have seen an average saving of 7 minutes per lock on a two-way transit (a normal lockage could take 40-50 minutes).

The handling of mooring wires is not a desirable function in the marine world. Fatalities continue to occur linked to the breaking of mooring wires. In our system, we witness a wires break every 13 days on average, potentially injuring employees on the lock or on the deck of vessels. Since we see approximately 3000 transits every year each going through up to 13 locks requiring wires handled by deck personnel and lock personnel, the hazards and frequency of occurrence is very concerning.

The recent success rate achieved by the fourth generation of equipment in 2013-2014 has led to a substantial investment from Transport Canada (almost \$100M CAD) into the Marine Mode of transportation. Since the Marine mode is the most efficient and environmentally-friendly way to move cargo, Ontario's transportation system benefits when cargo is placed on vessels, alleviating congestion and wear and tear causing considerable investments and environmental impacts.

The use of vacuum technology was never considered in a lock environment, until the Seaway started its development in 2007. The challenges resided in the fact that our locks either raise or lower vessels approximately 14 meters in 8-10 minutes, and the

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equipment needed to secure the vessels throughout the lockage. This was never done anywhere in the world. The use of vacuum pads secures the vessels very well and prevents the large movements normally witnessed in vessels secured with wires, and has eliminated the incidents where vessels make contact with the lock structures such as the concrete walls or ship arresters.

In addition, a function of warping a vessel forward was designed for moving the vessels to their Final Mooring Positions using the vacuum pads mounted on horizontal hydraulic cylinders, instead of using vessel engines or using the mooring wires for re-positioning the vessels.

Since the approval of the project by Transport Canada in late 2013 early 2014, we have received visits from the Panama Canal Authority, the Port of Montreal, BHP Billington, Port of Hamilton, Westshore terminals, and hosted a number of interested parties at our various installations.

The ingenuity has been the focus of numerous interviews, newsclips, and was also presented at the PEO sponsored Oakville Transportation Symposium on May 2, 2014, and the World Canal Conference in Rochester, New York.



- ABSTRACT 90 -

Asian Carp and the Corps of Engineers: Combating Invasive Species within the Inland Navigation System

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There is no question that globalization and increased shipping has fostered economic growth and improvements in living standards around the globe. However, increased shipping has resulted in greater opportunities for unwelcomed guests in ballast water which can create ecologic and economic havoc. Over the past several years, the Corps of Engineers has been struggling mightily to prevent Asian carp and other invasive species on the inland river system from reaching the Great Lakes. This paper highlights how quickly invasive species could take hold and potentially impact river traffic along with highlighting the actions the Corps of Engineers has taken to mitigate the problem, as explained in its recent Great Lakes and Interbasin Mississippi River Study (GLMRIS).

Implications of high availability requirements on the hydraulic design of the Panama Canal Third Set of Locks

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The Panama Canal Third Set of Locks has been designed to provide a safe and reliable transit system for Neo-Panamax vessels travelling in both directions between the Pacific and the Atlantic Oceans.

According to the employer's requirements, the single lane of locks must be functional, reliable, and able to operate 24 hours a day, every day of the year, and achieve a 99.6% level of availability - i.e., unavailable less than 36 hours per year. The lock filling and emptying system - involving multiple-lift lock chambers and water saving basins - is one of the critical systems necessary to meet this requirement. As a result, the system has been provided with redundant components such as culverts, conduits, valves, and operating systems. These redundant components, along with the need for the locks to be available even during most maintenance or inspection operations, involve many different operational scenarios while meeting operational safety and efficiency criteria.

This paper presents a summary of the main lock operations and lock chamber water level equalization scenarios, considering the chamber configurations, use of lock gates, lockage sequences, turnaround, initial water level conditions and the use of the filling and emptying valves (for the chambers and the water saving basins). In addition to the normal operating scenarios, the system must function acceptably under a variety of different maintenance conditions and unusual operating cases.

- ABSTRACT 93 -

AIS Land Infrastructure on German Inland Waterways

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The PIANC RIS Guidelines and Recommendations for River Information Services (RIS) list Inland AIS as a key technology in identifying and tracking vessels on inland waterways. River information services (RIS) is a collective term for the following services: fairway information services, traffic information and traffic management services, services in support of accident management, transport-related services as well as services for waterway and port charges.

Inland AIS is a system that automatically exchanges navigational data between vessels and between vessels and stations on land. It was developed to support navigation on board such vessels and for supporting River Information Services (RIS). The European Commission issued inland waterway AIS specifications in an inland waterway vessel tracking standard (EU Directive 415/2007). The Central Commission for Navigation on the River Rhine (CCNR) introduced mandatory Inland AIS and inland ECDIS for commercial inland vessels in December 2014. Most European countries are expected to make of AIS mandatory on their waterways. The entire inland waterway fleet will hence soon have the system on board. This will enable European inland waterway administration authorities to install and operate RIS, which predicates Inland AIS.

The German Waterways and Shipping Administration (WSV) has implemented a land based Inland AIS network at selected German category A inland waterways, i.e. on the Rhine, Mosel, Main and Danube River, the Main Danube Canal, the Western German canal network and the Mittelland Canal. Those waterways of the inland waterway network carry the vast majority of inland traffic as they connect the commercial centres of Germany and provide the link to the sea ports and the neighbouring countries. The AIS land infrastructure will be used for providing services to shipping covered by the RIS concept.

The German Inland AIS land infrastructure was designed in accordance with PIANC RIS Guidelines, IALA Rec. A-124 "on the shore based AIS Service" and UNECE Res. No. 63 "International Standard for Vessel Tracking and Tracing (VTT)". The network covered about 2400 km of inland waterways. It consists of 86 Inland AIS land stations, 9 AIS repeater stations, 4 regional AIS servers located in the regional service centres and 1 central technical evaluation centre for monitoring the system. AIS land stations located along the waterways are the transmitter/receiver of AIS messages. Inland AIS land stations are connected to the regional AIS server via the closed circuit land line internal data communication network of the Federal Waterways and Shipping Administration. AIS repeater stations are to be used where topography restricts ship to ship radio communication, e.g. in mountainous areas. The regional AIS servers acts as an interface for providing services to be transmitted to all vessels in a region or addressed to individual vessels.

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The project for setting up the AIS land infrastructure started in March 2014. The initial operation phase for testing has started after installation was completed in December 2014. The paper will introduce the technical concept and the experiences made.

- ABSTRACT 98 -

Preliminary Environmental Impact Assessment due to the Tietê-Paraná Waterway Traffic Interruption

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Since 2001, the Paraná River basin have faced certain years with severe hydrologic situations of draughts that increases in 2013, 2014 and 2015. This highly affects the hydropower generation and the navigation depth on the Tietê-Paraná Waterway, causing partial interruption of navigation traffic and reduces the production of hydropower energy. The navigation interruption starts on May 2014 until nowadays, affecting agricultural commodities cargo moved in the waterway. This situation obliges to transfer the waterway cargo to road transportation. This paper intends to evaluate preliminary environmental impacts due.

Renovation of a 1900's lock in Brugge

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The lock "Verbindingssluis" - literally translated connecting lock- is located at the medieval city of Brugge (Belgium) and connects the sea port of Zeebrugge with the hinterland. The lock has a bidirectional head difference (0.5m to 1.5m), requiring 4 gate pairs in total. Main lock dimensions (115m x 12m x 4m) reach about those for a CEMT class Va ship. The lock structure was constructed in the early 1900's, using the common techniques from that time. That means the lock was constructed in an open excavation, and consists of masonry gravity walls to create the chamber. These walls were founded on a debris-cement mixed slab, also forming the watertight lock bottom. The original 1900 mitre gates were made of steel, but were replaced by wooden gates during the sixties.

After 50 years of service, it was clear that the wooden gates suffered quite some damage and water tightness could not be guaranteed. Meanwhile the frequency of unscheduled repairs at the lock in Bruges increased with unpredictable periods of blockage as a result. A durable renovation of the lock was imposed to maintain a reliable connection of the sea port with the inland waterway network. Therefore it was decided to renovate all lock gates (including electric operating equipment) and replace them with a new pair of wooden gates.

Although quite simple as a concept, this renovation proved to be quite a challenge, given the fact that the (ancient) lock contained a lot of unknown parameters. Major challenges were the dewatering of the lock since it was not designed for this load, overcome the unavoidable tolerances that come with working with an unknown structure of more than 100 years old, and limit the installation period of the new wooden gates as much as possible in order to minimize the interruption of ship traffic (maximum allowed downtime of the lock was 2 weeks).

During a first phase, an extensive research programme was set up, to identify the existing situation as accurate as possible. Old construction drawings were consulted and several divers thoroughly inspected the chamber bottom slab. Core borings of the existing construction materials were taken and tested in the laboratory to determine the appropriate design mechanical parameters. To complete the geotechnical information already available in the database, some additional CPT's were performed. Automated divers were used to measure groundwater fluctuations over a longer period.

A particular aspect during construction was that the lock had to be dewatered completely, to enable the contractor to perform an accurate replacement of the lower turning pivot of the gates. After interpretation of all the new information that was gathered during the data collection programme, it became clear that the lock was not capable to resist the upward water pressures during dewatering and the bottom slab had to be stabilized. Several options were considered, and finally it was decided to stabilize the lock bottom using pre-stressed ground anchors, resulting in a permanent

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reinforcement of the lock. To avoid overturning of the quay walls, a strutting system had to be provided.

For the actual renovation of the wooden gates, the basic idea was to maintain the 100 year old design philosophy as much as possible. Using innovative design methods, the wooden doors were designed in an efficient and economical way, matching and even improving the original concept. Main feature was the use of a continuous timber back post rather than punctual steel supports. Special attention was given to durability of the structure, and for the most solicited gate elements a replaceable solution was designed. Especially the turning pivot at the gate bottom and the top hinge were engineered to enable an easy replacement in case of substantial wearing.

For the renovation of the operating mechanisms, the masonry of the quay walls was locally removed to create an operating basement for the electro-spindels and hydraulic jacks. The use of an electromechanical operating system was required due to the limited space at the upstream lock head, which is the first application of this kind for a lock in Flanders. The combination of both systems - hydraulically and electromechanically driven - on one structure will give an interesting base of comparison regarding the performance of both systems.

Comparison of Scale Model Measurements and 3D CFD Simulations of Loss Coefficients and Flow Patterns for Lock Levelling Systems

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The aim of lock operations is to minimize the delay caused by the lock. The engineering challenge is thus to design a lock that has a fast levelling process during which the forces on the ship in the lock do not exceed safety limits. Various types of forces can be identified: forces due to surface waves, due to the filling jet, due to friction, due to a density driven current or due to the momentum change along the vessel.

These various forces must be studied during the design of a lock in order to assess its safety. LOCKFILL, a computationally fast one-dimensional model is often used for this purpose. This model schematizes the flow in the lock chamber and around the ship to calculate all longitudinal forces separately and uses the principle of superposition to calculate the total force.

The force contributions mentioned above all depend on the discharge as a function of time and therefore are directly dependent on the discharge coefficient of the levelling system. This discharge coefficient varies according to the exact geometry of the levelling system (e.g. widening of the door openings, the breaking beam dimensions, or the shape of the culverts).

The complexity of levelling systems generally makes an a priori determination of its discharge coefficient difficult and uncertain. Traditionally, the determination has been based on physical scale models, which have provided a small but limited library of common designs. Alternative designs, as well as technological innovations which are presently being developed (e.g. composite lock gates), are not included in this library. These designs would require (expensive) scale model work. However, with the development of a Computational Fluid Dynamic (CFD) model, it is possible to avoid the expensive scale model work by performing computational simulations.

This paper reports the development and application of CFD (Star-CCM+) on levelling systems in lock doors. The method used involves 3D simulations of the turbulent flow field with a RANS approach. The free surface is modelled using a Volume-of-Fluid (VoF) method.

This CFD application has been validated using physical scale model tests of typical lock gate designs. The door openings are rectangular, diverging downstream. One of the designs has openings fitted with breaking bars. The dimensions of the door gates are based on typical door gates as found in The Netherlands.



A stationary flow situation is measured - a constant discharge is imposed and the resulting water level difference indicates the energy loss. The effect of merging jets is studied by considering a single opening separately from two adjacent openings. The discharge coefficients are also measured at four different valve positions (10%, 25% 50% and 100% open).

The accurate measurements are performed specifically for the purpose of validating the CFD model. Water levels are measured at several positions. These coupled with the accurate discharge measurements determine the discharge coefficient. The detail of the measurements, valuable in the evaluation of the performance of the CFD model, is given by a grid of velocity measurements in a vertical plane parallel to the lock door and at different locations downstream of the opening. Velocity profiles of the filling jet are captured and are used to confirm the flow field calculated in the CFD simulations.

The results from CFD simulations are compared with these measurements. Subsequently, the schematization of the 1D model can be adjusted to account for the flow field predicted by CFD calculations.



- ABSTRACT 106 -

Informing Life Cycle Investment Strategies Across the U.S. Inland Marine Transportation System (IMTS) using “Risk Exposure”

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The United States Inland Marine Transportation System (IMTS) encompasses nearly 12,000 miles of navigable inland waterways that play a vital role in the U.S. economy. Annually there are approximately 265 billion ton-miles of commodity movements on the IMTS with each movement often hundreds of miles in length from point of origin to destination and traversing many of the almost 200 locks in the system. It is imperative that the locks and dams on the IMTS are available and reliable to ensure these movements. This requires the understanding and focus of maintenance and capital investments on those locations and assets / components where mechanical failure(s) would cause an unscheduled outage with the highest economic risk exposure on shippers and carriers.

Introducing Smart Navigation into the Peruvian Amazon Waterways

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The Peruvian main commercial fluvial system - comprised by the rivers Marañón (Sarameriza - Ucayali confluence), Amazonas (Ucayali confluence - Santa Rosa), Ucayali (Marañón confluence - Pucallpa - Atalaya), Urubamba (Atalaya - Las Malvinas / Camisea), Huallaga (Marañón confluence - Yurimaguas) and Napo (Cabo Pantoja - Amazonas confluence) - covers a total river length of about 4,081 km. Such rivers are navigable throughout most part the year and, due to the almost total lack of roads, they represent the engine for economy development and for internal and external integration of the Peruvian Amazon region as well as and the main means for mass communication.

The influence area of such river network comprises almost all the regions of Loreto and Ucayali and part of Cusco region including 10 provinces and 57 districts that generate and receive cargo flows; the area of this region amounts to approximately 415,000 km² (32.3 % of Peruvian territory) with a population of 1,640,735 inhabitants (2013 projection).

The main ports correspond to the cities of Iquitos, Pucallpa, and Yurimaguas with populations of, approximately, 440,000, 220,000 and 65,000 inhabitants (2014 projection).

According to recent studies, during 2010 - 2012 the total number of vessels mobilized between those ports amounted to 1,361 (36 % were boats and river sliders, 28 % were motor barges and motor ships, 23 % were fluvial barges and 13 % were river pushers). Also, according to these studies, during 2012 the total flow of cargo amounted to 3,545,000 tons and 500,000 passenger meanwhile projections to year 2023 amounts to more than 5,000,000 tons and over 700,000 passengers. Petroleum and derivatives, wood and wood products, beer and empty beer bottles account for 60 % of the charges; the rest includes various products (food, cement, vehicles, machinery, steel / iron / boards, beverages, pharmaceuticals and toiletries products, textiles, hardware, chemicals, electrical appliances and construction materials).

Despite the importance of this vast river system, during dry season there are many elements that become restrictions to navigation (variability of the flow regimen, presence of "palizadas" and "quirumas", riverside erosion and river channel migration, sedimentation processes with formation of sandy banks and alluvial islands, presence of meandering and braided channels). Other important limitations must be also mentioned: a) navigation is basically of visual character (based on the knowledge of the river and on the crew experience), b) it is not common the use of the elements currently offered by technology (echo sounders, radars and global positioning systems - GPS), and c) river charts, notices to river mariners or simple sketches made by mariners themselves are not used.

Consequently, considering that essential conditions for safety navigation are the knowledge of the navigable channel location and the availability of water level

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information, during the studies conducted by SERMAN & Asociados SA - CSI Ingenieros SA at the Peruvian Amazon region (Napo river; 2009 - 2010; Marañón - Amazonas - Ucayali and Huallaga rivers; 2013 - 2014; Morona river, 2014) the main proposals for improving navigability have focused on the development of "River Information Systems" (RIS) that - as a WEB page format easily accessible to both the river mariners and the general public - will provide information about river channel axis and edge location (as *.gpx files), water level data at measurement stations and depth correction abacuses as well as information produced by the Hydrography and Navigation Service of the Amazonian - SHNA (river charts, pilot books and notices to river mariners).

The presentation and its corresponding paper will describe the fleet, the infrastructure and the magnitude of the river traffic as well as the main problems related to inland navigation at the Peruvian Amazon region and the most common practices applied for such navigation. Finally the main components of the "River Information Systems" (RIS) will be summarized.

Development Plan for the Peruvian Commercial Waterways: A Synthesis

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The Development Plan for the Peruvian Commercial Waterways (the so called "Waterways Plan") involves the Peruvian main commercial fluvial system - comprised by the rivers Marañón (Sarameriza - Ucayali confluence), Amazonas (Ucayali confluence - Santa Rosa), Ucayali - Urubamba (Marañón confluence - Pucallpa - Atalaya - Las Malvinas / Camisea), Huallaga (Marañón confluence - Yurimaguas) and Napo (Cabo Pantoja - Amazonas confluence) - covering a river length of 4,081 km. Such rivers are navigable throughout most part the year and, due to the almost total lack of roads, they represent the engine for economy development and for internal and external integration of the Peruvian Amazon Region as well as the main means for mass communication.

The Plan, through the diagnosis of the current situation, allowed to identify and to evaluate development opportunities and to define different sort of programs oriented to organize fluvial transport activities and, at the same time, to promote their integral development and to improve navigability, river transport and river infrastructure (encouraging the integration of a vast region of Peru).

The Plan has the "vision" that "by 2025, at the Peruvian commercial river system - originally formed by Huallaga, Ucayali, Urubamba, Marañón, Amazon and Napo rivers - efficient fluvial transport services has been developed and adapted to the Amazonian environment (considered fluvial transport services on a broad sense and including navigation systems, vessels, infrastructures, cargo and passenger transfer centers as well as the users and the public and private operators); such services represent an active part of the Peruvian multimodal transport corridors and contribute to the local communities quality of life, to the sustainable development of the region and to its regional and international integration". The "mission" is to "promote the improvement and expansion of accessibility, efficiency, safety, intermodal connectivity and competitiveness of the river transport services becoming the key for the internal and external Peruvian trade".

The Plan includes five strategic objectives with their corresponding actions and programs:

1. Improvement of governance and management by means of: a) the strengthening of the General Directorate of Aquatic Transport (Ministry of Transport and Communications), of the Regional Aquatic Transport Directorates, of the Regional Port Authorities and of the General Directorate of Captaincy and Coastguard (DICAPI); b) the setting-up of a "Permanent Commission for the Peruvian Commercial Waterways" (with public - private partnership); c) the formulation and developing of training programs for the staff of the institutions involved with the

fluvial transport activities; d) the evaluation of the applicable regulations and the generation of incentives focused on the formalization of the fluvial transport related activities; and e) the update of the fluvial transport rules and its compilation on an easily accessible "Compendium".

2. Improvement of management aspects - including efficiency and operations record, control and supervision - by means of: a) the establishment of local / regional organizations integrated by all the stakeholders involved with river transport activities; b) the implementation of a system focused on management facilitation; c) the implementation of integrated control systems; and d) the evaluation and improvement of the applicability of the tax regime.

3. Improvement of port infrastructures in order to promote their efficiency, safety and integration with the Peruvian logistic corridors by means of: a) the elaboration of port development and management plans (in coordination with urban development and management plans); b) the improvement of formality; c) the identification of alternatives for infrastructure and equipment facilities; and e) the formulation and developing of training programs focused on port operations.

4. Improvement of navigability conditions providing continuity, efficiency and safety by means of: a) the promotion of studies related to the analysis of the hydro - morphological evolution and the determination of sedimentation rates; b) the promotion of technology development programs; c) the increase of the number of river water level measurement stations; d) the improvement of navigation efficiency and safety during the dry season by the implementation of a river information system (RIS) based on the provision of information regarding the navigable channel location and river water level condition; and e) the formulation and developing of training programs focused on vessel crews.

5. Improvement of a modern, efficient and technologically updated fleet by means of: a) the promotion of the river fleet renovation; b) the strengthening of river transport companies in order to reach efficiency standards and competitive conditions; b) the provision of greater safety for cargo services; and c) the provision of greater regularity, reliability, comfort and safety for passenger services.

The presentation and its corresponding paper will summarize the description and diagnosis of the current situation of the Peruvian commercial waterways as well as the main proposals of its Development Plan.

The Paraguayan Stretch of the Paraguay - Paraná Waterway: An Update

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The Paraguay River, part of the Paraguay - Paraná waterway, is a meandering river with Northern - Southern runoff, an annual average flow of about 4,500 m³/s and a length of about 2,625 km. The stretch comprised between the Apa and Pilcomayo river mouths (554 km length) corresponds to the exclusive jurisdiction of Paraguay Republic and the one between the Pilcomayo and Paraná river mouths (385 km length) to the shared jurisdiction between Paraguay and Argentine Republics.

Commercial navigation had its beginning on 1870 with the export of tannin by Mihanovich Company ships, subsequently the cement industry products (Vallemí SA) were added as well as the supply to the populations located to the north (Bahía Negra, Corumbá and Cuyabá) and the commercial traffic between Asuncion and Buenos Aires cities.

In its current condition, coinciding with an alternating period of high and low waters, occurred between 1911 and 1961, navigation began at the mid of the 50's with the exploitation of iron ore deposits located at Mutúm and Urucúm (Corumbá and Puerto Quijarro surroundings) being interrupted during the low water period developed between 1962 - 1973. Later, since 1974, taking advantage of a new high water period, both navigation and cargo activities were restarted. Recently, since 1998, a new period of low water has started but retaining the high interannual variability.

Currently, the Paraguay River waterway is mostly operated by barge convoys carrying solid bulk (soybeans and soy products, wheat, iron ore and manganese, clinker, limestone materials, cement) and liquids (petroleum and its derivatives) between ports of South Western Brazil (Corumbá and Ladario), Western Bolivian (Terminal Aguirre) and Paraguay (Vallemí and other minor ports) to ports in Argentina, Uruguay and Paraguay (Villeta).

The navigation channel mainly responds to its natural morphological and sedimentological conditions being possible to assume that there is a balance between the water flow, the sediment carried by the river and the bed materials size and grading. Thus, as a result of erosion - transport - deposition processes, sandbanks are developed tending to reduce river depths and representing an important determinant for navigation. Additionally, the geological characteristic of the region determines the existence of critical areas ("pasos") linked to the presence of hard materials (including igneous and metamorphic rocks).

Early studies of the Paraguay River and, in general, of the Paraguay - Paraná Waterway dates from the 60's and the most complete ones from the end of the 80's and mid 90's (Conarsud SA, 1989; Internave Engenharia SC, 1992; Hidroservice - Louis Berger - EIH, 1996; Taylor - Golder - Consular - Connal, 1997; Consorcio Integración Hidroviaria, 2004).

Traditionally, based on studies made by Hidroservice - Louis Berger - EIH (1996), at the stretch of the Paraguay River under Paraguayan own and shared jurisdiction a total

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of 111 “critical stretches” (“malos pasos”) were recognized; however, morphological evolution of the river determined the occurrence of significant changes in the waterway pattern.

Consequently - according to meetings and consultations with captains of the main transport companies, with members of the captains and pilots societies and with authorities, technicians and staff of the Public Works and Communications Ministry (MOPC) and of the National Administration of Shipping and Ports (ANNP) - an update of the current state of the Paraguay River stretch under Paraguayan own and shared jurisdiction is presented.

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URUGUAY - BRASIL WATERWAY

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The eastern and northeastern Uruguayan boundary connects the country with Brasil. The eastern portion of Uruguay has great strategic importance, due to the vicinity of Brasil. The traffic of merchandises between both countries, directly leads to the necessity of establishing physical connections across the boundary. The axis of the region is a waterway formed by the Merin Lagoon (shared between Uruguay and Brasil), together with De Los Patos Lagoon (at Brazilian jurisdiction and connected with the Atlantic Ocean), and their respective tributaries. A natural channel named "San Gonzalo" connects both lagoons. A dam was constructed across this channel, to regulate the water levels of the lagoons and to prevent the passage of salt water to Merin Lagoon. This dam has a lock that allows the crossing of ships.

The waterway penetrates the Brazilian territory, and once entered in De Los Patos Lagoon, vessels can immediately reach the ocean port of Rio Grande or, following the axis of this lagoon, they can head towards several Brazilian inner ports. At the north extreme of this waterway, the port of Estrela offers its piers with railway connection directly to Sao Paulo, crossing the also very important Brazilian states of Paraná and Santa Catarina. The above described route can be naturally navigated in both directions. The waterway length, considering lagoons and rivers, is about 800 kilometers. It must be considered that a lot of Uruguayan productions with destination to overseas can be cheaply sent to the ocean deep water port of Rio Grande at Brasil, in order to be loaded on big ships serving the international traffics.

The heart of the project is to establish at least three ports on the Uruguayan side of the system, since the Brazilian side has already several active ports. These ports are located at the shore of rivers that lead on the Merin Lagoon, and they are:

- La Charqueada Port, at Cebollatí River
- Tacuarí Terminal, at Tacuarí River
- Rio Branco Terminal, at Yaguaron River.

Services expected to be given at the ports are: use of piers, mooring and unmooring, ship supplies, collection of garbage and other refused materials, loading and unloading merchandise, storage, land conveying, warehousing and silos, palletizing, etc.; together with industrial operations, particularly dedicated to wood industry but latterly extended to other areas so as to create an industrial zone. The merchandises and commodities mainly intended to be operated at the ports are clinker and cement, coal, agricultural grains, rice, wood, woodchips and containers.

This paper pretends to show and explain about the condition, possibilities and diagnostic of the so called URUGUAY - BRASIL WATERWAY, and the project of engineering of the three ports at the Uruguayan side of the waterway, including the opening and maintenance dredging, signaling and buoyage.

Sedimentation processes in River Plate's waterways, 15 years of history

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Sedimentation processes that occur in Rio de La Plata's waterways are mainly determined by fine sediment phenomena. For more than 15 years, EIH SA has developed and improved simulation tools specially designed for River Plate's special characteristics. The present paper describes the distinctive features of the developed tool and its implementation. In addition, the model application to several dredging projects is included, along with satisfactory comparisons between modeled sedimentation results and actual dredging records.

Sedimentation processes are mainly due to differences in flow transport capacity either between different areas or in averaged time. In general terms, when flow goes through a certain channel or deeper zone, transport capacity inside it becomes lower than outside, due to the decrease in velocity and the increase in depth. Because of this, when flow carrying a certain amount of suspended sediments goes through the channel, turbulence is not capable of retaining the same amount of solids in suspension, consequently depositing the excess on the waterway bed. There is an adjustment process between one situation and the other, which is not immediate but takes a certain time that becomes longer both as the suspended solids are finer and as greater the turbulence of the carrying flow is. This adapting process and its associated phenomena it is not always taken into account by old classic simulation's calculation algorithms, and thus requires a particular process treatment which has been incorporated to the AD32-TS model developed by EIH SA. This fact has become essential to positively simulate sedimentation in navigation waterways at River Plate, a river that is mainly characterized by high presence of fine and very fine sediments, identified as silt and clay, which form both wash load and bed load.

On the other side, from a hydraulic point of view, the River Plate is characterized by an estuarine behavior, with fluvial and marine systems, originated in the outflows of rivers Parana and Uruguay with high flow volumes, and oceanic tides that come to it from the Atlantic Ocean. In addition, there is a significant effect caused by winds blowing over and along the river's surface which intensifies both high and low tides, and results in an extreme complex hydrodynamic context.

This work presents a brief description of the main algorithms of the developed model and its applicability in the study of sedimentation at navigation channels. Also, some different applications of study cases and its expected annual sedimentation rates results for different channel sections are shown, and the consequent analysis of the truly dredged volumes during many years of waterways maintenance, focused in comparing the relation between modeled results and real data. The achieved results gives confidence in the validity of the developed tool with a high level of concordance, which becomes more relevant if the complex physical processes involved are considered and the typical margins of error at this kind of hydrodynamic and sedimentation studies are taken into account.

Validation of Actual Depth Measurements by Inland Vessels

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The just finished Dutch research project “Impulse Dynamic Traffic Management Inland Waterways” (IDVV) aims at realizing a modal shift in favor of inland navigation in order to handle the expected increase of the number of containers due to the “Maasvlakte II” development near the Port of Rotterdam in the Netherlands. One of the spin offs of the IDVV research program is COVADEM, a pilot project for collective water depth measurements in which the navigation sector participates. By sharing water depth information in a clever way it is possible to maximize the loading capacity, to sail more efficiently and to guarantee a reliable ETA (Expected Time of Arrival). This will save money and increase the profits.

As part of the cooperative pilot study COVADEM, about 50 ships are gathering, logging and exporting measured data from the Dutch Rhine River at the moment. During their trips, they measure the depth below the ship (i.e., underkeel clearance) every second by using conventional echo sounder equipment and the GPS location using a GPS meter. The underkeel clearances are translated into a water depth by correcting for draught, squat and trim. The draught is taken from the logged loading gauge just before the trip starts. The squat and trim is calculated using a model. Input of the model is some characteristic parameters of the vessel (stored in a database for all the 50 participating vessels) and the flow velocity. The flow velocities are derived from a two-dimensional (2DH) numerical model. The position on the ship of the GPS meter and the echo sounder sometimes differs; this is corrected for.

The aim is that the water depths collected by the participating ships will be shared with the navigation sector in a condensed way, such that decisions can be made on the loading capacity and on where/how to sail. This means that the measured water depths should be accurate and reliable. Therefore we have performed a validation of the measured water depths. First we translated the COVADEM water depth into bed levels by subtracting the water levels and water depths. The water levels along the river are measured every ten minutes at measuring stations. To obtain the water level both at the same location and at the same moment in time as the water depth, we interpolated in time and in space between the stations. Second, we compared the obtained COVADEM bed level with measured multibeam data, which are projected on a 1x1m raster. The multibeam data were made available by the Dutch Rijkswaterstaat. About every two weeks a multibeam measurement campaign was held; we received two-weekly data for over a period of 4 months (May - August 2014). Each COVADEM bed level has been compared with the value in the multibeam raster at the exact same location. In time, we selected the raster that was nearest to the COVADEM bed level. This means that the moment in time in the comparison deviated at most about a week. During a week the bed may change because bedforms migrate, which affects the comparison. The results are promising. So far we conclude that the average absolute

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error is of the order of 20 cm. All the ships measure the same pattern as in the multibeam data: shallow and deep parts and bedforms. Often a small systematic phase shift was visible, probably caused by the earlier mentioned fact that the moment in time for both data sets may deviate a couple of days. Also a small systematic vertical shift was often visible. This may be caused by an incorrect translation from underkeel clearance to water depth. Ships that did not perform well (for example had a large vertical shift), are now subject of further inspection. We check among other things characteristics of the ship in the database and the measured draught. The authors will present the aims of the pilot study together with the validation results, and future developments.

Benchmarking of Optimal Barge Train for the Navigation on Waterways that link Ecuador with Peru and Brazil

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As a result of the "Treaty of Commerce and Navigation" signed by Ecuador and Peru in 1998, the Ecuador may use the rivers that from the border with Peru, will allow the use of waterways that connects directly to the Amazon River.

Actually, there is only a river used by Ecuador for commercial navigation of barge trains, the Napo River. The commercial navigation that uses Napo River begins at Providencia (Ecuador), where a port is being constructed. The Ecuadorian stretch of the river presents strong limitations for navigation with 4 feet draughts (or more), in low water periods. Offices for border control are located at Nuevo Rocafuerte (Ecuador) and Cabo Pantoja (Peru).

At this point, there is the confluence with Aguarico River, so the discharge of Napo river increases and the navigation conditions at the Peruvian stretch of the river become better.

The optimal barge trains for each stretch of this river was analyzed and defined in 2010; the analysis include a proposal of a transference station in order to improve transport capacity. It can be located near the international border at Cabo Pantoja (Peru).

The Napo River falls into the Amazon River, 70 km downstream of Iquitos. From this point, the river has small limitations for the navigation of barge trains, upstream to Iquitos, or downstream to Santa Rosa (Peru), Leticia (Colombia) and Tabatinga (Brazil) in the triple Border Area (and beyond to Manaus).

Other relevant Ecuadorian rivers linking with the Amazon River, are Tigre, Pastaza, Morona and Santiago. All of them are tributaries to Marañón River (the Amazon River borns in the confluence of Marañón and Ucayali rivers).

The Tigre and Pastaza rivers have not been studied systematically until now, because they are small and not well linked to the road system of Ecuador. They falls in the stretch of Marañón River downstream the confluence of Huallaga River, where is possible the navigation of barge trains with 6 feet or more (during drought) and more than 50 m length (each barge), in a 2 x 2 array.

The Morona River was recently being studied (2014), in order to improve the navigation of barges with 4 feet of more during drought. It is a very meandering river so navigation is limited to barges with no more than 37 m length, in the upper reach near Puerto Morona (Ecuador). Currently, there is not systematic navigation between Ecuador and Peru using the Morona River, due to the absence of custom and migration controls at the border. If authorities wants to allow the commercial use of such river, they must implement those controls.

It was analyzed the possibility to build and operate a transference station near the end of the Morona River (at Puerto América, Peru), from reduced length barges to the big ones used in the Marañón River, in a 2 x 1 array.

The Santiago River is linked with Ecuador near the binational Vial Axis No. 5, and falls into the Marañón River 7 km upstream of a critical point for navigation of barge trains named “Pongo de Manseriche”. This is a relevant problem to use the Santiago River for navigation.

The current fleet sailing on the Peruvian commercial river system and the Ecuadorian Napo river is composed by a diverse set of vessels with particular characteristics:

- a) river boats and river sliders,
- b) motor self-propelled barges (a naval construction for cargo transport know as “motochata”),
- c) motor self-propelled ships (a naval construction for both cargo and passenger transport know as “motonave”),
- d) deck barges and
- e) fluvial pushers.

The paper explains the reasons for the restrictions for navigation in each stretch of the waterways, focused on the possibilities for commercial transboundary transport in barge trains, and the proposals for construction and operation of transference facilities, to optimize the barge capacities accordingly the different characteristics of each river stretches.

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Modern LED Light Solutions for Safe Navigation on Inland Waterways

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Despite the growing use of modern telematics systems, e.g. AIS, Inland ECDIS with satellite navigation (GNSS) and radar etc. visual aids to navigation (AtoN) are still further important for ensuring a safe navigation. LED (Light Emitting Diode) light sources have shown rapid developments in providing high light intensity and energy efficient light solutions. The German Federal Waterways and Shipping Administration (WSV) started the introduction of LED lights for AtoNs on inland waterways a decade ago. These developments mainly involved adapted technical solutions originating in coastal use. However, there are still a lot of lights and signal systems on the German inland waterways operating with incandescent or discharge lamps. Some panel signs still illuminated by propane gas powered lighting in locations that have no access to the electricity grid. The Federal Ministry of Transport and Digital Infrastructure (BMVI) decision to make comprehensive use of LED technology led to the development of standard technical light solutions. The light design is based on the recommendations of IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities). However, supplementary requirements are often needed on light engineering specifications. Road traffic signage rules have proven useful. The LED applications described in the paper are in accordance with:

- IALA Recommendation E-200 On Marine Signal Lights (Parts 1 to 4);
- European Standard EN 12899 - 1:2007 (Fixed, vertical road traffic signs).

The paper starts with photometric requirements that must be taken into account when specifying a light that ensure high quality, i.e. good detection, avoidance of glare etc. Further, examples of LED applications for fixed and floating AtoNs (fairway buoys, sector lights, waterway panel signs, signal rafts, lock signals and a new concept of entrance marks at locks) will be described. According to the examples aspects of light design engineering, power supply, work safety etc. will be considered.

The new signal raft that will be introduced in the paper is a floating AtoN for temporarily marking danger points and obstructions on inland waterways. In connection with the conversion of 60 rafts with regard to better operation and work safety LED-lanterns with photovoltaic power systems are planned. The signal equipment consists of special designed lanterns and panel signs that can be illuminated by a high efficient LED lantern specified to ensure a uniform lighting. The signal systems can be fully remote controlled and monitored.

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As one example of land based navigational aids a new concept of entrance marks at locks will be explained in the paper. An investigation confirmed that there is a need for improvement of the existing navigational aids with regard to visual conspicuity. A technical solution for daytime and night-time marking was drafted based on theoretical considerations and visual evaluation of test structures at the Koblenz lock. Internal LED lighting ensures an efficient illumination. The new marking system is now being tested at selected locks. Additional assessment with the employment of a ship handling simulator is planned.

Conceptual Design of a high discharge barrier in the Closed-Open-super dike ring “Rijnmond”

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During winter months the city of Rotterdam, Netherlands, experiences storm surges from the North Sea and high discharges in the River Rhine. Due to climate change the probability of simultaneous high sea water levels and high river water levels will increase, mainly because of sea level rise and increased rainfall in the Alps during winter time. Therefore, Rotterdam must be protected from both the North Sea and the River Rhine. This paper presents the conceptual design of a barrier for the Beneden Merwede, located southeast of Rotterdam. The barrier is to be a part of the Closed-Open super dike ring “Rijnmond” proposed by the Delta Commission in 2008. A multi-criteria analysis is conducted to select the final location of the barrier and the gate type. A sliding gate (here as a stretch meter solution) is chosen to be further developed.

First a gravity stable solution (triangular cross-section) is analyzed (steel and concrete). Under normal conditions, the gate would be stored in a dry dock adjacent to the river. Before a flood wave arrives, the dock would be flooded and the gate pushed along tracks located on the bottom of the Beneden Merwede. The gate would travel along these tracks until it reaches the opposite side of the river thus forming a closed barrier. Some benefits of a sliding gate design include movement only in the horizontal direction. This is in contrast to the Maeslant Barrier, for example, which features two floating sections that move in a horizontal plane about a bearing before being sunk vertically in the Nieuwe Waterweg. In addition, the load that works on the sliding barrier is equally supported along the length of the gate. This is also in contrast to the Maeslant Barrier because the hydraulic loads working on each floating section are directed to a single point (or bearing). The distributed load on the sliding barrier decreases the probability of failure of the sliding barrier when compared to the Maeslant Barrier. A drawback of the sliding barrier is that the track along the bottom of the Beneden Merwede must be clear before the barrier can be closed. To address this possibility, mechanisms to ensure the track is clear of debris before the gate is deployed from the dock are also proposed. Once the gate is in the closed position, the flood waters would then be redirected to natural reservoirs in the Zeeland Province for temporary storage. After the storm surge subsides, this stored water can then safely flow into the North Sea and the barrier can be opened.

A second solution using a composite material, UHMPE (ultra-high molecular weight polyethylene), is also investigated. The purpose of using this material is to obtain both short and long term cost savings. This is especially important because a total of four



barriers will be needed to complete the “Rijnmond” super dike ring. Therefore, the savings from using a composite material for all barriers could be quadrupled.

The gate in this solution, comprising of UHMPE and built in segments, would float to its final position guided or linked to tracks on the riverbed via C-type connections. Once fully extended, the gate would be partially flooded to withstand the design conditions and to close the barrier. The C-type connections would act both in tension and compression as the gate moves along the tracks. This system would allow the gate to overcome tolerances in the track where unequal settlements may occur. By constructing the gate in segments, longitudinal bending moments also stemming from the unequal settlements along the tracks would be avoided. In addition, the segments could be replaced individually thereby reducing costs. An advantage of the light UHMPE material is that no heavy moving equipment would be needed to replace a segment of this composite solution. Furthermore, this barrier could be stored at surface level without the need of building a gate recess.

It appears possible at this stage to construct the barrier with UHMPE. Following additional research, optimized structural dimensions could be found and the maximum cost savings realized. With the challenge of climate change and the proposed application of UHMPE this paper presents innovative solutions to address the growing flood risk in the Rotterdam and the Rijnmond region, core commercial and industrial areas for the Dutch economy.

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Navigable Inland Waterway Transportation Modeling: A Conceptual Framework and Modeling Approach for Consideration of Climate Change Induced Extreme Weather Events

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Transportation modeling of navigable inland waterways that examines the economic implications of waterway operational efficiencies on commercial shipping in the United States has been studied in detail for several decades. This is unsurprising given that inland waterway navigation in the U.S. plays a major part in the national economy by facilitating the shipment of goods. With the effects of climate change on extreme weather now gaining more attention, waterway managers are coming to realize that what used to be rare events may occur with increasing regularity, and that these events may begin to impose an increasing burden on commercial shippers and in some cases on entire supply chains, and subsequently society as a whole. In addition, the water resources of the U.S. navigable inland waterway system are also subject to several other demands, including drinking water supply, flood control, and hydropower production. Maintaining a balance between navigation and other competing demands is likely to become more difficult as climate change effects add stress to the system.

While there is no shortage of modeling and simulation studies and tools that describe navigable inland waterways, the conceptual frameworks adopted in the majority of studies simplify waterway systems to a single use (navigation) that is primarily dependent on seasonal vessel traffic and assume that variations in values such as vessel travel times can be adequately described by probability distributions and stochastic processes. To a certain extent, the conceptual framework adopted is limited by the modeling approach and computational requirements. Modeling and simulation approaches commonly utilized in navigable inland waterway studies, such as statistical analysis and discrete event simulation, make use of large datasets to identify key relationships and events, but are less computationally intensive than continuous modeling approaches. However, the simplifications of the system problem required by these modeling techniques reduces their ability to account for the effects of climate change induced extreme weather events on navigable inland waterway operations.

In this paper, we describe a conceptual framework and modeling approach for transportation modeling of navigable inland waterways based on an understanding of the competing demands for waterway services and the predicted increases in extreme weather events. We suggest that actions arising from the continuous decision-making processes of multiple autonomous waterway stakeholders in extreme weather scenarios lead to the bottom-up formation of system-level patterns. Additionally, we suggest that the behavior of individual stakeholders can be modeled using an agent based modeling approach framed by extreme weather scenario waterway operation

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guidance documents, including Waterways Action Plans. The model under development that is described in this paper will serve as a tool for assessing the utility of Waterways Action Plans, identifying inefficiencies in waterway operations, supporting thought-experiments for extreme weather scenarios, and assessment of commercial shipping related economic impacts of extreme weather scenarios.

Challenges in the design of the New Lock Terneuzen

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The canal between Gent and Terneuzen is a major shipping connection for inland navigation, as well as for maritime vessels. It concerns a waterway of CEMT class VIb. The canal is 32 km long, of which 15.4 km is located on Flemish (Belgian) territory and 16.6 km on Dutch territory. The canal zone Gent - Terneuzen is part of the Le Havre - Hamburg range, which can be seen as the major gateway of the European Union. Along the canal, the port of Terneuzen (Netherlands; part of Zeeland Seaports) and the port of Gent (Flanders) are located. The canal is part of the inland waterway network within the North Sea - Mediterranean Core Network Corridor of the Trans-European Transport Network. It therefore constitutes a crucial part of the envisaged high capacity inland waterway connection between Paris and Amsterdam.

The canal is accessible through a lock complex situated in Terneuzen on Dutch territory. The lock complex currently consists of three locks: one lock suitable for maritime navigation (built in 1968) and two inland navigation locks (built in 1910 and 1968). In 2013 almost 65,000 vessels passed through the lock complex in Terneuzen, a clear majority of more than 82% being inland vessels.

Companies in the canal zone between Gent and Terneuzen which make use of water transport have to deal with increasing transportation costs, because of congestion and the limited lock size of the current locks at Terneuzen. A new lock will contribute to the competitiveness of these companies, because of an increasing reliability and shorter transport times, which result in a reduction of transportation costs.

Hence the New Lock Terneuzen will satisfy three main purposes. First of all, the new lock will enable larger ships (Neo-Panamax class) to access the maritime zone on the Canal Ghent-Terneuzen. As a second objective the new lock will increase the capacity for inland navigation. Finally, the robustness of the maritime access is improved by doubling the largest lock in the complex. These three purposes will also create a driving force in the economic development of the surrounding industrial and commercial areas.

The basic measurements of the lock chamber will be 427m long x 55m wide x 16.44m deep. The new lock will be constructed within the existing lock complex in Terneuzen. On completion the new lock will rank among the ten largest locks in the world. The new lock will include four rolling lock gates and two bascule bridges. The paper includes an overview of the lessons learned in the design phase.

The preparation of this project is a collaboration between the Netherlands and the Flanders region in Belgium. The project organization is part of the Flemish-Dutch Scheldt Commission. Both countries have a strong reputation in hydraulic structures, dredging works and port construction. This allows the use of state-of-the-art knowledge and technology in a best-of-both-worlds approach.

Inland Waterway Transport on the Ayeyarwady River in Myanmar

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The Ayeyarwady River in Myanmar one of the longest natural, navigable rivers in the world, with vessels barging up to Bhamo, about 1500km upstream from Yangon. The country of Myanmar is going through a process of democratization and the country has been the focus of new investment into infrastructure, among others into the abundant waterway network.

This study presents an overview of the river system, the inland waterway transportation on the river, the developments in the last decades and the challenges for the future. River navigation on the Ayeyarwady River will play an important role in the development of Myanmar in the coming decades too. Since the country has opened its doors to international donors and private initiatives, much attention is given to improving the functionality of the river, not only for navigation purposes. The authors work closely with the Myanmar Government, especially the Directorate of Water Resources and Improvement of River Systems (DWIR) in selecting most promising options. The studies started end of 2014, and will be finalized in the summer of 2015.

This study has revisited a 1988 masterplan of the Ayeyarwady River and has reviewed whether significant changes have occurred on the river and in the inland waterway transport sector. Based on recent bathymetry maps, satellite image analysis and water level records, engineering measures to increase the navigability have been considered, which potentially deviate from what was concluded in 1988 when the situation was different.

The Ayeyarwady river shows an extreme seasonal variation; discharge during the dry season drops below 3,000 m³/s, whereas during the wet season, the average discharge increases to more than 15,000 m³/s, with peak water flows much larger than that. As a result of this, the annual water level variation along most of the river can be more than 10m. Draft limitation during the dry season limits continuous barging on the river and also limits the size of barges operating on the Ayeyarwady River; currently most barges have a carrying capacity which is not more than 1,000 DWT.

The large water level variation poses challenges to material handling in river ports too, which is currently still being done as in 1988 by beaching of barges on the river bank and manual cargo handling through intensive labour on small wooden gangplank. The Ayeyarwady River is a highly morphologically dynamic river, with quickly changing planforms.

Container transport is not yet seen on the Ayeyarwady River but the demand for cargo transport is expected to increase in the near future. Handling of containers at river ports is a design challenge due to large water level differences. The lowest water levels on the Ayeyarwady River have decreased over the past few decades. To maintain a

competitive option against trucking and rail for transport of goods, the Ayeyarwady River should be able to guarantee year round transport.

The Ayeyarwady River is still very natural and therefore very large and very dynamic. The channels are moving continuously, and it will be require enormous investments (and time) to train this river.

A first (incomplete) analysis has shown that engineering measures would mainly consist of dredging shallow spots and temporary river engineering measures. Fixating the river channel would only be justifiable at certain locations where natural hard points are located instead of dynamic, freely braiding river sections which are more commonly observed along the Ayeyarwady River.

Due to the very dynamic nature of the Ayeyarwady River, there is also a very interesting potential for developing smart shipping or “navigation with nature” on the Ayeyarwady. This would include:

1. A system of river training works with the aim of providing navigation at critical bottlenecks
2. Allow for navigation along certain routes which are not pre-determined but depend on the actual situation
3. Use of a real time low water level forecasting system
4. Crowd water depth collection by vessels plying on the river which are equipped with a smartphone connected to an echo sounder and sending to a central management unit via Internet and/or SMS
5. A pre determined LAD table.
6. Central management unit where all data is collected, processed and broadcasted via Internet and/or SMS.
7. Preparation of real time water depth forecasting allowing for safe navigation though depth limited stretches.
8. Broadcast most appropriated navigation route based on vessel dimensions and loading factor to smartphone on board of vessels. Main benefits of “navigation with nature” is that dredging volumes are minimized as much as possible, the shipping companies are up to date of the most actual water depth, the river is kept as natural as possible and the measures are relatively cheap.

Main benefits of “navigation with nature” is that dredging volumes are minimized as much as possible, the shipping companies are up to date of the most actual water depth, the river is kept as natural as possible and the measures are relatively cheap.

A target for developing a strategy for the river improvement works would be to guarantee 1,000 DWT barging year round. Based on a straight forward economic evaluation, investments up to 300°Million USD present value seem to be justifiable, and potentially more when volumes pick up and environmental considerations and other factors are considered as well. The paper and presentation provide more detail and insight in the most up to date situation of the Ayeyarwady River and the latest insights into most promising improvement strategies.

Development of waterway transport on the Musi River, South Sumatra

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Southern Sumatra is one of the main centres of natural resources in Indonesia, with many palm oil and rubber plantations and large reserves of coal. There are two coal mining areas in Southern Sumatra. Each mining area is connected by rivers to Palembang. The Musi and Rawas River from the northern mine area and the Lematang River from the southern mining area (Muara Enim). Coal is transported from the Southern area by rail to a port facility near Palembang as well as to South Sumatra. Currently, a small number of coal jetties have been constructed along the Musi River, but large scale navigation is not yet done.

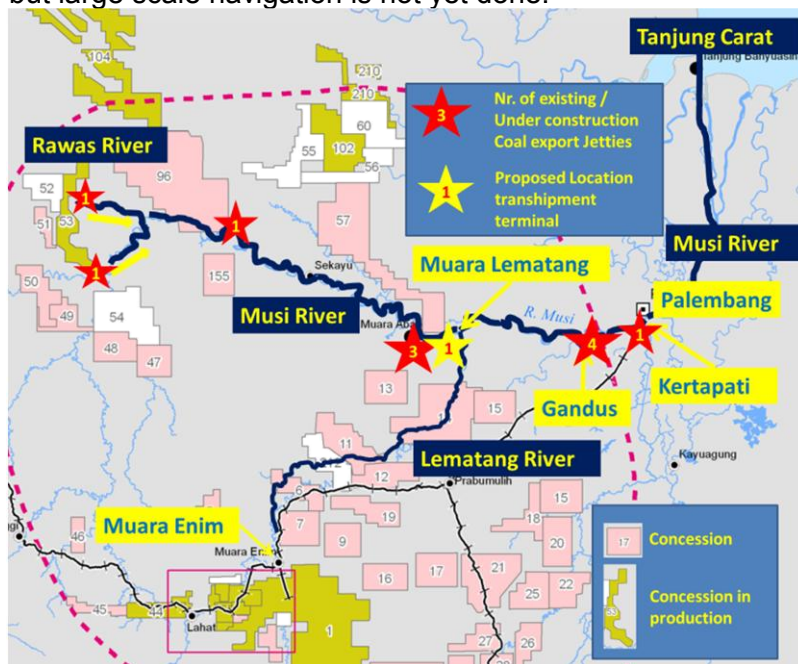


Figure 1: Musi River network with its tributaries and mine concessions

This study did a very comprehensive study on developing the river system and presented a strategy for involved parties to built upon. The coal transport capacity of the Musi River on the downstream section from Muara Lematang to Palembang in its present way of operating is smaller than expected coal export volumes in the future. This will initially result in congestion and consequently higher barging costs for users, and ultimately limit export volumes. Additional river transport capacity can be provided to barging companies by managing the traffic on the Musi River without high investments, thereby keeping barging costs at acceptable levels. The following vessel traffic management (VTS) measures can be applied to increase the transport capacity on the Musi River system:

- Allow night barging;
- Apply one-way direction timeslots at critical river sections (convoy barging): for example barges are sailing upstream in convoys for a period of 6hrs followed by barges downstream again in convoys during a timeslot period of 6 hours;
- Operating a VTS system which will benefit traffic planning and can also be used to monitor barges and collect fees;
- Install Aids to Navigation at critical river spots;

Upstream of Muara Lematang, the Musi River and its branches Lematang River and Rawas River have limited capacity due to seasonal depth restrictions as a result of large water level variations. Also for these sections, it is however with simple measures feasible to increase the capacity.

To further increase the potential of the Musi River system, the results show that from an economic point of view it seems feasible to canalize the Lematang River to unlock potential at the Muara Enim area. This option would however require a sufficiently large export volume to be cost effective. To achieve this, agreements with potential users are necessary.

A coal transshipment terminal is required to tranship coal from upstream or Lematang River 2,000 DWT barges to 7,500 DWT barges to reduce barging costs to acceptable levels. It is concluded that this provides a feasible business case, when export volumes of 10 Mtpa or more are reached. Therefore it is concluded that investment in a transshipment terminal is only interesting when the coal export volume from upstream sections or the Lematang River can be increased to achieve this throughput volume.

From this, it can be concluded that managing the Musi River would be an interesting business case, as investments are relatively limited and benefits for users can become substantial in the near future when 10 Mtpa of coal is transported on the Musi River. On long term when export volumes increase further, additional investment in river works and a transshipment terminal become feasible and beneficial too.

This case study shows that with simple and easy measures, the Musi River is a good example how rivers can be improved to allow for large volumes of transport. Key factor in success for long term developments and investments however will be the joint cooperation of the government investing in the river, and river users to use the river for their export covering for the investment costs. The paper and presentation will provide details on each of the various aspects considered during the study.

Smart Navigation System for the Port of Seville

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Enhancing the competitiveness of inland waterway transport requires the improvement of inland navigation safety in ports and rivers, the optimization in the management of resources, and the provision of value-added services to all the actors involved in the activity. The deployment of River Information Services (RIS) aims the achievement of these objectives; however, and according to the report provided by Panteia regarding the RIS implementation in Europe for the period 2006-2011, “few of the list of services are currently provided. Only basic information services are provided.” In addition, this report exposes that no activities were yet done in Spain in that direction.

The port of Seville is located in the Guadalquivir river course, being the only inland port in Spain. It is one of the 83 main European ports included in its Core Transport Network, whose maritime access is via the waterway E.60.02.

TECNOPORT 2025 is an initiative of the Port Authority of Seville (APS) co-funded by the European Commission by means of the European Region Development Funds under the Precommercial Public Procurement model. The University of Seville and several companies with leadership in their field (Telefónica, Thales, Isotrol and Portel) are carrying out this activity with the aim of building the “Port of the Future”. This lead implies developing technology and specific solutions to enhance the management and procedures of the Port of Seville turning it into a worldwide referent of inland ports.

As part of this initiative, RIS will be implemented in the Guadalquivir waterway, taking into account the specificities of the area. This implementation will be executed in a two-phase strategy: an initial phase to develop the infrastructure to provide the basic services and a second phase aiming at providing additional services such as transport information and statistics or waterway charges and port dues. The proposed system will not only offer vessel traffic services (VTS) and other RIS basic services but also those advanced and customized services of interest for the Port of Seville. Intense efforts will be done in the implementation of a monitoring and advanced signalling system based on the buoys and beacons deployed along the Guadalquivir River and Estuary. It contemplates the deployment of a set of smart autonomous sensor terminals in buoys and beacons that will enrich the information flux that feeds the management system. Using a low

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cost wireless sensor network based in the recent IEEE 802.15.4g standard, the system will provide useful magnitudes and variables for the traffic and transport management, safety, water quality assessment or emergency situation control that will have an impact in the development of sustainable and environmentally friendly transport.

Despite it is 52 miles from its mouth, the Port of Seville is a maritime port, whose navigation is determined by the tides and constrained by the shallowness of its waterway. This imposes restrictions in the size of the vessels and in the composition of convoys circulating on the river. Due to these circumstances, a Smart Portable Pilot Unit (SPPU) that takes into account the specificities of the Port of Sevilla will be one of the main outcomes of TECNPORT 2025 project. The SPPU will implement smart strategies for vessel navigation in the river and will interact both, with a navigation centre located in the Port facilities, and with the monitoring system deployed in the waterway, which will act as a virtual signalling system.

The conference paper details contribution to the conference will detail the proposed architecture, advances and services that have been developed in the TECNPORT 2025 project regarding the river navigation systems, and the SPPU.

Smart ICTs for the enhancement of traffic logistics in the Port of Seville

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Optimizing the management of freight is one of the main targets of the intermodal transport. From the supplier, the freight is transported using multiple modes (rail, ship and truck) without cargo handling to its final destination. Independently from the means of transport, it is important to monitor the exact location and status of the merchandise in order to ensure an efficient management, at the same time that goods are not damaged or their quality is not impaired (especially important in the case of perishable goods).

TECNOPORT 2025 is an initiative of the Port Authority of Seville (APS), co-funded by the European Commission by means of the ERDF (European Region Development Funds), under the Pre-commercial Public Procurement model. The University of Seville and several European companies (Telefónica, Thales, Portel e Isotrol) with leadership in their respective field are carrying out this activity with the aim of building the "Port of the Future".

This lead implies developing technology and specific solutions to enhance the management and procedures of the Port of Seville turning it into a worldwide referent of inland ports. As part of that initiative, special efforts have been done in the creation of a cooperative unitized tracking system allowing, not only optimization of the transport management, but also offering added value services and relevant real-time information to the stakeholders involved in the process.

The proposed system is based in a low cost heterogeneous communication network covering the entire port facilities and the Guadalquivir estuary, which is connected via Internet to (usually smaller) network replicas deployed in warehouses, trains and vessels, or to single communication terminals installed in trucks. A set of autonomous, low cost, communication terminals interact with this network infrastructure. These terminals, attached to containers, are equipped with a GPS module and a set of optional sensors that monitors the container contents (temperature, humidity, movement detection, etc.), and the presence of events that will generate alarms under critical circumstances, such as detection of an open door, fire, gas leakage, etc.

The network infrastructure is based on the recent IEEE 802.15.4g standard, and takes profit of a wide area network based on WiMAX (IEEE 802.16), that covers most of Sevilla Port facilities.

The data measured by the attached sensors along with the location information of the containers are sent to an open and cooperative platform for data analysis, and offered to an integrated service centre based on the Internet of the Future Fi-Ware platform, that will provide specific services to each of the stakeholders in



the transport chain. Moreover, using the capabilities of cloud computing, the proposed solution will offer scalability, intensive data processing, flexibility and easy management through web tools.

Compared to conventional tracking systems, the one proposed here is conceived as a public service with open architecture and interfaces, so that different suppliers will design communication terminals and sensors according to the user needs. The Port Authority will maintain the network infrastructure and will provide services and APIS to logistic operators and to the different stakeholders in the logistic chain, so that can take benefit from this infrastructure.

Thus, the proposed system can be perceived as an enhancer for the efficiency in transport management, at a very low cost, that will have an impact in the profitability of each of the relevant stakeholders. Although it has been conceived to reinforce the leadership position of Sevilla Port in the Madrid-Sevilla-Canary Islands corridor, the proposed system will be offered to other ports and logistic centres. The conference paper will detail the proposed architecture, advances and the offered services that have been developed in the TECNOPORT 2025 project, that will enable the development of the first open-access, public service to offer real-time individual control and traceability of containers in transit from origin to destination and incident notification to users.

RIS Implementation in Poland

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Inland navigation is one of the most neglected branches of transport in Poland. Despite its undeniable advantages, such as the capability to transport goods of considerable mass and volume, the lowest transport cost for an individual item, minor impact on natural environment and therefore low external costs, inland navigation does not play a significant role in transport business in Poland. Decades of underfunding have caused technical dilapidation of waterways and port infrastructure. River Information Services, with their relatively low implementation costs, may help improve transport via inland waterways and allow to fully use current navigation conditions.

The necessity to implement the River Information Services (RIS) on the Lower Oder was initiated by the provisions of the Directive 2005/44/EC of the European Parliament of 7 September 2005. According to this directive, EU Member States have been obliged to adapt the RIS system on all IV-Class waterways (and higher), if they are connected to other waterways of the same standard. In Poland, this condition is met only by a short section of the Oder, from the border with the internal waters in the Szczecin Water Junction in the north to the town of Widuchowa in the south.

The adaptation of the RIS on the Lower Oder in Poland, due to the structure of linear infrastructure, had been divided into 2 stages.

In the first pilot stage, the system was dedicated to the development of nodal infrastructure in the minimum scope required by the EU legislation so that the structure of data transfer would provide acceptable security and reliability. Despite the narrow range of adaptation of the first stage, it was an undertaking requiring a considerable amount of work, particularly in the area of planning and designing the architecture of the system.

The RIS system in Poland is based on the following technical solutions:

1. Automatic Identification System (AIS),
2. CCTV system,
3. System of radars,
4. A system of meteorological sensors,
5. A system of hydrological sensors,
6. Differential global positioning system (DGPS),
7. VHF communication system
8. Internet information portal of the Inland Navigation Office in Szczecin,

Due to limited research and a very short time of RIS Centre activity in Poland (it was officially launched in May 2014), it is difficult to assess clearly the cost and benefit ratio of the RIS implementation. One should, however, assume that the main benefits for the RIS implementation are for the water management offices which, thanks to the information obtained via RIS system, may improve:

- law enforcement, e.g. punishments for stopping in a prohibited place or finding the facts in case of an accident
- navigation safety through continuous traffic supervision,
- Polish and German icebreaking actions on the Oder (thanks to CCTV images one may observe the ice cover and its movements and therefore optimise the action plan)
- gathering statistical data on traffic flows

The main benefit for RIS users is the free access to electronic navigational charts which will be supplemented with the bathymetric layer. Moreover, RIS have the access to hydrological and meteorological information, which facilitates planning the journey.

Carrying out the pilot RIS implementation constituted a great challenge for the Inland Navigation Office in Szczecin. The challenge was made even more difficult due to the short time provided for the project (since the project was co-financed by the European Union, it had to be finished by the end of 2013) and the fact that the whole project followed the critical path as all tasks in the project had to be carried out in a certain sequence.

Challenges of the RIS implementation on the Lower Oder may be divided into three categories:

- technical challenges,
- legal challenges,
- organisational challenges.

Experience gained during the pilot implementation on the Lower Oder RIS and the preliminary evaluation of the project constitute a basis to prepare the 2nd stage of the implementation which will affect the further development of the nodal infrastructure and improve the future development of the linear infrastructure in the West Oder

It is too early to fully evaluate the potential of this new technology and analyse all benefits coming from its implementation. However, all analyses published so far show indisputably that river information services bring considerable macroeconomic profits. It is therefore essential for Poland to continue the development of the RIS system and to join the internationally harmonised RIS implementation in Europe and research on the future of river information services in the EU.



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Design Guidelines for River Harbours and Verification of Harbour Layout in the Portable REMBRANDT-INLAND Bridge Simulator Including Public Demonstration

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The Rhine is the most important inland waterway in West Europe. Every year more than 130,000 vessels carry around 150,000,000 tons of cargo across the Dutch/German border near Lobith. Push-barge units and most of the largest vessels sail on a 24/7 scheme. Navigation regulations prescribe that vessels are allowed to sail for 14 to 20 hours between breaks, depending on the number of crew. Due to the intensive traffic on the river, anchoring along the navigations channel is no longer a safe or tranquil option.

The Dutch government has decided to create special harbours along the main routes at a maximum interval of 30 km (2 hours sailing) to provide mooring facilities to satisfy overnight rest needs for the inland vessel crew. At the boundary on the main transport route between Rotterdam/Amsterdam and Germany a total of 70 berths has to be added.

The existing harbour at Tuindorp will be upgraded to accommodate twenty CEMT Class Va vessels with a length of 110 m. Some 4 km upstream in the flood plain Beijenwaard near Spijk a new harbour will provide some forty-five berths for CEMT Class Va vessels with a length of 135 m and four berths for pushed convoys CEMT Class Vb with a length of 190 m.

Between twenty and forty vessels will pass through the harbour entrances twice every 24 hours. Therefore, the speed of access is a very important design aspect for these harbours as well as the nautical safety of manoeuvres around other traffic. In additions the harbour should provide tranquil situation with berths protected from flow and waves due to the traffic sailing on the river.

The range between extreme high and low water level is more than 10 m and the current in the river varies from 0.8 m/s to more than 1.9 m/s (3 to 7 km/hour).

At the beginning of the design process guidelines have been set for the design of the harbours. These guidelines taking into account nautical, hydraulic and morphological aspects and concern:

- Level of nautical bottom;
- Width and shape of the harbour entrance;



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- Manoeuvring area;
- Orientation of the berths;
- Departing vessels' view of through traffic.

The nautical safety and speed of access for the proposed harbour layouts were tested using BMT's portable manoeuvring simulator REMBRANDT-INLAND. A wide range of conditions were made available for the simulations:

- 2 harbours;
- 3 vessel sizes;
- 2 loading conditions;
- 4 sailing trajectories;
- 3 current/water levels combinations;
- 4 wind conditions.

In five days some 80 manoeuvring simulations were carried out. The simulation program was intended to cover the whole range of conditions, with the focus on the difficult ones. Three active and licensed inland skippers were hired to sail the model vessels. Each simulation took about 30 minutes for instruction, sailing and debriefing. The findings of the skippers regarding the safety and the swiftness of the manoeuvre were recorded in the "sailing report". At the end of each day the tentative program was adjusted to account for the lessons learned.

Safety was a major concern of the local people, particularly since some of the berths will be assigned to vessels with dangerous cargo (ADN-goods). Therefore, the harbour lay-outs had to be tested thoroughly both to ensure safety during entry and departure. This included consideration of the vessels berthed at jetties inside the harbour that may be at risk because of these manoeuvres. The result of the simulations was an assessment of the lay-outs and a proposal for alternatives to guarantee safety.

The project team from "Provincia Gelderland" (the regional authority) made a conscious decision to involve the public in the design process and to be open on the content of the ongoing studies, with special consideration for the people that live near the future berths.

Since BMT's Inland bridge was designed to be portable, the project team very much welcomed the idea of involving a local skipper and to execute (part of) the simulations in Lobith. The visitors to the demonstration took an active part in the simulations and got a good idea of the type of studies that are performed to ensure that the harbour designs are safe for navigation.

Simulating lock operations in the generic salt intrusion model WANDA-Locks

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Shipping locks at the coast do not only serve as an entrance for sea going vessels to the inland waterways, but also separate the saline sea water from fresh systems. These purposes are opposing, and designing a lock that performs well on both is an engineering challenge.

Maintaining the water quality of fresh water systems is crucial from an ecological perspective, but also necessary to guarantee the quality of drinking water as well as water used for agricultural purposes. Often the required salinity levels of lakes and inland waterways impose a very strict limitation on salt intrusion through sea locks.

An engineer designing a lock should be able not only to determine its navigational capacity, but also to take into account the various processes governing salt intrusion. The salinity in the lock chamber changes during levelling, depending on the levelling system used and the fresh water or sea water salinity. When the doors are opened saline and fresh water are interchanged, a process appropriately known as lock exchange. This process continues with varying rate until the doors are closed.

Salt intrusion and the effect of salt intrusion mitigating measures can be calculated with WANDA-Locks. The one-dimensional and computationally very fast model WANDA has been developed over the last decades and is used in hydraulic design of a wide variety of applications, such as pipelines, channel flows and weirs. The software can be linked to other applications and has been extensively tested and validated. The process of salt intrusion has been added in the WANDA-Locks library of this software, which also includes the possibility to model several salt intrusion mitigating measures. These can be connected simply as components in a block diagram. An advantage of this one-dimensional model is the computational speed, which allows the calculation of numerous locking cycles; calculations of a year length can easily be made.

The rate of salt intrusion through a lock naturally depends on the intensity with which the lock is used. The distribution of the traffic over time is an important parameter. In relatively busy hours, the lock is filled quickly and the lock doors are open only for a short period. During relatively quiet hours however, the lock door is kept open for approaching waterborne traffic. The lock operation or lockkeeper thus highly affects the rate at which salt intrusion occurs. The WANDA-Locks model must therefore include the statistical nature of traffic distribution and the lock operation characteristics. This paper reports the development of a control routine as part of WANDA-Locks which is able to simulate the locking operation with the requirements given above and in a realistic sense. It reacts to traffic demand and, by using a small number of variables, mimics the lockkeeper and his considerations. The routine directly activates valves and



doors thus simulating lock procedures. Waiting times and durations of sailing into or out of locks are taken into account.

The method used is based on a functional diagram that has been defined in a very generic manner, in order to be able to model all sorts of locks, either varying in geometry, leveling system or boundary conditions. Subsequent steps in lock operations are translated in states which are activated based on hydrodynamic or traffic based conditions. Differences in locking procedures can be easily accounted for. The generic principle of this method matches the philosophy of WANDA-Locks.

The method has been applied to a study concerning a lock in the south of The Netherlands, between the saline Eastern Scheldt and the freshwater lake Volkerak. It has shown to adequately model a real lock operation. Combined with the salt intrusion calculation included in WANDA-Locks, this has been used to identify critical processes within the lock operation and to quantify the effect of changes in this operation. In this specific case, the average duration of lock exchange per cycle could be heavily reduced.

The development of this method has proven a valuable addition to the WANDA-Locks library in calculating salt intrusion through sea locks. The generic WANDA-Locks library provides a method for engineers to account for salt intrusion as well as navigational capacity of a lock in an early stage.

Analysis of the Motive for the Use of LNG-Powered Ships in the Yangtze River Basin

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In order to respond to the decisive deployment of the State Council about building the Yangtze River Economic Zone relying on the Yangtze River golden waterway, the construction of Yangtze River waterway stays in a stable development stage. Yangtze River, as the first inland river golden waterway with freight volume ranking the first all over the world, undertakes the turnover of inland river waterway cargoes in China. In 2013, the inland river freight volume was 1.855 billion tons and cargo turnover up to 704.4 billion tons via Yangtze River, respectively covering 55% and 49% of the nationwide waterway freight volume. With the increase of cargo turnover, oily water and air contaminants resulted from ships also rise unavoidably and ships at ports of Yangtze River centralize comparatively, and the total discharge of oily water and aerial pollutant is extremely considerable as well. Therefore, it is extremely important to seek for a clean energy source to reduce the pollution to water body and air. The clean green fuels generally recognized presently mainly include LPG, CNG and LNG, all of which hardly pollute water body and atmospheric environment during burning and are widely applied to shipping industry accordingly. Therefore, this paper carries out analyses on the inevitability of the wide application of LNG-powered ships from global energy source structure, economic demands for shipping and formulation of relevant international conventions; secondly analyses on domestic relevant policies about LNG-powered ship to promote its wide application in inland river of Yangtze River, and finally discussions on the use situation of LNG-powered ship in inland river basins of China in recent years under the impulsion of various factors.

Factors including:

(1) Change of global energy source structure

The exploitation of natural gas has changed the global energy source structure and become a motive for rapid development of LNG-powered ships at home and abroad.

(2) Inherent requirement for shipping economy

Reduction of air and oil pollution via LNG fuel; high economy efficiency of LNG fuel; high gas supply guarantee of LNG fuel;

(3) Promotion of the Convention on the International Maritime Organization

Promotion of MARPOL supplementary provision VI; Promotion of international gas fueled ship safety rules

(4) Driving of national policies

<The Safety Supervision and Management Regulations on LNG Fuel Ships in Inland Rivers>; <The Notice Of Relevant Items On Promoting the Application Of Liquefied Natural Gas As Ship Fuel>; <Provisional Rules for Safety Supervision and Management on Water Liquefied Natural Gas Filling Stations>; <The State Council's Guidance on Promotion of the Development of the Yangtze River Economic Zone by Right of the Golden Channel>.

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The latest United Statesge of LNG-powered ships in China inland water is summarized in the end of this paper. China mainly focuses on the reconstruction of fuel powered system with regard to the popularization of LNG-powered ship. On March 5, 2015, China's first pure LNG-powered ship named " Green Power 6002" had a successful sailing trial, which adopted pure LNG fuel engine as main propulsion mainframe, reaching 25% reduction of the carbon dioxide emissions, 90% reduction of nitrogen oxide emissions and zero emission of sulfur oxides, PM2.5, oily water and domestic sewage, so it is regarded as a real clean ship.

Experience of Revegetation of On-Land Sections in the Lower Delta of the Paraná River

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Within the framework of the construction of an LNG Regasification Terminal - YPF S.A. - 2.585.000 m³ of sediment were dredged from the Paraná de Las Palmas River in Km 74.5, District of Escobar, Province of Buenos Aires between September and December 2010. The dredged material was disposed on-land in two sections of 15 and 32 ha, built in an area adjacent to the dredged section, raising the surface level up to 4 meters above the local zero.

The on-land sections were previously devoid of vegetation that covered them. They were mainly composed of floodplain dominated by typical native species of the Delta and Paraná Islands Eco-region, and also by secondary forests in better drained areas dominated by invasive species that have evolved from abandoned plantations of fruit trees and salicaceae species.

Periodic surveys of the on-land sections with the aim of recording the evolution of plant communities that settled on the deposited material and the development of soils were performed between January 2011 and June 2013. This information allowed to know and understand the structure of plant communities that developed spontaneously in said sections and design intervention measures aimed at boosting revegetation.

This work consisted of restoring the vegetation cover of the on-land sections enabling the restoration of spontaneous vegetation through management actions.

In most parts of the surface, the vegetation cover was spontaneously restored during the first year after the completion of the filling process. The pioneer vegetal community which largely colonized the area was dominated by two forest species that formerly filled local secondary forests: willow (*Salix spp.*) and Poplar (*Populus spp.*). However, the results of the monitoring of vegetation have shown the evolution of pioneer plant communities in a process called "vegetal succession", with significant increases in plant cover and, although milder, species richness, diversity, and evenness.

In the sectors where the thicker materials were deposited and with greater relative height, there was no spontaneous vegetation, remaining mostly bare soil. The restrictive edaphic conditions in these sectors were associated with water (low infiltration) content and salinity. The planting of rustic pastures (*Agropyro sp.*, *Festuca sp.*, *Melilotus alba*) as measure of intervention, allowed to quickly achieve the coverage in these sectors promoting the evolution of their edaphic conditions and as a result, the subsequent evolution of plant communities. In this sense, the planting of rustic pasture was aimed at facilitating the settlement of a pioneer plant community which, through the development of its root system and the incorporation of organic matter, could improve the physical (infiltration of water, porosity) and chemical properties (reduction of salinity by leaching, increase in content of organic matter and biological nitrogen fixation) of these soils.

The plant communities that developed in the on-land sections are in the early stages of the succession process that began after the disturbance which meant the loss of plant

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cover and the deposit of dredged material. We expect a progressive increase in diversity due to the evolution of edaphic conditions, and the consequent incorporation of late emerging new species in the succession process stratifying the oligo-specific forest which currently dominates the area.

Two issues should be mentioned that may be of interest to replicate similar projects: the choice of time for the execution of the dredging (and subsequent fill material discharge); and the limitation on the strict removal of the vegetation cover of the area in order to preserve the seed bank and the plant remains that might favor the settlement of vegetation cover

Finally, given the emergence of a wide restrictive surface as to the spontaneous vegetation restoration, please see the filling process of the on-land sections as to their location and time of use of the material discharge sites.



- ABSTRACT 142 -

Maintenance of the Panama Canal Navigational Channels

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The Panama Canal provides a safe and expedite passage between the Atlantic and Pacific oceans by maintaining its channels at navigational depth. A living Maintenance Program is continuously updated and executed in order to remove natural or induced siltation, slides and obstructions from the waterways, as a key solution.

Monte Carlo simulation model to determine the vessel impact energy for the design of port terminals in river and estuarine environments

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For the design of certain types of harbour works it is necessary to consider the possible impact of a vessel on the structure. In particular, for structures that support hydrocarbon pipelines this is a design requirement established in international standards (see e.g. ISO 19902). However the definition of the impact scenario (type, size and speed of the vessel) included in the standards do not necessarily fits to the specific conditions found in a fluvial or estuarine environment.

An alternative is to define an impact scenario based on expert opinions: that is choosing a type of ship (size, type and speed) from the local fleet as well as the expected environmental conditions (winds and currents) that may lead to the occurrence of the impact. However this choice would be arbitrary and subjective and, not being guided or supported by any standard or recommendation, a significant uncertainty would remain about the level of reliability of the structure. In particular, once the impact energy is estimated from the chosen scenario, this energy could be exceeded by several different combinations of ships and environmental conditions (e.g. bigger ships and milder environmental conditions, or vice versa).

This article describes the development and implementation of a simulation model based on Monte Carlo techniques to estimate the probability distribution function of the vessel impact energy for a given structure. This model enables the designer to more accurately select the impact energy that must be used in the design in order to achieve the reliability level required by standards or recommendations, providing also the set of combinations of ships and environmental conditions that leads to the selected energy. The model simulates a large number of transits from the fleet of ships transiting the area (current as well as future fleets). During the simulation each ship is assigned a speed and a set of environmental conditions (wind and current) obtained from the local climate. Then the model estimates, depending on the type and size of the ship and on the environmental conditions, the probability that the ship drifts and impacts the structure. If a given ships does not result in an impact of the structure, then the impact energy assigned to the transit is zero. If instead the ship do drift and impacts the structure, then the model calculates the impact energy. The calculation of the drifting probabilities and of the impact energies are performed following the methodology described by DNV recommendations, with some specific modifications introduced to better fit our case study.

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The model is applied in the design of a structure located west of the port of Montevideo, Uruguay, where the fleet that travels alongside the structure comes mainly from Buenos Aires and from the Parana and Uruguay River waterways. The obtained results show: (1) the usefulness of the model for optimizing the impact energy used in the design of the structure, and (2) that the definition of design scenarios based on expert judgment may result misleading in terms of the expected reliability of the structure.

Design of the Central Connection, a key component of the filling / emptying system of the Panama Canal Third Set of Locks

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The Panama Canal Authority (ACP) has developed the 'Third Set of Locks' project to expand the vessel transfer system capacity, allowing the passage between the Atlantic and the Pacific Ocean of large vessels presently unable to cross through the existing lock system. These will obviously increase the inland water transport.

The National Institute for Water (INA) was hired by Montgomery Watson Harza (MWH), in charge of the consulting studies for the construction Consortium 'Grupo Unidos por el Canal' (GUPEC), to undertake numerical modeling in order to test project alternatives for the filling / emptying (F/E) system, which constitutes the key element to maximize the rate of vessel passage, and minimize the forces on the moored vessels. Maximization of the rate of vessel passage requires reducing as far as possible energy losses, mainly associated to form drag, i.e., flow separation.

Regarding forces on moored vessels, during a lockage operation they experience nearly hydrostatic forces due to water surface oscillations within the chamber. These oscillations are produced by the discharges or uptakes from the chamber ports. The amplitude of the oscillations is measured in terms of the water surface slope in the chamber. Design restrictions are imposed to both the longitudinal and lateral water surface slopes.

The Central Connection, a non - standard component of the F/E system, is responsible both of the main energy losses, and to ensure equitable flow distribution in the lockage operations, hence minimizing free surface oscillations. Different design alternatives for the Central Connection were studied, taking into account both structural advantages and hydraulic performance. The general criterion applied to optimize for the hydraulic design alternatives was based on reducing the velocity in those specific regions where the flow change direction, in order to avoid or minimize flow separation and the occurrence of adverse vortexes effects.

A numerical modeling system was implemented to analyze, improve and compare project alternatives. The optimization strategy consisted in starting from the simplest representative numerical schematization, and proceeding towards more complex schematizations. Two theoretical approaches for turbulence - Reynolds Averaged Navier - Stokes (RANS) and Large Eddy Simulation (LES) - were used. The final design was tested in a physical model.

A very good agreement was obtained between calculation (numerical model) and measurements (physical model) for the velocities in the ports and the water surface



slopes in the chambers, both for constant and variable discharge. The numerical model correctly predicted the longitudinal free surface slope using RANS turbulence approach for relatively low initial head differences (up to around 9 m) between Chamber / Lake / Ocean. However, this approach failed for higher initial head differences (maximum 21 m), as an irregular oscillation with a much higher amplitude was recorded in the physical model. In order to capture this phenomenon, the LES turbulence approach was applied, indicating that the cause was resonance between the water surface oscillations and the largest turbulent eddies.

The validation of the numerical model was performed using the physical model dimensions. Afterwards, the numerical model was run with the prototype dimensions in order to extrapolate the results to this scale.

Quantifying Effects of Policy Changes on Navigability in the Dutch Rhine Delta

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In the Bovenrijn (where the Rhine enters the Netherlands), bed level degradation is ongoing at a rate of approximately 2 centimeters per year as the river is still adapting to the river training, which has taken place over the last centuries. To counteract this, two sediment nourishments are foreseen in 2016 and 2019, and possibly more will be performed in the future. The effect of such nourishments on navigability is investigated within the scope of this paper.

The Dutch Rhine is a busy navigation route for transport from the port of Rotterdam to the German Hinterland. The above mentioned measures to counteract the effects of the bed level degradation influence the morphology of the river bed, and thus affect navigability. To maintain navigability the navigation channel is regularly dredged, and in the Netherlands the regulation is that the sediment should also be dumped back into the river except for locations which are governed by sedimentation or for maintenance of the summer bed lowering, where sand mining is allowed.

In order to quantify the cumulative effects of the combined measures, a case study of the Dutch Rhine (Bovenrijn, Waal, Nederrijn and IJssel) was setup and computed using the hydrodynamic and morphologic modeling system Delft3D. The first scenario considers two nourishments with a layer thickness of 30 cm at Millingen aan de Rijn (2016, 2019) in the deep parts of the fairway between river kilometre 862 and 864.5. In the second scenario nourishments similar to those at Millingen aan de Rijn are performed on a yearly basis from 2020 onwards in all eroding branches of the river (Bovenrijn, Pannerdensch Kanaal, Nederrijn, upstream IJssel and behind the fixed layer at Nijmegen).

Results show that the stabilisation in the first scenario has a positive effect on the average bed level in the channel. In the second scenario the average bed level remains approximately constant in the Bovenrijn, increases on the Pannerdensch Kanaal and still decreases in the Waal. The increasing bed level in the Pannerdensch Kanaal is caused by two main mechanisms: the change in discharge distribution at the bifurcation, and because the nourishment criteria are evaluated per kilometre (instead of per reach). In both cases bed stabilisation is shown to affect the navigation depth but shipping requirements are still satisfied. Further optimization of the bed stabilization, both in nourishment criteria as well as balancing the nourishments in both downstream branches, is recommended. The model is also shown to be a valuable tool to assess the effects for navigation based on the combined influence of multiple river engineering measures, and changes in the sediment management policy for the decades to come.

Port of Buenos Aires future role and its link with inland waterway transport

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The present work deals about the river transportation system with its corresponding intermodal connections in the Southeast region of South America. Special attention is given to Port of Buenos Aires with its hinterland and regional foreland. Furthermore, competitiveness between major Argentine's port and other South American ports is treated in detail, including also its interaction to the maritime transport and the expected expansion works correlated with the prospects of global ports demands.

Containerized cargo throughput in Latin America was studied as a direct outcome it resulted that it increased during the last decade at same global rates. This implies that its incidence is around 7%, according to the last report published by the Economic Commission for Latin America and the Caribbean. In consequence, port infrastructure must be planned and developed accordingly to this growing rate during the coming years.

The main inland navigation waterway in South America is the Paraná- Paraguay waterway that runs around 3440 km from Port of Cáceres in Brazil to Nueva Palmira in Uruguay. It is divided in different sections based on its specific nautical characteristics and rules. To reach natural water depth in the South Atlantic ocean, in addition to the Paraná-Paraguay waterway, vessels need to sail around 240 extra km through the Rio de la Plata waterway (Emilio Mitre channel). Almost half way in between the starting of Paraná-Paraguay waterway and the Atlantic ocean, the access channel to Port of Buenos Aires is located. This access channel, as the whole inland waterway system and the Emilio Mitre channel, ensures its navigational depth throughout continuous dredging. The importance of river navigation is based on being able to transport larger amounts of cargo at low cost, avoiding truck and train transport, reducing transport times, without damaging the routes or interfere with the transport of private vehicles (accidents) and favoring the environment.

Port of Buenos Aires plays a fundamental role in this logistics chain. It is one of the main ports (and usually last call) of every shipping line operating at the Atlantic coast of South America. Besides, it is positioned in a strategic location, either for maritime transport, but also where more than 5000 Km of inland waterways converge. Therefore, it is also benefited by its almost exclusive hub location, receiving and distributing inland cargo from various countries in the region, including Uruguay, Brazil, Paraguay and Bolivia.

To boost its current situation Port of Buenos Aires Authority (AGP - Administración General de Puertos) had prepared several plans for the future development of the port. All the considered expansion works are meant to enhance its regional hub position, and to strengthen its competitiveness.

The 2040 master plan includes the extension of existing quay walls; the filling of old dock basins to increment storage areas for containers; land reclamation in the river

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for port expansion and the optimization of port equipment. The aim is to respond, in a sustainable and planned way the rapid growing international demands for accommodating larger vessels and throughputs.

This paper discusses different current and future actions proposed by Port of Buenos Aires to remain as a key inland and maritime port within the Atlantic South American port system.^{II}

To conclude, it is important to mention that ensuring Port of Buenos Aires' permanence in the market as a main regional hub, honouring Buenos Aires inhabitants spirit ("porteños" or port people), and driving Argentine's economic growth are a must for a port with more than 400 years of history.

Amazon Basin Inland Waterway Transport Aspects

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When confronting railway and road transport maps with charts of the Brazilian waterways, it is promptly noticeable that they cover distinct regions. The countries' North region has the most developed inland waterway system with the capability of receiving ocean going vessels due to its rivers big dimensions; however, its connection with two very productive areas, the agricultural Central-West and the industrial South-East, is not well developed. The end of this isolation of the Amazon Basin relies on the integration of the Railway system projected for the Central-West teaches the navigable Amazon river right bank tributaries.

This paper intends to demonstrate the Brazilian waterway system, its characteristics, the most important Brazilian government recent transportation plans and the consequences of the present arrangement not only to Brazil but in a regional perspective as well.

The waterway transportation in the Amazon Basin, due to its fluvial system extended coverage area, wraps many aspects. It goes from subsistence, with the transportation of small amount of cargo and passengers, until big ventures, like cabotage or long distance navigation. The Solimões-Amazon Waterway is the main Brazilian waterway corridor in terms of transported quantity. Its physical characteristics, resulted from the smooth Amazon topography, contribute to the waterway transportation. The Madeira River Waterway, the third largest waterway when it comes to quantity transported by inland navigation, accounting for more than 4 million tons annually. The most important waterway for transportation of cargoes from the state of Mato Grosso is the Tocantins River waterway, which also would meet the logistics demands of Maranhão and Pará, besides the state of Tocantins. The Tocantins and Araguaia Waterway transports 9 million tons over the long distance and 3 million through inland navigation, according to the Antaq data, but only in the stretch of the waterway that is near to the mouth. The main products transported were ores, mainly bauxite, and petroleum derivatives.

The transport costs in inland navigation are lower than in other transport modals; however, it requires complementary transportation and highly efficient transshipment terminals. Other aspects that must be considered are the waterways operating all year long, even with restrictions, and the possibility of using convoys with high capacity of cargo. In the Amazon basin, river navigation is essential to the movement of people and goods, due to the inexistence of roads and to the capillarity of waterways. In the South and Southeast regions, the main rivers flow directed to west, because of Serra do Mar and Serra Geral and do not reach the ports of the Atlantic Coast, with the exception of the Port of Rio Grande. Despite the fact that the country can count on large waterways basins, most of the Brazilian rivers

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need transshipping works, dredging and regulation. The waterway navigation is completely disconnected from the railways and would requires at least ten multimodal big river-rail terminals to become attractive.

- ABSTRACT 152 -

Galheta Canal Capacity Analysis - Port of Paranagua

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Nowadays' economy organization success directly relies on the beginning and end of each trade, the ports. However, for historical reasons, productive areas and human occupation are not only located on the coast; often, ports are located at protected sites on the countryside. Regardless of that nature, vessels are getting deeper and wider, ignoring that river channels are kept nearly the same. Brazil has a characteristic found in few places worldwide, ocean going vessels call at river ports as well. Vessels performing cabotage routes that navigate the Brazilian coast from north to south have to navigate Amazonas river for more than a thousand kilometers before reaching the sea. The Approach channel is 30km long inside land and has three bends. The bends and also the straight sections that connect them were analyzed. Furthermore, this paper analyzed 12 Anchorage Areas and the Turning Basin. To achieve that, this work applies PIANC's methodology at a conceptual level, which its first step consists of gathering location's physical data together with vessel's normally navigating the area characteristics. To determine what kind of vessel should be considered a design vessel, this paper reviewed vessels that operate cabotage routes navigating from Manaus to Rio Grande, and call the port through its course. Cabotage companies ship containers and, for that reason, two container vessel carriers were analyzed. The first chosen container vessel has the maximum allowed dimensions that currently call the port. The second vessel is the one with the biggest dimensions operating cabotage and consequently inland navigation in Brazil.

PIANC published Report nº 121-2014 to provide guidance for the design of vertical (depth) and horizontal (width) dimensions of harbour approach channels and the maneuvering and anchorage areas within harbours. PIANC guidelines are currently the most reliable and up to date on the subject. Considering the Brazilian reality of ocean going vessels calling at river ports this paper intends to evaluate the capacity of the maritime configuration of Paranaguá Port, one of the most important ports of Brazil and an existing call in the cabotage route companies.

Simple indispensable environmental data are missing for many ports in the country, situation that implicates on the adoption of less secure and efficient maritime configurations. In addition, there is a lack of professionals and research centers dedicated to this subject. Paranagua port maritime configuration evaluated in conceptual design guidance was considered adequate in rare occasions even for the smallest considered vessel. Detailed design evaluations would most probably

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approve the maneuvers since they already happen frequently and there is no registration of incidents.

Galheta Channel deepening and widening, Anchorage Area and Turning Basin transversal dimension extension together with its deepening are recommended interventions. Notwithstanding, specific comments apply. Operational solutions could be discussed for the Anchorage Areas since a direct berthing could occur. Considering its horizontal dimension, this work considered vessels dropping just one anchor ahead, thus multiplying the need for space.

The drop of one bow anchor and one stern anchor could reduce the need for space and consequently reassess the recommendation of a costly intervention. Pier 217, located ports downstream and next to Surdinho Canal, could have its maneuvers greatly facilitated if Palangana and Surdinho rocks were demolished. Besides increasing safety margins, that work would enhance harbor approach channel flow capacity, being also a recommended intervention.

- ABSTRACT 153 -

RENOVATION OF THE LIQUID BULK TERMINALS LA PLATA PORT

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The YPF (Argentinian Oil Fiscal Deposits) port structures have reached the end of their useful life. These are not safe for the operation of dangerous products so they have to be reformed.

The YPF port terminals, that are located La Plata harbor, are divided in 2 river banks: Ensenada and Berisso, the annual movement of these river banks is 3.700.000 tons per year; 56% in the intern market and 44% for exportation.

The Ensenada river bank operates with loads of petrochemical products and unloads oil for biodiesel, while the Berisso river bank loads mostly petroleum-derived liquid fuels.

The dock draughts (24/28 ft) are insufficient to fully complete the load causing the conducting activities of top off in lightening area. On the other side, to accomplish greater depth and as a consequence greater loading of the vessel, the moorings are leashed or separating pontoons are used.

The terminals are designed to operate with a proyect vessel that is far from the actual needs as they were never reformed since their construction in 1890, so they have to be updated.

Furthermore, as one would expect, the future fleet of vessels will vary in accordance of the future demand. The goal of YPF is to take care every one of them in their different sizes without the need of top off jobs in the next 50 years.

By the exposition of this work, a preliminary design is presented for the modernization and optimization of both Ensenada and Berisso river banks in order to ensure minimum standards of security, operational productivity and lowering costs in transport.

Soil studies in different strategic points of the port were taken into account in the preliminary design in order to be able to determine the most reliable solutions.

Also, to achieve the redevelopment with the purpose of determining the most favorable one, an analysis of multiple criteria was carried out considering different types of design taking into account:

- Environmental security and integrity
- Economic efficiency
- Productivity and competitiveness

In order not to leave without operation the YPF terminals, a 5 stage plan was made to make the remodeling:

- Stage 1: The adequacy of work area
- Stages 2,3,4: Remodeling of the Berisso river bank
- Stage 5: Remodeling of the Ensenada river bank

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The proposition in the Ensenada river bank was to continue with the redevelopment that was made in the dock of La Plata port more specifically in the public use area adjacent to the YPF dock. The existing structure is a sheet piling located in front of the preexisting dock. The continuation of the sheet piling proposed by the consortium of said port was chosen, achieving a 28 feet dockside draught referred to the local cero. Knowing that the vessel traffic in Ensenada is low, it will be able to take care of the vessels in optimum security conditions in this way.

Regarding the Berisso river bank, the design of the vessel was actualized choosing a Panamax tanker and, as a consequence of this choice, the structure was remodeled to fit its characteristics. Between the options proposed of sheet piling, gravity wall and a retaining wall. The last one was the chosen one for being the most technical, economic and environmental friendly. This solution would allow the operation of the terminal the 365 days of the year in optimum security conditions.

At the same time, the central dock (interior access channel) had to be resized fulfilling the recommendations given by the PIANC InCom WG 121-2014 Harbour Approach Channels - Design Guidelines report due to the increased sizes of the vessels that will reach the port during the next 50 years.

This job presents long term solutions for the redevelopment of the existing docks. These redevelopments guarantee navigation security, safe mooring actions, docking, loading and unloading, and elimination of top off assignments. This allows to revitalize and to enhance the value of one of the most important liquid bulk terminals in Argentina. The remodeling proposals will lead to greater efficiency of La Plata port system. This system being a key area and natural alternative because of the proximity with Buenos Aires port, the port of the capital city of the country which counts with more than 13 million habitants.

- ABSTRACT 155 -

Comparative variant analysis in using ship handling simulators with special respect to assess ease quality and human factor

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Manoeuvring models and real-time simulators are usual tools applied in channel and fairway design, both in maritime ports and inland navigation. The active Incom WG141 "Design Guidelines for Inland Waterways" is also considering this approach. Starting with a basic design (Conceptual Design) supported by general guidelines and empirical data, the fairway can be optimized in a further stage (Detailed Design) by using more precise formulae or even simulation models.

Nowadays, an additional aspect becomes more and more important in addition to layout and dimensions of channels. There is a general tendency to characterize "safety and ease" levels of the fairway, both for the present and future operation conditions (possibly new vessel types and sizes will use the fairway in a few years time). A method for the evaluation of simulation runs will be described, together with several application cases in rivers: approach to lock-gates and effect of cross currents.

Nautical Studies for the Installation of a LNG FSRU in Parana de Las Palmas River (Project "LNG Escobar", Argentina)

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Escobar LNG project started operations in May 2011. This is the second LNG receiving terminal in Argentina after Bahia Blanca, aimed at increasing the supply and getting closer to the main consumption areas. On the initiative of YPF and ENARSA a new berth was designed and built in River Parana de Las Palmas (km. 75) to host a FSRU (regasification vessel) and carry out ship-to-ship LNG transfer operations.

LNG safety requirements are well known. This is the most demanding traffic regarding risk analysis both for the design and operation. The result is an extremely high standard in overall safety. On the other hand, Escobar LNG terminal is located in a river, which means unfrequent and specific conditions that have to be analyzed and solved in an innovative manner. Very large specialized seagoing vessels must navigate River Plate and a long section of Parana River. This implies a large number of issues to deal with both in the design and operation phase.

RAMS analyses for the next generation of waterways

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The aim of this paper is to evaluate how a design methodology based in RAMS analysis (Reliability, Availability, Maintainability, and Safety), commonly used in other land transport infrastructures, can also be applied to inland waterway environments, more precisely to the RIS Systems design and implementation, taking profit of its holistic scope for dimensioning operation and maintenance procedures taking into account not only functional and operational requirement, but also construction and design constraints.

Methodologies and standards from other transport infrastructures like highways and port terminals are being increasingly adapted to the special waterways' features but any common and standardized body of knowledge seems to have been established. In this sense, this paper states an initial basis for RAMS analyses implementation under the scope of operational management and maintenance of waterways activities. The analyses will focus on the use of the International Standard for Electrical, Electronic and Programmable Electronic Safety related systems (IEC 61508) to describe a fully risk based approach for determining SIL (Safety Integrity Level)(SIL) requirements for those functions that are involved in the safety of the operations or in the achievement of the availability targets. This international standard uses a systems engineering approach the safety lifecycle as a framework in order to structure requirements relating to specification, design, integration, operation, maintenance, modification and decommissioning of the specific system. Each phase has a set of defined inputs and outputs, and towards the end of each phase, a check shall be performed to confirm that the required outputs are as planned. This approach is essential as part of a development project and requires an extensive analysis work. Some key areas related to SIS design that will be discussed are the relationship between SIL and failure probability, the restrictions on design based on the safe failure fraction, safety specification for different elements and the control of system failures.

The paper provides an initial set of recommendations for evaluating the effectiveness of RAMS analyses for the functional and operational risk assessment of two SENER case studies: (1) the third set of locks for the Panama Canal and (2) a potential application of those systems in the envisioned project of Hidrovías, which is currently under the consideration of South American governments. The systems considered under this scope are all of those related with availability of the system and functional safety of the operations and that includes electronic and electric components, process control systems, traffic control, communication systems and hydraulic control.

The conclusions of the paper will refer to the factors that must be taken into account to contribute positively in the success of RAMS analyses for the next generation of waterways. Reference to key infrastructure and allied logistic strategies will also be discussed for a complete approach of the management of waterways.



SMART RIVERS Conference 2015

- ABSTRACT 163 -

What is a Smart Buoy, fitted with AIS, and how will this technology make our navigable waterways safer for mariners and more profitable for its operators.

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Smart floating Aids to navigation fitted with AtoN AIS assist mariners in making landfalls when approaching from overseas, mark isolated dangers, make it possible for vessels to follow the natural and improved channels, and provide a continuous chain of charted marks for piloting. River environmental conditions, such as current, seasons, rain and sediments have an extreme impact on the safety of navigation. Smart buoys greatly improve the availability of real time data to Mariners, Authorities and Operators making our waterways safer, more efficient and ultimately more competitive

Cooperative Agreement between the RWS and the UNITED STATES CE in developing the use of Composites for Hydraulic Structures

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The paper summarizes cooperative efforts between the Rijkswaterstaat (RWS) and the United States Army Corps of Engineers (UNITED STATESCE) to advance the use of composites for hydraulic structures. The agencies agreed that sharing of efforts and lessons learned will help accelerate the use of these materials in new construction or to extend the life of existing infrastructure. Hydraulic structures are exposed to severe corrosive conditions and noncorrosive materials have been engineered to prevent these structures from extensive in-service maintenance and replacement. Fiber Reinforced Polymer (FRP) Composites have evolved over the years and now dominate the marine, aviation, and auto industry. Fiber Reinforced Polymer (FRP) composites provide excellent corrosion and wear resistance while also providing superior thermo-mechanical properties. Their widely accepted use in these industries is because composites offer many and varied superior material properties such as high strength-to-weight ratio, corrosion and chemical attack resistance, ease of construction, low moisture absorption, excellent durability, enhanced fatigue and wear resistance, low thermal expansion, etc. Their use in the civil works industry has been limited to secondary structures, such as hand railings, gratings, because Civil Works Engineers have been reluctant to take advantage of these properties, partially due to the lack of well documented success stories and the absence of an accepted design code. This paper summarizes independent efforts by each agency and chronicles the progress of the agencies cooperative agreement to share vision of potential applications, peer review, R&D, lessons learned, and development of guidance documents for acceptable use (composite code) in advancing the use of composites for hydraulic structures. Key efforts to date include the world's largest FRP miter gate, a FRP wicket gate, underwater curable FRP wrapping of submerged concrete discharge ports, FRP blocks for miter gates, FRP recess filler panels, FRP coatings for gates and repair of corroded steel columns of a concrete bridge deck. FRP composite shapes and wraps were designed and developed for offering new features or to rehabilitate some of the current waterway infrastructure members built with conventional concrete, steel and wood. The vision is with the success of this agreement in advancing the use of composites for hydraulic structures, other cooperative agreements can be fostered by water resource agencies in the era of declining infrastructure budgets. This paper summarizes the hard work of Dr. Hota V. S. GangaRao from West Virginia University and Richard Lampo from UNITED STATESCE, Jos Vorstenbosch-Krabbe, from RWS, Jan Peeters from FiberCore Europe, and others.

- ABSTRACT 172

Development and Rehabilitation of Waterfronts in Internal Waters

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Nowadays investments for projects of rehabilitation or new developments in waterfronts, both urban or industrial, can help in recovering marginal, misused or abandoned areas. Good and bad things were done and lessons are learned for best practice. In these kind of projects, recreational navigation infrastructures can help for successful interventions.



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- ABSTRACT 173 -

RCC Jack Jetty and Bamboo Submerged Vanes Application for Navigation Fairway in Ganga River of India

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The conventional techniques of erosion control and river channelization for navigation are focused mainly on using bank revetment, spurs and groynes. These have proved to be highly capital intensive as well as fraught with instances of devastating sudden failure as in the case of stone spurs of Koshi river in Nepal / India during August 2008 causing the river to radically change its course by 120km. In the above context, there is an imperative need to develop cost effective and reliable techniques. Development of scientific design approach for RCC Jack Jetty system along with bamboo submerged vanes based on comprehensive lab investigations in IIT Roorkee and supported by pilot field application results near Nakhwa village on the Ganga river in India, is to be considered for developing countries as a semi-permanent cost effective approach of river management to develop inland navigation fairway in highly complex and unstable large river systems like the Ganga and the Brahmaputra in South Asia.

- ABSTRACT 174 -

Workshop on Design Guidelines for Inland Waterways - Application of WG 141 Approach including Elaboration of Field Data and Fast Time Simulation for Class Va Vessel passing narrow Jagstfeld Bridge in the German Neckar River

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In the future report of PIANC INCOM WG 141 on Inland waterway design, generally three steps will be recommended: first, applying the “Concept Design Method”, which provides concrete numbers for the necessary waterway dimensions, coming mostly from existing guidelines, second the “Practice Approach” will be recommended, comparing the design case with comparable examples from existing waterways and third, if the design problem considered cannot be solved with the a.m. simplified methods, a “Case by Case Study” will be recommended. These three steps will be applied by example of the future approval of 135 m long Class Vb motor vessels in the impounded German Neckar River at a special width bottleneck, the very narrow Jagstfeld Bridge. Particular attention is being paid to the recommended approach how to account for safety and ease of navigation demands in design and the principle of comparative considerations. The results from the three approaches, especially concerning the absolute navigational space needed are very different, but not the differences between the present and the future situation. Because the appropriate ease quality for the design case with very well equipped 135 m vessels is comparable to the present nautical condition with older 105 m long vessels and because the existing navigational space is just sufficient, the differences between spaces needed define the necessary widening of the fairway. This widening can thus be determined. Nevertheless, the three applied methods lead to different results, which demand for specifying the design case more precisely.



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- ABSTRACT 175 -

Seine-Scheldt, a new gateway to Europe

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The inclusion of the Seine-Scheldt link as a priority project within the North Sea-Mediterranean corridor in October 2013 firmly establishes the waterway as a sustainable solution to meet the challenges of bulk transport and reduce the congestion of major European consumption and production areas to serve Europe's domestic economy and trade with the rest of the world through its major seaports. Developing ports' hinterlands requires links to several multimodal European corridors: the North Sea-Mediterranean corridor, the Atlantic corridor, the North Sea-Baltic corridor and the Rhine -Alpine Corridor. The main countries involved are France, Belgium and the Netherlands, as well as Germany, the UK, Luxembourg, the Baltic states and the Danube countries via the European waterway network. With the beginning of the construction of Seine-Nord Europe in 2017, for initial operations in 2023, the Seine-Scheldt link promotes the role of the waterway and its multimodal potential, alongside rail and road transport, at the heart of Europe's network of multimodal corridors



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- ABSTRACT 176 -

Challenges and Opportunities for the Waterborne Transport Infrastructure Sector to strive for sustainability - overview of activities of PIANC's Environmental Commission

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To prepare and support the waterborne transport infrastructure (WTI) sector for the future, the Environmental Commission of PIANC has taken up some new activities and continues existing ones. These initiatives and activities are briefly described in this paper and they are also an offer for experts inside and outside the WTI sector to actively participate in and contribute to a sustainable development of the WTI sector.

- ABSTRACT 177 -

The California Drought and a Marina Relocation Case Study

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Going into its fourth year, the drought currently experienced in California is severely impacting boating and marina businesses in lakes, reservoirs and waterways. Boat owners have been pulling their boats out of the water, boat ramps have been closed, and marinas are closing or relocating. A case study is presented, where the feasibility of relocating a marina in Lake Tahoe was assessed and a conceptual design developed. The initial step in the assessment was the characterization of the site's physical and metocean conditions, which was followed by the conceptual definition of the marina perimeter and breakwater layout. Breakwater types were evaluated and a sheet pile breakwater resulted to be the preferred alternative. Numerical wave simulations showed that the breakwater layout would be effective in maintaining wave agitation in the relocated marina within PIANC's recommended levels.

Why We Need a Coastal Channel from Buenos Aires to Luján, with Beaches and Green Spaces

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This article answers the question posed in the title. Although it does not pretend to have all the answers, the responses herein are meant to start a discussion among the people of the City of Buenos Aires and the Province of Buenos Aires for the purpose of raising awareness as to the importance of maintaining a natural corridor of waterways by dredging the old river channel from San Antonio and Luján to the City of Buenos Aires, taking advantage of the excavated sediment to shape and give continuity to the riverbank, thus creating recreational public spaces that improve human development and further social inclusion.