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Title:
Good Navigation Status (GNS) – A suitable concept for navigation improvements on rivers and canals?
Lessons learned at the Rhine
Good Navigation Status (GNS) means the state of the inland navigation transport network, which enables efficient, reliable and safe navigation for users by ensuring minimum waterway parameter values and levels of service¹. The inland waterways of the trans-European network in the transport sector (TEN-T network, EU Regulation 1315/2013²) are intended to be part of a sustainable transport system in the European Union. The GNS is supplemented by a corridor transport infrastructure development policy³ with the objective to remove bottlenecks, build missing cross-border connections and promote modal integration and interoperability.

Although GNS and corridor management are rather recent concepts, the Central Commission for the Navigation of the Rhine (CCNR) can look back on 200 years of transboundary management of a waterway corridor to enhance navigation conditions. The basis for the corridor-like transboundary development and management of infrastructure as well as for maintaining high quality navigation on the Rhine were already laid in the founding principles of the CCNR, the Mannheim Act and were thereafter subject to continuous further development. Because the CCNR is convinced that corridor infrastructure development policies together with concepts for the management of waterway infrastructure like GNS are the most efficient way to generate benefits for all stakeholders, it supports the European Commission in the development of the TEN-T network. The CCNR shares lessons learned and experiences gained in the successful management of the Rhine as international waterway. The authors are convinced, that also in other parts of the world, the combination of corridor management in combination with infrastructure development policies for achieving GNS could be inspiring and at the same time useful for the further development of inland waterways. Even for already well-developed waterways, this approach could help to better understand success criteria and to elaborate additional initiatives to further develop inland waterways.

![Map of TEN-T waterways in the European Union](image)

Figure 1: Map of TEN-T waterways in the European Union¹.

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¹ Definition according to „Guidelines towards achieving a Good Navigation Status”, STC-NESTRA for European Commission, January 2018 (https://ec.europa.eu/transport/modes/inland/studies/inland_waterways_en)


³ [https://ec.europa.eu/transport/node/2443](https://ec.europa.eu/transport/node/2443)

⁴ Guidelines towards achieving a Good Navigation Status”, STC-NESTRA for European Commission, January 2018
Corridor management

Inland waterway transport (IWT) has a significant potential as sustainable transport mode and can help to cope with future challenges, in particular the transition to a carbon neutral economy. Ships can transport large amounts of cargo safe, reliable and energy as well as cost efficient. To contribute to the fullest extent to the coping of these challenges, inland navigation has to become more efficient and sustainable. Improvements in ships design (hull, propulsion system and automation), infrastructure as well as digitalisation will become essential. Such developments are best organized in harmonized approaches. The trend is to move away from sole national approaches to corridor-oriented management concepts. The corridor management approach, meaning the coordinated management of a navigation corridor, has proven in practice to be more efficient than a national or regionally focussed approach.

Good Navigation Status (GNS) concept

The Good Navigation Status (GNS) is a concept under development in the European Union. The TEN-T Regulation does not further specify the GNS, but lays down objectives for rivers and canals to be reached by 2030, such as minimum requirements on draught (not less than 2,50 m) and minimum height under bridges (not less than 5,25 m) to be fulfilled throughout the year as well as the objective to reach and thereafter maintain a GNS. Therefore, the European Commission asked a consortium of consultants to further define the GNS together with the member states, river commissions and users. The GNS concept as proposed by the consultants in 2018 comprises so called “hard” and “soft” GNS components, GNS indicators based on technical data (TENtec database) and minimum standards of a process on GNS development as well as a GNS definition. The hard GNS components, also known as core navigability standard, reflect the minimum requirements as defined in the TEN-T regulations. Based on the interpretation that these hard GNS components shall be uniform along a corridor and available on 365 days a year, the European waterway administrations shall make available a draught of at least 2.50 m on all waterways, including free-flowing rivers and a minimum headroom under bridges of at least 5.25 m.

![GNS PROCESS: Implementation, monitoring](image)

- **“Hard” components:** Core Navigability Standards
  - Addressing freight and traffic demand versus supply of available dimensions
  1. Static physical dimensions: fairway channel, locks, bridges
  2. Availability of dimensions over time and capacity issues (waiting times, predictability, reliability)

- **“Soft” components:**
  1. Process infrastructure management: waterway maintenance, fairway marking, emergency response, administrative processes, ...
  2. Process traffic management: RIS, further information to users, traffic regulations, incident management, ...
  3. Wider scope: facilities along waterways; clean fuels, mooring places, waste reception, ...

Figure 2: GNS “hard” and “soft” components.

However, these minimum requirements on draught are not suitable for free-flowing rivers such as the Rhine or the Danube, because navigable channel depth cannot be guaranteed on 365 days a year. The minimum requirements on headroom under bridges are not ambitious enough for free-flowing rivers but at the same time unrealistically high to be achieved on some canals like on the Mittellandkanal. Hence, a further discussion of these objectives and a further development towards a more flexible approach, which takes into

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5 TEN-T Regulation (EU 1315/2013), Art 15 (3) b): Rivers, canals and lakes are maintained so as to preserve good navigation status, while respecting the applicable environmental law;
6 Guidelines towards achieving a Good Navigation Status”, STC-NESTRA for European Commission, January 2018
account the individual hydro-morphological characteristics of rivers, canals and lakes as well as regional traffic and economic development, is needed.

**Lessons learned at the Rhine**

Transport on the Rhine is a success story even though the Rhine for most of its navigable part does not fulfil the minimum requirements on draught as laid down in the TEN-T Regulation nor does it have identical navigable channel conditions on its navigable sections. Considering the required draught of 2.50 m and a safety clearance of approximately 30 cm, a navigable channel depth of 2.80 would have to be maintained to fulfil the TEN-T requirements on draught. Neither are these values realistic for the entire Rhine, nor can these be reached on 365 days per year. However, even with lower target values for navigable channel depth and availability, the Rhine remains by far the most important European river basin, offering safe and efficient navigation conditions for reliable and environmentally friendly waterway transport.

In the Middle Rhine valley, the section between Rhine-km 508 and Rhine-km 557, a navigable channel depth of only 1.90 m at equivalent water level (Gleichwertiger Wasserstand (GW)) is available for navigation at approximately 345 days per year. This section is often considered as a bottleneck hindering efficient transport on the Rhine. Nevertheless, in 2017 a total of 75 Mio. Tons of cargo and 1.33 Mio. TEU of container were transported on this section of the Rhine.

![Inland navigation transport in 2017](image)

Figure 3: Transport in inland navigation in 2017

In the same period, waterway transport on other rivers were significantly lower, although similar navigation conditions were available. This shows that even with limited infrastructural parameters like at the Middle Rhine section, inland navigation can be efficient and effective. So, what are the key criteria for effective efficient inland navigation on free-flowing rivers then?

The infrastructural development of the Rhine is coordinated in a corridor-like approach by CCNR’s Committee for Infrastructure and Environment (IEN). The parameters for navigable channel depth and width, headroom under bridges and availability are agreed upon by the CCNR Member States and are laid down in the so called “Waterway Profile of the Rhine”. These parameters vary in the different Rhine sections like Upper Rhine, Middle Rhine or Lower Rhine, depending on sections individual hydro-morphological characteristics. The competent waterway administrations develop based on these characteristics physical and numerical models to identify optimized navigable channel parameters with the objective to minimize maintenance work and to guarantee efficient navigation taking into account environmental aspects like sediment transport. In a bottom up approach, these parameters are presented in CCNR’s IEN Committee, agreed upon commonly and thereafter

maintained in a coordinated way. Therefore, waterway administrations have developed a well adopted maintenance plan to guarantee the navigable channel depth on at least 345 days per year. However, it is also a characteristic of free-flowing rivers that outside of times of low water, a significantly deeper navigable channel is available, making navigation even more efficient.

![Figure 4: Available navigable channel depth at five selected Rhine gauging stations](image)

Inland navigation on the Rhine is in addition supported by other well-developed services like Rivers Information Services (RIS). The CCNR in its role as a forerunner of such digital services implemented RIS applications to serve boat masters with up to date information on navigable channel conditions, in particular water level information.

Of at least equal importance for the elaboration of best suited navigable channel profiles are the actual and foreseeable industrial developments in the network, in the corridor and in the regions. Sufficient ports and terminals together with well-maintained waterways and sufficient berths are a prerequisite for safe and efficient inland navigation. Hence, waterway development policies need to be elaborated alongside industrial development polices to pave the way for new industrial parks and further economic development to guarantee most efficient investments in inland waterway infrastructure development.

**Conclusions**

The example of successful IWT on the Rhine allows for the following conclusions:

- Other factors than sufficient draught and headroom under bridges seem to be of higher or at least equal relevance for the success of increasing transport volume in inland navigation.
- Development of inland waterway infrastructure has to be organized and managed in a corridor approach. Going further, corridors can be combined following a network approach and its guiding principles.
- Demanding overambitious waterway requirements for free-flowing rivers year-round are neither realistic nor necessary. Instead, realistic waterway requirements, such as on navigable channel depth, guaranteed through excellent, user-oriented maintenance, should be developed and coordinated in the corridor.
- GNS has proven to be a useful concept for individual corridors such as the Rhine. It could be developed further and applied for navigation improvements on rivers and canals worldwide.
- Common terminology for example on draught and navigable channel depth is needed to avoid misunderstanding in policy development and implementation.
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Keywords:  
Rhône Saône inland waterway, multimodality, goods traffic, gouvernance, planification

Title:  
The Méditerranée Rhône Saône waterway logistic

Full Paper:  
Abstracts must not exceed 1 page and must not exceed 1500 words. No graph no picture included. (Times New Roman, 11pt).

Introduction  
The Mediterranean-Rhone-Saône axis benefits from a favourable geographical context with the 1st French harbour (the Grand Port Maritime de Marseille) and the two great French urban area after Paris (Grand Lyon and Aix Marseille Provence) each including important industrial areas. Despite this context, the Rhône-Saône basin is only the 5th largest river basin in France in terms of traffic volume. In addition, the increase in river flows has slowed from a 36% increase in tonne-kilometres between 1995 and 2005 to 6% between 2005 and 2015, even though the river’s capacity can accommodate 4 times more traffic. The purpose of this article is to present the organisation of freight transport in the Rhône-Saône river basin and to propose actions.

The current situation  
In a morose national context of inland waterway transport, this basin of nearly 1,000 kilometres, including 540 km of large template (CEMT 5), suffers from being isolated to the north without any connection to the Rhine or the Seine. Nevertheless, it is an attractive transport route for the regions crossed, which benefits from the presence of two seaports near its delta: Marseille-Fos and Sète. In addition, the main actors in local river governance have organised themselves by creating the Medlink Ports association in order to meet the demands of professionals. Recently, this association has been extended to railway actors to take intermodality into account.

The analysis of the 2017 river traffic matrix transmitted by Voies Navigables de France showed that 5.8 million tonnes, transported on 612 journeys, travelling a total of 1.2 billion tonne-kilometres have transited on the Rhône and Saône rivers. Two types of flows are distinguished:  
- Flows from Bourgogne and Rhône-Alpes to the seaports of Fos and Sète and vice versa (57% of the tonnes transported, 87% of the tonnes.kilometres travelled),
- Domestic flows which are mainly internal to the regions, or even to the departments (41% of the tonnes transported, 12.5% of the tonne-kilometres travelled).

The mean part of domestic flows is represented by the single rock and soil sector, while flows to/from seaports are shared between several sectors: cereals, hydrocarbons, chemicals and containers. The use of the river in domestic flows is oriented towards construction and public works, when its use in import/export flows looks towards industry and distribution.

In the current river flows, therefore, there is a significant weight of seaports and the construction industry in the current river flows, but without any direct link or competition between them. The river is currently attractive for industries which are connected to international markets, for the distribution that imports goods abroad and for construction and public works. But the river is also dependent on the ability of the seaports of Fos and Sète to offer quality access links to the rest of the world.

The forecasts

In the sectors mentioned, the attractiveness of new flows was estimated by a study commissioned by VNF in 2010. The flow attractiveness capacity in these sectors has been estimated at 2.5 million tonnes, or just over 40% of the tonnes currently transported by the river. According to the evolution of flows, these estimations still seem to be relevant.

In 2012, the Grand Port Maritime de Marseille made forecasts for an increase in flows in its container sector of around 5% per year between 2012 and 2030, which for the time being realised. Although the river mode is struggling to benefit from these increases for the moment, the latest investments made in Fos give confidence for the future of the river mode. The objectives envisaged by the GPMM were 185,000 TEUs carried by the river in 2030, i.e. 2.5 times more than today. The attractiveness of the river is therefore still relevant for the import/export sector that is the container.

But the river is also able to attract flows from other sectors. The flows of future-oriented sectors such as recycling, reverse logistics or urban logistics, can also benefit from this mode of transport. Thus, the river has a capacity of attractiveness that is still important in these historical sectors but can also be attractive for other sectors. However, the natural reluctance of stakeholders to change transport mode remains but may be mitigated by the implementation of appropriate public incentives, and gradually implemented over time to allow stakeholders time to adapt.

Although these forecasts are positive compared to current river flows, they remain marginal compared to all flows handled by other modes of transport (river transport handles 1% of goods crossing the Mediterranean-Rhône-Saône axis). Indeed, the Mediterranean-Rhône-Saône river system is limited by these geographical constraints, since only 9 departments (out of 39 departments in the 4 regions crossed by the axis) are crossed by an inland waterway capable of receiving flows of goods. Thus, the Grand Port Maritime de Marseille estimated in its 2012 forecasts that the maximum share of container flows captured by the river was 10%.

Possible actions

The different actions we have chosen to concern different subjects and actors.

Public actors can help to make the river more attractive by participating in the optimisation of logistics chains around the river. Among the various measures, we can mention incentives to:
- Install warehouses in dense logistics areas close to or in direct proximity to massive transport infrastructures;
- Use spaces along waterways for river transport;
- Use massive transport for specific fields, as that is the case for careers in the Drôme.

In addition, the introduction of value-added logistics services in ports, such as containerization or preparation of delivery units, enables shippers to outsource this service and facilitate the pooling of flows on the river by offering not only a transport service but a complete logistics service.
In addition, several innovations are being developed, both in this river basin (installation of a blockchain) and in the river and logistics sectors (new motorization, tools for tracking goods, etc...). These innovations make it possible to offer an ever cleaner, more efficient service that is close to customer needs.

Finally, forecasts of increases in modal shift will only be possible with support on river use. Indeed, it has been observed that one of the main obstacles to modal shift is the lack of culture of massified modes in companies that could benefit from them. We can only recommend that the actors supporting the use of inland waterway educate people about the added value and functioning of inland waterway to facilitate the appropriation of this culture by shippers.

**Conclusion**

Thus, we have a high-capacity inland waterway axis, but with difficulties in offering attractive solutions for shippers (slowing down volume increases while there are still accessible volumes). All stakeholders supporting the river must be involved and coordinated to put in place complementary measures, including planning, education, innovation and logistics services. The implementation of these actions requires a global vision shared by all the actors involved in logistics on the Mediterranean-Rhone-Saône axis. In this sense, the interministerial delegate for the development of the Mediterranean-Rhône-Saône port and logistics axis, appointed on 1 May 2017, has made it possible to put in place a global strategy in coordination with seaports, manufacturers and other stakeholders.

It is recommended that the river axis be considered as part of both local and global logistics systems. Indeed, more and more logistics systems operate as globalized networks with flows that are constantly moving according to the needs of private actors. In this context it is essential that this closed waterway is not perceived as a logistics system for local systems, but as a local system for logistics networks.
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Mots clés:
Bassin fluvial Rhône Saône, multimodalité, flux de marchandises, gouvernance, planification

Title:
La logistique fluvial de l’axe Méditerranée Rhône Saône
L’Article:
Les résumés ne doivent pas dépasser 1 page ni 1500 mots. Pas de graphique, pas d'image incluse. (Times New Roman, 11pt).

Introduction
L’axe Méditerranée-Rhône-Saône bénéficie d’un contexte géographique favorable avec le 1er port de France (le Grand Port Maritime de Marseille) et les deux plus importantes métropoles de France après celle de Paris (le Grand Lyon et Aix Marseille Provence), ces deux métropoles incluant chacune des bassins industriels forts. Malgré ce contexte, le bassin Rhône-Saône est seulement le 5e bassin fluvial de France en terme de volume de trafics. De plus, l’augmentation des flux fluviaux a ralenti passant d’une hausse de 36% des tonnes.kilomètres entre 1995 et 2005 à 6% entre 2005 et 2015, alors même que la capacité du fleuve permet d’accueillir 4 fois plus de trafic. Cet article a pour objectif de présenter l’organisation du transport de marchandises sur le bassin fluvial Rhône-Saône, et de proposer des pistes d’actions.

La situation présente
Dans un contexte national morose du transport fluvial, ce bassin de près de 1 000 kilomètres dont 540 km de gabarit CEMT 5, souffre d’être enclavé au Nord sans raccordement vers les fleuves du Rhin ou de la Seine. Malgré tout, c’est une voie de transport attractive pour les régions traversées, qui bénéficie de la présence de deux ports maritimes près de son embouchure : Marseille-Fos et Sète. Par ailleurs, les acteurs principaux de la gouvernance fluviale locale se sont organisés en créant l’association Medlink Ports, afin de répondre aux demandes des professionnels. Depuis peu, cette association a été élargie aux acteurs ferroviaires pour une meilleure prise en compte de l’intermodalité.
L’analyse de la matrice du trafic fluvial de 2017 transmise par Voies Navigables de France a montré que 5.8 millions de tonnes, transportées sur 612 trajets, parcourant un total de 1.2 milliards de tonnes.kilomètres ont transité sur le Rhône et la Saône. Deux types de flux se distinguent :
- Les flux depuis la Bourgogne et les Alpes vers les ports maritimes de Fos et de Sète et inversement : 57 % des tonnes transportées, 87% des tonnes.kilomètres parcourues,
- Les flux domestiques majoritairement internes aux régions, voir aux départements : 41% des tonnes transportées, 12,5% des tonnes.kilomètres parcourues.

On a donc dans les flux actuels du fluvial un poids important des ports maritimes et de l’industrie du BTP mais sans lien direct entre les deux, ni compétition. Le fluvial est actuellement attractif pour les industries connectées aux marchés internationaux, pour la distribution qui importe des biens à l’étranger et pour les BTP. Mais le fluvial est aussi dépendant de la capacité des ports maritimes de Fos et de Sète à offrir des liaisons d’accès de qualité vers le reste du monde.

Les prévisions

Dans les filières évoquées, la capacité d’attractivité de nouveaux flux a été estimée par une étude commandée par VNF en 2010. La capacité d’attractivité de flux dans ces filières a été estimée à 2,5 millions de tonnes, soit un peu plus de 40% des tonnes actuellement transportées par le fluvial. Au vu de l’évolution des flux, ces estimations semblent toujours d’actualité.

En 2012, le Grand Port Maritime de Marseille a fait des prévisions d’augmentation des flux de sa filière conteneur de l’ordre de 5 % par an entre 2012 et 2030, qui pour le moment se sont concrétisée. Bien que, le mode fluvial peine à bénéficier de ces hausses pour le moment, les derniers investissements réalisés à Fos permettent d’être confiant pour le futur du mode fluvial. Les objectifs envisagés par le GPMM étaient de 290 000 EVP transportés par le fluvial en 2030, soit 2,5 fois les flux fluviaux actuels. L’attractivité du fluvial est donc toujours d’actualité pour la filière d’import/export qu’est le conteneur.

Mais le fluvial est aussi en capacité d’attirer des flux d’autres filières. En particulier, les flux de filières d’avenir tel que les filières du recyclage, de la logistique inverse ou de la logistique urbaine, qui peuvent bénéficier de ce mode de transport.

Ainsi, le fluvial a une capacité d’attractivité encore importante dans ces filières historiques, mais peut aussi être attractif pour d’autres filières. Toutefois, la réticence naturelle des acteurs à changer de mode de transport demeure, mais peut-être atténuée par la mise en place de mesures publiques incitatives adaptées, et mise en place progressivement dans le temps afin de laisser aux acteurs le temps de s’adapter.

Bien qu’au regard des flux fluviaux actuels ces prévisions sont positives, elles restent marginales par rapport à l’ensemble des flux traités par les autres modes de transport (le fluvial traite 1 % des marchandises traversant l’axe Méditerranée-Rhône-Saône). En effet, le système fluvial Méditerranée-Rhône-Saône est limité par ces contraintes géographiques, puisque seulement 9 départements (sur les 39 départements des 4 régions traversées par l’axe) sont dits « mouillés », c’est-à-dire traversés par un cours d’eau en capacité d’accueillir des flux de marchandises. Ainsi, le Grand Port Maritime de Marseille a estimé dans ces prévisions de 2012 que la part maximale des flux de la filière conteneur captable par le fluvial était de 10%.

Les actions possibles

Les différentes actions que nous avons retenues concernent différents sujets et acteurs.

Les acteurs publics peuvent aider à l’attractivité du fluvial en participant à l’optimisation des chaînes logistiques autour du fluvial. Parmi les différentes mesures, on peut évoquer des incitations à :
- Installer les entrepôts dans des aires logistiques denses proches voire à proximité directe d’infrastructures de transport massifiés ;
- Utiliser les espaces à bord de voie d’eau pour faire du transport fluvial ;
- Utiliser les modes massifiés pour des filières spécifiques, comme c’est le cas pour les carrières dans la Drôme.
Par ailleurs, la mise en place de services logistiques à valeurs ajoutées dans les ports, tels que la mise en conteneur, la préparation d’unité de livraison, permet aux chargeurs de sous-traiter ce service et de faciliter la mutualisation des flux sur le fluvial en proposant plus uniquement un service de transport mais un service logistique complet.
De plus, plusieurs innovations sont en cours d’élaboration, tant sur ce bassin fluvial (mise en place d’une blockchain) que dans les domaines fluvial et logistiques (nouvelle motorisation, outils de suivi des marchandises, etc…). Ces innovations permettent de proposer un service toujours plus propre, efficace et proche des besoins des clients.
Enfin, les prévisions d’augmentations de report modal ne seront possibles qu’avec un accompagnement sur l’usage du fluvial. En effet, il a été observé que l’un des principaux freins au report modal est le manque de culture des modes massifiés dans les entreprises qui pourraient en bénéficier. On ne peut que recommander les acteurs soutenant l’usage du fluvial de faire de la pédagogie quant aux plus-values et aux fonctionnements du fluvial afin de faciliter l’appropriation de cette culture par les chargeurs.

**Conclusion**

Ainsi, cet axe fluvial est largement capacitaire, mais avec des difficultés à proposer des solutions attractives pour les chargeurs (ralentissement des augmentations de volumes alors qu’il reste des volumes captables). Tous les acteurs soutenant le fluvial doivent s’impliquer et se coordonner afin de mettre en place des mesures complémentaires, passant par de la planification, de la pédagogie, de l’innovation et des services logistiques. La réalisation de ces actions nécessite une vision globale partagée par l’ensemble des acteurs participants à la logistique sur l’axe Méditerranée-Rhône-Saône. Dans ce sens, le délégué interministériel au développement de l’axe portuaire et logistique Méditerranée-Rhône-Saône nommé le 1er mai 2017 a permis de mettre en place une stratégie globale en articulation avec les ports maritimes, les industriels et les autres acteurs concernés.
On recommande que l’axe fluvial soit perçu comme une part des systèmes logistiques tant locaux que mondiaux. En effet, de plus en plus de systèmes logistiques fonctionnent comme des réseaux mondialisés avec des flux qui se déplacent en permanence en fonction des besoins des acteurs privés. Dans ce contexte, il est essentiel que cette voie d’eau fermée ne soit pas perçue comme un système logistique au service des systèmes locaux, mais comme un système local au service des réseaux logistiques.
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Keywords: 
Low water, loading degree, industrial production 

Title: 
Low water levels on the Rhine in 2018 and their economic impact on the inland navigation industry and on the industrial sector in Germany
**Introduction - freight transport on the Rhine**

The monthly series about goods transport on the Rhine reveals that variations in the level of goods transport on this major European inland waterway are caused by economic and hydrological influencing factors. As an economic influencing factor, the financial crisis had a strong impact on goods transport in 2008, 2009 and 2010. However, natural influencing factors, such as hydraulicity or water levels, play an important role too.

In the following figure, low water periods are shaded in blue and are recognizable as V-shaped reductions of cargo traffic. The major part of the financial crisis (in 2008, 2009 and 2010) is shaded in yellow. For October and November 2018, the impact of hydraulicity on goods transport was even stronger than the impact of the financial crisis. All product segments in Rhine transport suffered under the low water conditions in 2018.

**Figure 1: Goods transport on the traditional Rhine (in Mio. t), financial crisis and low water periods**

![Graph showing goods transport on the Rhine with financial crisis and low water periods shaded]

*Source: analysis CCNR based on Destatis*

**Impact of water levels on operational parameters, transport prices and transport volumes**

Hydraulicity influences inland navigation in various ways, as the following schematic picture shows.

**Figure 2: Effects of low water levels on variables in inland navigation**

Low water levels  ➔ 1) Vessels cannot be fully loaded

2) Reduction of effective transport capacity (effective fleet capacity)

3a) Reduction of transport volume  ➔ 3b) Change in supply-demand-ratio

4) Reduction of industrial production  ➔ 5) Increase in freight rates (transport prices)

*Source: own compilation*
To summarize, low water periods lead to a falling transport activity and to rising freight rates or transport prices. The first effect (3a) can be further verified by correlating the vessels’ loading degrees with goods transport.

**Reduction of transport volume**

Low water periods correlate in a negative way with the transport activity on the Rhine, as shown in the following figure. A reduction of vessels’ loading degree cannot be compensated by putting more vessels in operation, as the number of vessels (= fleet capacity) is limited in the short and medium run.

The hydraulicity data, which are the basis for the calculation of the vessels’ loading degree, are taken from the gauging station of Kaub, located in the Middle Rhine valley and regarded as a critical gauging station for the whole Rhine goods transport.

*Map of the Rhine with its main gauging stations*

*Source: CCNR*
Figure 3: Quarterly goods transport on the Rhine and vessels’ loading degrees at Kaub/Rhine

Source: Destatis and calculation CCNR based on data provided by the Federal German Office of Hydraulics.

The correlation between goods transport on the Rhine and vessels’ loading degrees shows that larger vessels are more vulnerable to low water periods. The size of vessels is hereby indicated by the draught: for vessels with a draught of 3 meters the loading degree, and therefore the capacity reduction is more pronounced than for vessels with a draught of only 2.5 meters. This higher vulnerability of larger vessels towards low water levels becomes relevant in the light of a falling number of smaller vessels.¹

Increase in freight rates (transport prices)
Prices for the transport of liquid cargo (gasoil) from Amsterdam and Rotterdam to destinations along the Rhine in France, Germany and Switzerland (Duisburg, Dortmund, Cologne, Ludwigshafen, Karlsruhe, Strasbourg, Basel) are collected via regular surveys amongst tanker barge operators. Based on these price data, a freight rate index was calculated. In October and November 2018, during the strong low water period on the Rhine, the index reached values that were more than four times higher than under normal conditions (see figure). In order to visualize the negative correlation between vessels’ loading degrees and freight rates, the series were depicted in one single figure.

Figure 4: Freight Rate Index for liquid cargo (gasoil) from the ARA region to destinations along the Rhine - compared with vessels’ loading degree at Maxau/Upper Rhine

Reduction of industrial production

The reduction of cargo traffic had consequences for the entire (German)\(^2\) economy. Logistical chains, notably for the delivery of raw materials (iron ore, coal) and final products of the chemical and petrochemical industry, were heavily disturbed. According to statistical calculations (regression model) by the Kiel Institute for the World Economy,\(^3\) the disturbances in logistical chains decreased the industrial production in Germany in the 2nd half of 2018 by almost 5 billion Euro.

**Figure 5: Index of industrial production in Germany, and effects of low water levels on the Rhine (2015=100)**

Source: Kiel Institute for the World Economy

Low water levels from a historical perspective

Looking back over the last 200 years helps to put the low water period of 2018 into perspective. At Kaub, Middle Rhine, data on the number of days with a discharge of less than 783 m\(^3\) per second (which corresponds to the equivalent low water level of 78 cm at Kaub) show that years of severe low

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\(^2\) It is evident that the effects of the 2018 low water period were especially relevant for the German economy, as the Rhine flows to a large extent in Germany.

water periods occurred also in the past. The impact on transport volume was certainly not as strong in these decades, due to smaller vessels with a lower draught.

*Figure 6: Number of days per year with a discharge Q < 783 m³/s at KAUB, Middle Rhine including 30-years-moving average*

Source: Federal German Office of Hydrology. * corresponds to a water level of 78 cm (equivalent water level)

**Summary and Conclusions**

Rhine navigation is crucially dependent on the water level conditions on its free-flowing parts. The extreme low water period that occurred in the second half of 2018 proved this in a clear way, in the form of a strong limitation of vessels’ loading degrees and a strong reduction of goods transport in 2018 on the Rhine. At the same time, freight rates (transport prices) went up very strongly.

Low water periods therefore have multiple effects: Due to rising freight rates, a positive effect on the earning situation of barge owners, but the following negative effects from a more macroeconomic and societal point of view should not be underestimated: decrease in total transport volume, loss of market shares for an ecologically rather friendly mode of transport, reduction of industrial production in river-related industries and countries.

Conclusion: The inland navigation sector should face climate change and related low water periods by adapting its immobile infrastructure (fairway depth) and mobile infrastructure (vessel types and design, vessel size) in order to become less vulnerable towards future low water periods.
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Keywords:  
Multimodal, Corridor, Seine-Scheldt, Logistic, Industry, Land development, Europe

Multifunctional and multimodal role of waterways: Waterborne, Land development and water resources: the case of Seine-Scheldt

The Seine-Scheldt basin is the largest European inland waterway network at the heart of the 5 European multimodal corridors: North Sea – Mediterranean, Atlantic, Mediterranean, Rhine-Alpine, North Sea – Baltic, and concentrate 44% of the inland waterway traffic and 19% of the railway traffic of goods in Europe.

The power of this network has been gradually developed since the end of the 19th century by controlling the hydraulic flows of the 4 rivers of the network (Seine, Oise, Leie, and Scheldt), connecting them with canals and developing riverside industrial and logistical activities since the beginning of the 20th century.

The contribution of the network was high for the growth of Europe despite the impact in France of the two world wars, resulting in an uneven development of these territories and their ports.

The level of congestion achieved today in some parts of the Seine-Scheldt network, near the large cities highlights a continuous increase of road traffic during the last 60 years. It stresses the need to enlarge and even the major European industrial and logistic area and optimize the efficiency of the different modes of transport with a multimodal approach using inland waterway and rail for medium and long distance and for urban distribution.
Seine-Scheldt an industrial accelerator for European industries

Covering 1100 km and with a network of multimodal platforms, the Seine-Scheldt network drives economic development with the aim of increasing the gross domestic product of the 56 million European citizens of Normandie, Île-de-France, the Grand-Est, Hauts-de-France, Flanders and Wallonia. It offers sustainable economic logistics solutions to companies in a range of industrial sectors (construction, wood, steel, automotive, agro-industry, chemicals, waste, mass distribution). For the 200 cities with populations of more than 20,000 located beside this network, it provides congestion-free trade in goods and commodities, a gateway to Europe and renewed competitiveness in terms of exports. The power of waterways reached over centuries with a good control of the waterways (river level and flood control) benefits to a smooth, economic and ecological transport as well as land development along rivers. The Seine-Nord Canal (107 km from Compiègne to Aubecheul au Bac) is designed and build by the Société du Canal Seine-Nord Europe and will be operated by Voies navigables de France within its 843 km Seine-Scheldt network in France. Developed with its four partners (Voies navigables de France, Société du Canal Seine-Nord Europe, De Vlaamse Waterweg et Service Public de Wallonie) in an integrated structure: European Economic group of Interest (EEIG) Seine-Scheldt, it will create high European additional value for citizens, cities, ports and industrial sectors.

Multifunctional contributions of Seine-Scheldt network

The power of waterways reached over centuries with a good control of the waterways (river level and flood control) benefits to a smooth, economic and ecological transport, land development along rivers as well as canals and water management, which are a key resource for the life of billions of people. These functions create values for the European citizens not only for the efficient logistics of goods but for the benefit of many European public policies: development and cohesion of cities and territories, foreign trade, ecological transition (environment, water, landscape), industry, energy transition, economy, multimodality, agriculture, jobs, budget, tourism, digitalizing...).

The table below evaluates the level of the impact of Seine-Scheldt network on these policies. They are implemented at various levels, local, regional, interregional, national and European through an integrated management system developed for 15 years between the partners of the Seine-Scheldt network.

The way for an integrated inland waterway model in Europe
The integrated approach of waterway creates benefits, similar to the « Economic Network Albert canal (ENA) » developed at the beginning of this century in Belgium between Antwerp and Liège, and provides a better understanding of the effects and of the role of each partner (Europe, State, Regions, local authorities, ports, shippers, bargers, logisticians, waterway managers).

The initial impulse of the European Commission with the nomination of coordinators along the 9 multimodal European corridors pave the way to a better integration and interconnection between European countries with a solid inland waterway network (France, Germany, Belgium, Netherland, Poland, Austria, Romania, …).

At stakeholder level, the sharing of the benefits between the various functions of the inland waterway relies on a common evaluation of the effects and of the actions needed to implement them both for public and private partners. The wider socio-economic approach derived from the proposals of Prof. Emile Quinet (Emeritus Professor at the High School of Road and Bridges - ENPC) in 2014 contributed to better taking into account the impacts of the largest European inland waterway network to be operated 24h a day by 2030 over 1100 km of a large gauge network connected to multimodal inland ports and main European seaports.

The choice of a multimodal logistic approach with the railway sector (intra Europe and hinterland of seaports) is the result of the consultation from 2013 to 2016 with more than 450 stakeholders in the inland ports from Amsterdam to Marseille.

The need to have a good quality and efficiency of infrastructures and services on both massified modes of transport is a key for a competitive modal shift integrated with the internal logistic process of these industries (construction, agro-industry, chemical, waste recycling, mass distribution…).

Their involvement in the definition of the solution is a guarantee to fulfil their expectations. This approach has been implemented since 2017 to develop the Multiregio project, an innovative integrated and mutualized logistic solution, directly developed by the end-users.

The partnerships and the alliances developed with the various stakeholders by the four partners of Seine-Scheldt network during the last decades paved the way to develop a sustainable, modern, efficient and innovative global system for the benefit of citizens and economy.
CITY PORT RELATIONSHIP AND ITS INFLUENCE IN THE SOCIAL ENVIRONMENT

Abstract:
Port of Buenos Aires.

The modern world has innovated in such technologies that it produces a speed of reaction unimaginable some generations before. Any minor or extreme event can be communicated to the whole world in terms of seconds. This speed on the spread of information online including real-time access to many corners of the world can even produce an economic or geopolitics’ crisis. This reduces the time of different cycles including a reduction on the laziness of the big transformations. Also, people are becoming fewer patient to long term transformations. The society is immersed in a VUCA environment (an acronym which stands for Volatile, Uncertain, Complex and Ambiguous environment). The society and more over the new generations are becoming more eager to see the results in short terms. In a word, people are becoming less patient and more powerful (Alpha generation). It also seems as if the global warming also is not outside this phenomenon. The extreme storms or climate catastrophes happen with shorter cycles and redundancy, something that can be explained by the Anthropocene – Age of Man. A modern concept explained by Paul J. Crutzen the Dutch, Nobel prize-winning atmospheric chemist who made popular this term to describe the human actions and its effect on the earth.

This phenomenon makes the long term transformations including great scale infrastructure works become more challenging to project and develop in shorter terms. The real challenge is to find flexible designs with sustainable actions which permit the coexistence of both realities.

Now regarding the specific ports facilities, a fact that requires mega infrastructures transformations is the growing of the ship’s length and capacity in the world. The shipping companies and ship-owners' trend to construct bigger vessels is a big concern for the world port authorities. The vertical integration of the companies in the logistics chain and the horizontal joint ventures makes that the port infrastructures get stressed as Ricardo Sanchez from CEPAL has defined at one of his papers. This pressure on the infrastructures puts the authorities in check to plan for an uncertain future. Olaf Merk at the International Transport Forum round table in BA with the title: “The Container Port of Buenos Aires in the Mega-Ship Era” shows how the vessel cascading effect is affecting the ports enhancing the need to have quick solutions. Therefore this mega-engineering works must be done being aware of the actual world context and future scenarios finding flexible projects.

Argentina is not alien to this phenomenon. The port’s infrastructure was constructed more than 100 years old with a strategic vision focused on the industry but not having real thinking on the environment and its surroundings. As a landlord port, Buenos Aires has leased the land to 6 different operators 25 years ago. There are now three operators where the Terminal 1, 2 & 3 have joined together conforming one group. The Terminal 4 and 5 are being operated by two private groups each one and the terminal 6 is being operated by the Ports’ Authority. The three of the private operators’ groups are ending their contracts on the same date by May 2020. This fact puts Buenos Aires on the scene and at a big challenge full of opportunities. When having this opportunity of leasing the whole operation of the cargo facilities it's a compulsory moment to rethink and review a strategic plan for the ports and urban politics at Argentina. Assuming the commitment to encourage a resiliently transformation.
Nowadays to develop a big infrastructure transformation has new challenges to undertake. That's why in the case of PBA there has been launched a Strategic Sustainable Plan. This plan has three dimensions: a SOCIAL, an ENVIRONMENTAL and an ECONOMIC dimension. The three of them related between each other are proposed to be impulse in three stages as well.

Thinking first on the long term project with a holistic view but putting the wheel to roll with such guidelines of mid-term and short term actions. It is important to present solutions which help to prepare the society to such a big transformation that will produce a cultural transformation as well and would calm the claim of quick solutions to such needs.

PBA has spent more than the last 50 years without significant infrastructures investments. This lack of civil works provoked a list of negative externalities which has driven a heavy lobby done by many groups including the non-port community society to move the port from BA to another location. Without taking into consideration how the hinterland of PBA would have suffered making an economic and politic damage to the Argentines logistics indeed.

Long Term plans such as the project of modernizing of the whole infrastructure becoming capable to attend the new Panamax Vessel of 14,000 TEUS (Final plan image 2). A better hinterland access to the port by the construction of the exclusive for trucks Highway called Paseo del Bajo. By reclaiming land in order to gain more logistic areas as the filling of 24 acres for Customs and 24 acres for pre-gate and parking of trucks. Refurbish of the Freight Trains railways of the access to the port. Generate better conditions for dry ports at the midland province Cordoba (400 miles north). Work on the foreland by recovering the barges traffic from the country neighbor ports of Paraguay and Bolivia. Encourage a digital positive transformation by the development of a Port Community System. Recover a leadership role with the port community. In terms of economic measures, it is important to mention the importance of becoming competitive as a port with better logistics perform index, (LPI). This is an important goal to undertake in order to be sustainable. All the infrastructure improvements must think in an efficient way of operating in order to improve all the processes which will allow reducing costs. Work with incentives to private companies who are compromised with different green organisms or associations. (Green Awards, Esi, Right Ship, etc).

Social integration addresses different programs such as:

Educational programs, healthy living actions, gender integration programs and social activities with the vulnerable community. Sports such as the organization of a race along the ports non-primary zone areas. Sustainable mobility between the different port buildings by connecting the different sites by a port bike system. Constructing a promenade for the community. Art interventions. Public Spaces. New commercial activities such as food-trucks or gastronomic uses.

Environmental specific actions in short term such as reducing the scrap of the drunken ships, cleaning the water of the river, or even the classification and treatment of garbage. Encourage the use of renewable energies. E.g. by giving discounts to the ships which have green certifications such as Green Awards, ESI, Rightship.

In the midterm, the PBA plan contemplates the construction of green and public areas to make a buffer between the city and the port. As seen on image 3: The promenade Paseo Areneras in Basin F, in reference to the sand silos which are still operating for the storage and drying of half of the whole sand the city uses for the construction in general. Also by the construction of a large human scale corporeal sign of the Puerto Buenos Aires brand at a visible area of the port. Hypothetically speaking it is a way to hug the brand and recover that virtual distance between the port and the city. Another way to rejoin the coexistence is by having a new signaling system much more clearly in its message of communication. It is important also to think the waterfront from all visions, including the night sightseeing of the port. Improving the
illumination of the historic buildings and even the port infrastructures with modern ways of LED lightning can help to shorten the virtual distances between the port and the city. Each of these actions shows that there is happening a new transformation at the port. The society starts to construct a new way of relating to its port and starts to understand the importance of this industry according to the foreign exchange. The city starts to relate in a different way with the port and realizes that there is a possible and real way of coexistence.

To maintain alive the three stages of long, mid and short term actions it is important to have an active academic center. At PBA there exists a Port Training Center. By integrating to educational institutions, inviting young alumni to learn about what's happening at the port and organizing visits to the infrastructure works and showing the masterplan in its whole with the presentation of the strategic environmental plan to the people, it’s a smart way of strengthening the relationship between the citizens and the port. It is an excellent way of creating cultural changes in the society. By communicating and teach to the new generations the importance of the long term plans and works that the port is overtaking is a way to enforce and accelerate this change. These actions help to enforce the support of the society to the big scale infrastructure transformations. With many academic papers which justify the high costs investments on such works sometimes may not be sufficient if there is not a good way of getting the society involved.

The Cruise industry is an important element of integration too. It is important to encourage the growth of this industry planning better conditions for the passengers and planning in the long term better facilities to have a dedicated infrastructure. Nowadays the cargo vessels and cruises ships share the port’s facilities. This is why in the short term the port has worked on reducing considerably the cost of operating at the port as well as simplifying many bureaucratic and useless controls made by customs and related organisms. Each cruise moves between 3000 and 4000 passengers who get to the city and consumes generating an economic benefit for the city more than the port in itself. But by organizing the uses of the land and considering the first piers for the development of real estate activities which includes a new cruise terminal together to cultural and commercial mix uses is a good way of creating new income for the Portland segregating both cargo and cruise industries.

Working on the marketing and construction of the trademark of the port is also important to bring near the port to people. The construction of a new identity associated with a modern, sustainable, secure and efficient port it is necessary to make a better basis for the big transformation. Having an effective communication of the different improvements done is important not only for the social integration but for the port community stakeholders involved in the logistics performance index.

To maintain the economically sustainable growing it is important to have an open vision of the port activity and capture new markets. Improving the port infrastructure or its environment only it’s not sufficient. All kind of software improvements are recommended. For example the implementation of a Port Community System PCS which digitalizes all the operation and commercial administration giving efficient and quicker results of the logistics processes. Also, that's why the whole hinterland and foreland vision is needed to consider. An example of this is the development of logistics hubs (dry ports) in the center of the country as a positive way of capturing more cargo and be more competitive as a port in its hinterland.

It is important on this strategic wide vision of the PBA plan, to get involved as a port authority in the improvement of the whole waterway channel access to the port. It is a smart decision to capture new cargo of transshipment coming from Paraguay and Bolivia by the Hidrovia waterway in barges to enforce the leadership of the port and the sustainability of the plan for the future. As seen on Image 4.
Last October 1st, 2018, the Bolivian President Evo Morales was seen at the International Court of Justice, the UN's highest court for disputes between states, in The Hague, The Netherlands, before the ruling of a dispute between Bolivia and neighbour Chile on access to the Pacific Ocean.

This court decision causes a potential business for Argentina and Uruguay. By sailing through the Paraguay – Parana Rivers along the Hidrovia channel, the Bolivian cargo will get to the sea by this new route in order to be transshipped to the maritime vessels. The PBA quickly reacted and in order to increase the cargo and movements of the port, worked on different measurements to capture such cargo. The project is to impulse the barges traffics to fetch the containers at the Bolivian ports (image 5) and get to the sea ports by travelling through the Hidrovia as the Paraguayan cargo does.

- It has been eliminated the "Red Alert" 365/12 of Customs that forced the scanning of all containers generating extra costs.
- It has been repealed Resolution 1108/13 that prohibited the transshipment of barges with Argentine exports in foreign ports.
- It has been lowered 90% of the Migratory Rate for ships entering or leaving Puerto Buenos Aires for any port more than 300 km and 99.2% for the rest of the ports.
- It started to operate the TERBASSA dock space and generated new waiting sites for the barges with services for the crew.
- It has impulse a benefit of 100% reward of the General Rate for Use of Port (0.075 / TRN is charged for entrance to the port) and the rate of Services for Use of Port and Cabotage Vessels (Rate of use of pier.) Charge per day of stay is 0.025 / TRN).

By all these measurements PBA has recovered 70% of the cargo coming from Paraguay. Image 6

Finally, when facing a long term project which includes an important infrastructure work it is highly recommended to have a holistic and sustainable vision of the whole plan. Attending the needs of a wide spectrum of issues that goes moreover the specific infrastructure work. As happened in Buenos Aires at the beginning of the century, getting focused only on the modernization of the ports infrastructure without an open vision made the port to become obsolete in a short time not being sustainable. The integration to the city, getting involved to the community in the different long, mid and short term ways gives smart solutions for the future with minor steps which calms the societies and port community anxiousness to see the final work finished and operating.
English title: Comparing national port strategies helped building the French national port strategy and could pave the way for new PIANC works.

Titre français: Comparer les stratégies nationales portuaires a facilité l’élaboration de la stratégie nationale portuaire française et pourrait ouvrir de nouvelles perspectives aux futurs travaux de l’AIPCN

Summary- Plan de l’intervention

Introduction sur le type de modèle portuaire
1- Evolutions historiques du système portuaire français
2- Les différents niveaux de planification stratégique et les principaux enjeux des projections à prendre en compte
3- Les travaux propres à l’AIPCN en matière de planification portuaire
4- Les exemples de stratégie nationale allemande, espagnole et italienne
5- Que retenir du parangonnage pour la stratégie nationale portuaire ?
Conclusions : vers de nouvelles pistes possibles de travail pour l’AIPCN ?

Introduction sur les types de modèle portuaire

Pour caractériser de façon simple les différents types de modèles portuaires en Europe, on a généralement recours à une double grille de lecture, une lecture historique culturelle et une lecture fonctionnelle qui établit une forme de correspondance entre les choix opérés par les politiques portuaires et les modèles portuaires retenus.

La première grille de lecture distingue le port hanséatique, le port latin et le port anglo-saxon.

Le port hanséatique est issu du modèle historique des villes de la Hanse du Nord de l’Europe qui ont su développer une tradition marchande de commerce maritime dès le Moyen-Âge, si bien que l’on a eu affaire à une véritable ville portuaire, ce qui explique la persistance d’une étrange symbiose entre ville et port : en effet le port était et reste une des composantes économiques essentielles à la richesse de la ville, structurante pour son économie. De ce fait la forme juridique de port municipal, puis d’entité portuaire municipale a progressivement émergé, la séparation comptable de l’entité portuaire par rapport à la ville ne s’étant réalisée en pratique que depuis les années 1990.

Le port latin que l’on retrouve avec des formes variées en Espagne, en France ou en Italie a été longtemps caractérisé par une prédominance de l’Etat, initiateur des politiques portuaires et, à la faveur des décentralisations progressives opérées au cours des années 1980, a fonctionné avec une gouvernance variable d’un pays à l’autre, mais avec une tradition de port public autonome dans sa gestion et largement contrôlé par la puissance publique (Etat ou région).
Le port anglo-saxon est marqué par une moindre intervention de l’État et, depuis les privatisations opérées au milieu des années 1980 combine au Royaume-Uni des entités portuaires publiques pour les ports secondaires et des ports largement privés, les UK major ports.

La grille de lecture fonctionnelle traditionnelle a primitivement distingué trois modèles :
- le port propriétaire qui limite son action à la valorisation des espaces fonciers dont il favorise l’aménagement laissant le soin aux acteurs privés d’y réaliser des activités portuaires, industrielles ou logistiques.
- le port outil, qui ajoutait à la fonction précédente celle de fournir principalement des outillages de manutention et qui s’est largement aménusée dans les années 1990 avec l’idée que les opérateurs de manutention sont les mieux à même d’optimiser leurs moyens s’ils les contrôlent eux-mêmes;
- le port exploitant qui ajoute aux deux fonctions précédentes celle d’un exploitant à part entière.

Actuellement, les deux ports majeurs du système européen, que sont Rotterdam et Anvers ont évolué vers une structure de société anonyme à capitaux entièrement publics pour gagner en souplesse et en réactivité dans le déploiement de leur stratégie de développement d’activité ce qui amène naturellement les autres ports à s’interroger sur l’adaptation de leur propre système portuaire. On retrouve d’ailleurs une tendance similaire en Asie, au Japon par exemple, où les deux ports voisins de Kobe et d’Osaka ont créé en 2014 une société de gestion des activités conteneurisées avec là aussi une société à capitaux essentiellement publics.

1- Evolutions historiques du système portuaire français

Trois éléments ont servi à caractériser à grands traits le système portuaire français :

- l’autonomie portuaire des ports de commerce les plus importants par rapport aux milieux économiques marquée par une distanciation progressive par rapport au rôle moteur initial joué par les chambres de commerce et par un rôle croissant de l’État dans la capacité à investir dans ces ports avec une première loi sur l’autonomie en 1920 dont l’application est restée limitée, puis une loi sur l’autonomie de 1965 dans un contexte économique bien plus favorable et un recentrage de l’activité des ports autonomes sur la fonction de port aménageur grâce à la réforme portuaire de 2008 qui a abouti à la transformation des anciens ports autonomes en 7 grands ports maritimes en métropole (Bordeaux, Dunkerque, La Rochelle, Le Havre, Marseille, Nantes-Saint Nazaire et Rouen) puis en 2013 à instaurer quatre grands ports maritimes d’outre-mer (Guadeloupe, Guyane, Martinique et Réunion)

- la manutention organisée dans l’immédiat après-guerre par la loi de 1947 instaurant les dockers occasionnels et les pools de dockers, profondément remaniée par la loi de 1992 qui a mis un terme aux pools et aux dockers occasionnels en transformant les dockers en personnels à part entière des entreprises de manutention, cette transformation s’accompagnant d’une diminution significative du nombre des dockers du fait de la transformation de dockers occasionnels en dockers permanent

- la décentralisation, initiée pour les ports de Corse en 2004 et qui s’est poursuivie avec la décentralisation des anciens ports d’État d’ts d’intérêt national pour devenir principalement des ports régionaux comme dans le cas de Calais ou des ports bretons de Saint-Malo, de Brest et de Lorient, avec dans le cas prépondérant une remise en concession de l’exploitation de ces ports au profit des chambres de commerce ou avec la création d’établissements publics régionaux comme à Sète en région Languedoc-Roussillon (devenue région Occitanie).

Parallèlement la stratégie des grands ports maritimes a été mise au point grâce à des plans stratégiques, les premiers d’entre eux sur la période 2009-2013 principalement destinés à faciliter le transfert des personnels opérant les outillages (grutiers ou porteurs et agents de maintenance de première intervention) au sein des entreprises de manutention ainsi qu’à la cession des outillages. La seconde génération de plans stratégiques s’est développée sur la période 2014-2018 en reprenant certains éléments d’une stratégie nationale portuaire élaborée en 2013 et organisée autour des missions principales de ces grands ports maritimes aménageurs (accueil de trafics, valorisation de leur domaine y compris dans sa dimension environnementale, desserte terrestre routière ou massifiée (fer et fleuve), développement de la logistique.

2- Les différents niveaux de planification stratégique et les principaux enjeux des projections à prendre en compte

L’une des difficultés de la planification portuaire est que l’activité portuaire est fortement liée au commerce extérieur et tributaire de ce fait de tendances macroéconomiques ou géopolitiques globales.

Après les réorientations de trafic énergétiques observées suite aux chocs pétroliers des années 1970 et après le développement progressif des marchés conteneurisés des années 1980, puis des trafics routiers de véhicules importés ou exportés, les ports se sont attachés à situer leur position concurrentielle, à développer leurs trafics et à mettre en valeur leur domaine en se référant à des tendances globalement croissantes. Ainsi leurs investissements étaient globalement portés par des trafics croissants et diverses études prospectives sur trafics maritimes remontent au début des années 1990.

Par la suite, la réalisation du marché unique européen a continué à porter la croissance des trafics conteneurisés et a aussi compliqué singulièrement la connaissance statistique puisque les données du commerce extérieur liées aux opérations douanières ne donnaient plus d’indication précise sur le port d’accès pour les trafics intracommunautaires. La croissance du marché conteneurisé s’est poursuivie et les ports se sont adaptés aux effets d’échelle qui ont vu les navires croître de façon considérable : d’une capacité de 6 000 à 8 000 EVP pour les porte-conteneurs de la fin des années 1990 pour aller progressivement à 15 000 puis à 22 000 EVP, voire encore davantage aujourd’hui. C’est dans ce contexte que les ports du Havre et de Marseille ont pu réaliser les investissements majeurs que représentaient Port 2000 au Havre et Fox XXL à Marseille.

Parallèlement, la montée en puissance de la Chine et de plusieurs pays émergents ainsi que l’importance de la révolution numérique des années 2000 ont créé de tels bouleversements qu’aucun exercice prospectif national sur les filières maritimes n’a pu être valablement engagé.

Conçue en partie pour permettre aux hubs portuaires de conteneurs de se remettre à niveau dans la compétition européenne, la réforme portuaire de 2008 intervient dans un contexte macro-économique marqué par la crise financière de 2009. Les premiers plans stratégiques portuaires (2009-2013) destinés essentiellement à mettre en œuvre cette réforme interviennent donc dans un contexte de fermeture de raffineries (Dunkerque, Marseille) ou de réorientations des flux pétroliers vers les ports concurrents (cas de Marseille et de Trieste). De ce fait le bilan positif attendu de la réforme tarde à se manifester si bien qu’après la stabilisation de la situation sociale à la fin de la mise en application de la réforme en 2012, le ministère des transports publie en mai 2013 [2], une stratégie nationale dite de relance portuaire élaborée de façon interne qui repose sur quatre piliers :

- une ambition qualitative de redressement des flux passant par les grands ports maritimes, exprimée sous forme de carte schématique amorçant une coopération interportuaire des trois portes d’accès principales

- un pilier logistique qualitatif exprimé de façon très générale en termes de compétitivité, de massification, de fluidité de passage et de reprise de parts de marché

- un pilier industriel mentionnant un plan d’actions prospectif et des processus compétitifs favorisant de nouvelles implantations

- un pilier d’aménagement foncier intégrant les dimensions économiques et environnementales
Cette stratégie nationale donne les axes de travail aux grands ports maritimes pour élaborer leurs plans stratégiques respectifs de la période 2014-2018.

Depuis, les engagements pris par de nombreux pays lors de l’accord de Paris consécutif à la COP21 en 2015/2016, les préoccupations mondiales sur l’évolution climatique et les préoccupations croissantes en matière de santé et d’environnement plus particulièrement en Europe, notamment en matière de pollution de l’air ou de bruit ont confronté les nouvelles planifications stratégiques à une situation nettement plus complexe que précédemment puisque les transitions énergétique, environnementale et numérique bouleversent l’économie mondiale et modifient sensiblement les processus productifs.

Dans ce contexte, il est utile de définir, ce que les travaux récents de l’AIPCN (cf. partie 3) et le parangonage européen peuvent apporter en la matière (cf. partie 4)

3- Les travaux propres à l’AIPCN en matière de planification portuaire

La commission maritime de l’AIPCN a mené deux travaux complémentaires sur ce sujet, dont nous nous proposons de reprendre les éléments essentiels à la planification portuaire:

- le groupe de travail 158 intitulé « Plans stratégiques1 pour le développement de ports existants » dont le rapport a été publié en 2014
- le groupe de travail 185 intitulé « Ports sur des sites nouveaux : un guide pour la sélection des sites et pour leur planification2 » , dont le rapport a été mis en ligne début 2019

Nous les compléterons par quelques éléments issus d’un travail transversal mené par la task force 181, état et perspectives des infrastructures de transport maritimes et fluviales publié en 2018.

3-1 Groupe de travail MarCom 158 sur les plans stratégiques de développement des ports existants [3]

Le rapport définit les objectifs des plans de développement (masterplans) en leur assignant cinq objectifs :

- celui de communiquer une certaine vision partagée du port à un certain nombre de parties prenantes
- celui de contribuer au développement portuaire selon les législations et les bonnes pratiques internationales et nationales
- celui d’une bonne intégration des considérations économiques, d’ingénierie, environnementales et de sécurité dans la planification portuaire
- celui de l’organisation spatiale des zones adaptées aux principales opérations portuaires
- celui d’une certaine forme d’agilité permettant au port de s’adapter aux innovations technologiques, aux tendances du fret, aux législations et aux réglementations tout en se situant dans la compétition portuaire

Les horizons de ce type de travail sont résumés dans le tableau ci-dessous :

<table>
<thead>
<tr>
<th>Période de temps</th>
<th>Infrastructure</th>
<th>Opérations-Exploitation</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 à 5 ans</td>
<td>Zonage du plan d’investissement portuaire</td>
<td>Zonage du plan de gestion portuaire</td>
<td>Plan d’affaires</td>
</tr>
<tr>
<td>5 à 10 ans</td>
<td>Plan d’investissement</td>
<td>Plan stratégique</td>
<td>Plan d’affaires</td>
</tr>
<tr>
<td>20 à 30 ans</td>
<td>Masterplan</td>
<td>Masterplan</td>
<td></td>
</tr>
</tbody>
</table>

Si l’on se réfère à ce tableau, force est de constater qu’en planifiant à 5 ans avec certaines trajectoires financières à 10 ans, les ports français procèdent plus fréquemment à des plans stratégiques éventuellement assortis de zonages localisant les investissements correspondants ou les implantations recherchées et complétés au besoin de plans d’affaires plutôt qu’à des masterplans de plus long terme (20 à 30 ans). Evidemment comme le souligne le rapport, ce travail exige une mise en cohérence avec les stratégies de transport et d’urbanisation des villes et des régions adjacentes.

1 en anglais le terme est masterplan : la traduction proposée est celle de plan stratégique par référence aux plans stratégiques des GPM, mais le masterplan est le fruit d’une réflexion stratégique exprimée sur un plan-masse plus ou moins contraignant juridiquement selon les pays

2 le terme anglais retenu est celui de masterplanning ; nous avons retenu ici dans la traduction de ce terme celui de planification pour désigner plutôt le processus d’élaboration du plan stratégique
3-2 Groupe de travail MarCom 185 sur la sélection de sites portuaires nouveaux et sur leur planification [4]

Ce rapport qui s’intéresse à des sites nouveaux concerne aussi bien les extensions portuaires (création de nouveaux terminaux) que les créations de port ex nihilo. Des ordres de grandeur de durée de conception y sont donnés à titre indicatif : 4 à 5 ans pour une création de terminal et une dizaine d’années pour un nouveau port (sans tenir compte du temps consacré à la consultation du public sur l’acceptabilité du projet qui varie beaucoup d’un pays à l’autre).
La vision qui sous-tend la réflexion stratégique se réfère à la notion de durabilité, qu’un autre groupe de travail a largement précisé (le groupe de travail EnviCom 150 [5], guide destiné aux autorités portuaires sur l’acception de port durable) et la conception fortement inspirée de la philosophie « (Évurer avec la nature » (largement expliquée grâce au groupe de travail EnviCom 176 [6] consacré à l’application de cette philosophie aux infrastructures de navigation maritimes et fluviales), qui vise en faisant intervenir très tôt dans le processus de conception l’ensemble des parties prenantes à trouver les solutions gagnant-gagnant pour tous. Le rapport insiste pour que la vision de long terme soit partagée par l’ensemble des parties-prenantes. Aux processus permettant de passer de la vision de long terme au masterplan en passant par un plan stratégique, le rapport ajoute une dimension de plan de commercialisation selon le schéma ci-après.

Le port de Rotterdam a ainsi mis au point une vision 2030 en 2011 avec la ville de Rotterdam, qui identifie une dizaine de facteurs clefs de réussite de la démarche. De même le port de Bahia Blanca a développé une vision à l’horizon 2040 pour consolider sa position de port céréalier au sein du cluster industrialo-portuaire argentin.

3-3 Task force 181 sur l’état et sur la perspective des infrastructures maritimes et fluviales [7]

Cette task force transversale a été mise en place à la suite de la résolution prise par l’assemblée générale annuelle de l’AIPCN à San Francisco aux Etats-Unis qui précédait le congrès de 2014 pour répondre aux besoins exprimés de mieux pouvoir connaître les tendances technologiques, économiques et financières en matière d’infrastructure de navigation maritime et fluviale. Au terme de quatre années d’effort, la task force s’est appuyée sur les données transmises par un nombre limité de pays (Allemagne, France, Japon, Pays-Bas, Etats-Unis) pour dresser un état des lieux et pour inventorier les perspectives ouvertes par les nouvelles infrastructures afin de formuler diverses recommandations.

L’un des éléments forts de ce travail a été de montrer un sous-investissement chronique des pays développés en matière de financement d’infrastructures comme l’illustre le graphique ci-dessous qui donne pour chaque grande catégorie d’infrastructure le poids des investissements consentis rapportés au PIB en moyenne sur la période 1992-2013. La Chine se situe largement en tête avec un taux moyen de 8,6%, l’Inde se situe autour de 5% tandis que les Etats-Unis, le Canada, les pays d’Europe de l’Ouest et l’Amérique latine se situent autour de 2,5% soit un point de moins que la moyenne mondiale.
Il en résulte notamment pour les ports un sous-investissement dans la régénération des infrastructures ferroviaires ou fluviales qui sont susceptibles à moyen terme de dégrader les capacités exportatrices des pays concernés comme les États-Unis le constatent avec le vieillissement des écluses du système fluvial du Mississippi qui contribue largement aux exportations céréalières des États du Middle West.

4- Les exemples de stratégie nationale allemande, espagnole et italienne

4-1 La stratégie nationale allemande de 2015 [8]

Celle-ci a été élaborée à la fois pour les ports maritimes et pour les ports fluviaux et a été publiée en 2015, après qu’une première tentative a été menée en 2009 pour reconnaître au secteur portuaire l’importance politique et économique qu’il revêt. D’emblée les mesures de mise en œuvre ont impliqué le niveau fédéral, les Länder et les acteurs de l’économie portuaire. Bien entendu cette nouvelle stratégie nationale s’est emparée de sujets émergents :

- le maintien et le développement de infrastructures portuaires et de transport
- l’accroissement de la compétition internationale et européenne
- les nouvelles initiatives européennes du secteur portuaire
- la nécessité de disposer d’infrastructures portuaires adaptées au développement de l’énergie éolienne offshore
- les développements technologiques en matière d’automatisation et de numérique
- la défense de l’environnement et du climat
- le besoin d’infrastructures pour des carburants alternatifs et pour des énergies alternatives
- la sûreté et la sécurité, notamment en matière de technologies de l’information
- l’évolution démographique

Afin de disposer d’une cohérence d’ensemble de toutes les parties prenantes portuaires et logistiques, la coalition politique au pouvoir s’est entendue pour faire de l’élaboration de la stratégie 2015 un prolongement de la stratégie nationale 2009 associant État fédéral, Länder, économie portuaire et logistique et syndicats, et une vraie stratégie pour les dix prochaines années. Elle s’appuie sur une partie analytique pour déboucher sur des mesures concrètes.

L’analyse montre à partir de diverses considérations macroéconomiques mondiales et en tenant compte des accords de coopération passés par l’Allemagne avec la Chine que les prévisions de trafic font croître les ports allemands de 269 MT en 2010 à 468 MT en 2030 soit 2,8% par an avec onze des dix-neuf ports en mer du Nord proches de 3% tandis que les 8 de la Baltique se situeraient plutôt autour de 2%.

Il convient d’observer que la stratégie décline des mesures ou actions concrètes sur chacun des sujets émergents et accorde une importance toute particulière aux infrastructures comme en témoigne le fait que la coalition gouvernementale a pris l’option d’accroître de façon significative le niveau des crédits alloués.

L’augmentation des crédits d’investissement reprise dans la stratégie est la suivante:
- 5 G€ pour la 18ème période de législature avec un montant de 1,8 G€ en 2018 et en 2019
- 3,1 G€ pour la période de 2016 à 2018 avec 10 G€ pour le programme des investissements du futur
- des moyens d’investissements complémentaires par accroissement des paiements mis à la charge des usagers (extension en deux phases des taxes poids lourds en 2015).

Est aussi mentionnée une augmentation du montant des investissements en infrastructures de transport (rail, route, voie d’eau, combiné) de 10,2 à 13,4 G€ en 2018.

Enfin en matière de gouvernance, deux facettes sont abordées : la coordination des trois niveaux d’administration publics (Etats, Länder, communes), la coopération logistique et portuaire entre ports maritimes et intérieurs, entre acteurs de l’alliance logistique pour l’Allemagne et grâce à une mise en valeur de la position de leader de l’Allemagne dans le classement de la Banque mondiale pour la logistique (LPI ou Logistics performance index).

4-2 Stratégie portuaire espagnole

Puertos del Estado, agence nationale portuaire espagnole a été créée le 1er Janvier 1993 pour assurer la coordination, le contrôle et la création de synergies entre les 28 ports autonomes antérieurement gérés par le Ministère.

Le conseil d'administration de Puertos del Estado est entièrement composé de représentants des différents ministères d'État dont les activités des ports dépendent.

La gouvernance de chacun des 28 ports (en réalité 46 car certaines autorités portuaires ont en charge plusieurs ports comme Valence et Segundo) est assurée par:

a) un conseil d'administration de 15 membres (à l'exception de quelques ports comme celui des Baléares où chaque île est représentée ce qui porte ce CA à 18 membres); l'État compte 4 représentants dont un de Puertos del Estado, 4 pour la région (autonome) dont dépend le port, 2 pour la où les villes, 1 pour la CCI, etc... Le CA approuve la nomination du DG

b) le président qui est nommé par la seule région, l'État n'intervenant que pour authentifier la nomination ( ceci n'a pas été acquis dès 1993 mais seulement en 1996 à la suite de la constitution d'un gouvernement ayant eu besoin d'être renforcé par des partis régionaux)

Chaque port établit un plan d'activité quinquennal glissant approuvé conjointement par le président du port et par le président de Puertos del Estado; cette année il s'agit du plan 2018-2022. Il n'y a eu depuis plus de 20 ans qu'un seul cas où les deux parties n'ont pas réussi à se mettre d'accord sur ce plan glissant.

Chaque ministère dispose d'une stratégie et le ministère des transports et de l'équipement dispose en gros d'une stratégie qui couvrirait la période 2012-2024 et qui a été repris et prolongé ensuite jusqu'à 2030. De plus, un cadre stratégique (strategic framework) du port en tant que place portuaire a été mis au point en 1998 pour permettre à chaque port de réaliser sa stratégie. Il est en cours de refonte grâce à une large consultation des ports, des utilisateurs et de toutes les parties prenantes (la phase de consultation devait être achevée fin octobre 2018).

4-3 Stratégie portuaire italienne


Ce plan a servi de fondement à la réforme portuaire : ce plan initialement a été invalidé par la cour constitutionnelle car il ne prévoyait pas la consultation des régions ce qui a été corrigé par la suite par le ministère des transports qui a transmis le plan stratégique à la conférence Etat-Régions si bien qu’un accord a été obtenu à ce sujet le 31 mars 2016.
Le document comprend deux parties, la première décrit le cadre de compétition internationale du système portuaire italien. Ainsi des prévisions de trafics à l’horizon 2020 sont données :
- pour la croisière : croissance de 23% par rapport à 2015
- pour le fret : fourchette de croissance de 12 % à 22 % entre 2014 et 2020

La seconde partie identifie dix objectifs stratégiques et les décline en dix actions stratégiques :

1- une volonté de simplifier et d’accélérer les procédures d’instruction : le champ est vaste puisqu’il touche aussi bien les procédures d’approbation des infrastructures que celles des dragages, et des implantations industrielles et logistiques ainsi que l’instauration d’un portail unique douanier pour les formalités aux frontières
2- amélioration de la compétitivité : grâce à une meilleure mise en concurrence et en visant l’amélioration de la qualité des services portuaires
3- accessibilité : amélioration du lien entre le transport maritime et les transports terrestres
4- intégration du système logistique et de l’activité manufacturière sur le territoire
5- renforcement des infrastructures portuaires et amélioration des dessertes terrestres
6- innovation : mise en place d’incitations pour la recherche, pour la formation et pour le développement de l’innovation technologique
7- durabilité : mesures d’améliorations de l’efficacité énergétique et mesures environnementales
8- sécurisation des financements : mesures de gestion et de programmation d’investissements ; sont recensés 700 M€ de fonds européens pour les régions du Mezzogiorno ; 85 millions de dotation de l’Etat aux ports ; 600M€ pour le transport maritime et pour assurer une participation croisée des acteurs du système portuaire : création d’un fonds pour les Greenports ; mesures d’efficacité énergétique du transport maritime ; programme de formation sur l’économie bleue ; encouragement d’investissements privés
9- coordination nationale : coordination et promotion centrale
10- une nouvelle gouvernance portuaire en l’adaptant à la stratégie qui va conduire à un regroupement des ports : celle-ci prévoit une DG spécifique portuaire et logistique, 24 autorités portuaires regroupées en quinze systèmes portuaires ainsi qu’une conférence nationale portuaire

5- Que retenir du parangonnage pour la stratégie nationale portuaire de 2019 ?
De ces comparaisons internationales comme du travail de l’AIPCN, la stratégie nationale portuaire en France a retenu plusieurs sujets d’intérêt :
- le premier qui marque une forme de rupture avec la stratégie nationale de 2013 est que la stratégie doit pouvoir concerner l’ensemble du système portuaire et ne pas se limiter aux seuls ports d’Etat ce qui a nécessité d’impliquer les régions qui ont bénéficié lors des décentralisations du transfert des ports d’intérêt national dans la réflexion et dans l’élaboration concrète de la stratégie
- le second est l’importance des moyens de desserte de l’hinterland ce qui renforce la collaboration entre Etat et régions pour une desserte massifiée de qualité, notamment le long des grands corridors de fret et qui en France vient de se traduire pour le fret ferroviaire par la mise en place d’une plateforme d’acteurs du fret ferroviaire organisée par SNCF réseau
- le troisième est celui des axes stratégiques qui se ressemblent assez fortement d’un pays à l’autre et qui illustrent le lien étroit existant entre les différentes stratégies nationales. En France celles-ci concernent aussi la logistique avec la singularité de la logistique urbaine dans nombre de grandes agglomérations (Paris, Strasbourg, Lyon, Lille, Marseille, etc…), mais aussi stratégie nationale bas carbone et rythme de transition vers les énergies moins carbonées ; stratégie de la transition numérique ; protection de l’environnement et de la biodiversité et limitation de l’artificialisation des sols
- le quatrième sujet est celui de la mise en cohérence entre la stratégie nationale et les déclinaisons des plans stratégiques des différents ports
- le cinquième sujet est celui de la prospective : le calendrier assez serré d’élaboration de la stratégie nationale portuaire ne permet sans doute pas de réaliser ce travail pour chacune des filières existantes ou émergentes si bien que le CGEDD s’en est saisi un peu plus complétement en se lançant dans un exercice de prospective des mobilités incluant un volet fret, actualisant sensiblement un travail analogue mené en 2005 et en se plaçant aux horizons de temps 2040 et 2060, qui devrait déboucher en 2020.
- enfin le sujet de la recherche et de l’innovation représente lui aussi un axe de progrès collectif qui peut s’appuyer sur les pôles de compétitivité mis en place par le ministère de la recherche et dont la dimension numérique est aussi essentielle

Enfin on peut aussi observer que les réflexions menées depuis plusieurs années sur le système portuaire ont conduit à privilégier trois axes de pénétration ou d’exportation des flux internationaux avec le sous-système Le Havre/Rouen/Paris sur l’axe Seine, la façade méditerranéenne autour de Marseille vers l’axe Rhône-Saône et le sous-système Dunkerque-Calais donnant accès aux Hauts-de-France, qui comme nous l’avons dit antérieurement déclinent la notion de port gateway.

Comme on peut donc aisément le constater les sept groupes de travail installés au printemps 2019 pour élaborer la stratégie nationale répondent très clairement aux sujets d’intérêt identifiés :
- compétitivité, attractivité commerciale
- transition écologique
- transition numérique
- infrastructures et logistique
- gouvernance
- emploi et formation
- recherche, innovation et développement

Conclusions : vers de nouvelles pistes possibles de travail pour l’AIPCN ?

Cet aperçu du sujet complexe des stratégies nationales portuaires illustre d’une part le lien étroit qui existe entre stratégies nationales portuaires et stratégies logistiques de pénétration des hinterlands ou de corridors de fret, comme le recours fréquent à une vision de long terme des évolutions de flux correspondants qui permet de vérifier plus localement si des goulets d’étouffement nécessitent des investissements complémentaires en infrastructures.

La commission maritime de l’AIPCN sous l’impulsion des ingénieries susceptibles d’assister les ports dans l’élaboration de leurs plans stratégiques ou de leurs plans s’est intéressée aux masterplans des ports existants (MarCom 158-2014) puis, plus récemment, sur des sites nouveaux (MarCom 185-2019) et a montré ce faisant que des liens étroits doivent être établis avec les politiques urbaines. En France la politique de réduction des surfaces artificielles aura une incidence sur la stratégie nationale portuaire.
Il pourrait être utile à l’avenir que ces réflexions soient élargies aux stratégies nationales d’autant que la TG 181 s’était en partie intéressée aux infrastructures qui en représentent une composante importante.

D’autre part un sujet que nous n’avons pas développé ici est celui de l’interaction entre les stratégies d’adaptation au changement climatique que développe le groupe de travail EnviCom 178 qui devrait être publié cette année et les réflexions de beaucoup plus long terme comme celle initiée à titre exploratoire par le port de Rotterdam à l’horizon 2100 avec l’appui du programme climat du Club de Rome [10].

A cet égard, la prochaine publication du rapport spécial du GIEC sur les océans et sur la cryosphère devrait permettre de revisiter le sujet de la conception, de la résilience et de l’adaptation des structures maritimes. Une enquête auprès des ports, lancée auprès des ports par le groupe qui co-anime avec notre association sœur l’IAPH le World Ports Sustainable Program (WPSP) devrait y contribuer.

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Le Port de Lyon, outil multimodal au service du développement du territoire

Description

Le Port de Lyon Edouard Herriot (PLEH) est le premier ouvrage réalisé par la Compagnie nationale du Rhône (CNR). Tête de pont d'un réseau portuaire concédé à CNR, constitué de 18 sites et de 9 quais publics exploités par CNR le long du Rhône, le PLEH offre à ses clients une desserte par cinq modes de transport : fluvial, fluviomaritime, fer, route et pipeline. Cela lui permet de remplir sa vocation visant à massifier et à transporter les marchandises au plus près des lieux de consommation et de fabrication. Ce faisant, il limite sensiblement le transport routier réservé à la livraison sur les derniers kilomètres.

D'une superficie de 184 ha, le Port de Lyon s'organise autour de 3 zones principales :

- une zone d’activités (produits métallurgiques, matériaux de construction, logistique) avec une cinquantaine d’industriels implantés, soit plus de 1 300 emplois, représentant de nombreux secteurs d’activités ;
- des dépôts pétroliers ;
- des terminaux à conteneurs (20 hectares).

Implanté au cœur de la métropole lyonnaise, au contact du centre-ville et à proximité immédiate des lieux de consommation, le Port de Lyon est la première plateforme multimodale de la Région Auvergne-Rhône-Alpes mais aussi le principal point nodal de l’hinterland du Grand Port Maritime de Marseille.

Grâce à sa position géographique privilégiée et à ses interconnexions aux grands axes de circulation routiers, ferroviaires et fluviiaux européens, le Port de Lyon, hinterland du bassin méditerranéen, facilite la logistique de ses clients sur l’axe Rhône-Saône et leur ouvre l’accès à la Méditerranée et à l’Europe du Nord.

Un Schéma directeur du Port de Lyon

Infrastructure exceptionnelle en cœur de métropole, outil économique et industriel majeur, le PLEH est un Port urbain qui, au-delà de ses activités historiques, réfléchit au rôle qu’il peut jouer au bénéfice du développement d’une métropole du XXIe siècle. C’est dans ce cadre qu’un Schéma directeur du Port de Lyon est en cours de rédaction.

À cette fin, le Préfet de Région a lancé le 19 juillet 2018 une démarche prospective et collaborative sur le Port de Lyon. Cette démarche partenariale implique en particulier les signataires de la Charte portuaire de 2005. L’objectif est de bâtir d’ici fin 2019 un Schéma directeur du port fixant les grandes orientations de son développement à horizon 2030, dans une perspective 2050. Les travaux doivent
également s’articuler avec ceux du Délégué interministériel au développement de l’axe logistique et portuaire Méditerranée-Rhône-Saône.

Ce document, élaboré conjointement par l’Etat, CNR, VNF et les collectivités locales intéressées, se fixe comme objectif d’ouvrir le champ des possibles pour imaginer le port « idéal » de 2050 et décider d’actions structurantes à mettre en œuvre, à horizon 2030, afin de parvenir à la réalisation de trois ambitions :

- Le port de toutes les énergies : site de production, de distribution et de stockage d’énergies propres (électricité, hydrogène, gaz naturel…) ;
- Un port de services, connecté à la Métropole : déchetterie fluviale, Quai des énergies, Hôtel de logistique urbaine, économie circulaire, évacuation des déchets du BTP… ;
- Le port, pôle économique et hub intermodal au cœur de l’axe Méditerranée Rhône Saône, au cœur des synergies avec les ports de la façade méditerranéenne, en particulier Fos-Marseille.

Le port de toutes les énergies

Producteur d’énergie et site de stockage d’hydrocarbures, le Port de Lyon se donne comme ambition d’accompagner, dans les années à venir, la transition énergétique du territoire à travers :

- L’évolution des stockages d’hydrocarbures vers l’accueil de nouvelles sources d’énergie ;
- Un démonstrateur de projets : nouvelles énergies renouvelables, stockage d’énergies 100% vertes…

Un port de services connecté à la Métropole

Au cœur de la ville, maillon essentiel du développement durable et économique de l’agglomération lyonnaise, le port de Lyon est un fournisseur de services pour la Métropole. À ce titre, il a pour vocation de :

- Développer la logistique urbaine durable ;
- Proposer des solutions logistiques adaptées au développement de la Métropole en utilisant au mieux le Rhône et la Saône ;
- Devenir le maillon essentiel de l’économie circulaire de l’aire lyonnaise ;
- Développer de nouveaux services en faveur de la navigation fluviale ;
- Repenser la connexion au quartier Gerland et à la Métropole (traitement des franges urbaines, organisation de ses flux en adaptant ses portes d’entrées…) ;
- Se connecter à la politique de développement des infrastructures de la Métropole ;
- Devenir un atout pour le tourisme industriel.

Le port, pôle économique et hub intermodal au cœur de l’axe Méditerranée Rhône Saône

Le Port de Lyon, maillon logistique et intermodal de l’axe Rhône-Saône-Méditerranée, connecté aux ports de Marseille-Fos et de Sète, se fixe comme objectifs, à horizon 2030, de :

- Renforcer ses synergies avec les ports de la façade méditerranéenne et en particulier Fos-Marseille ;
- Confirmer son rôle majeur de plateforme logistique intermodale de l’axe en s’intégrant aux stratégies territoriales ;
- Participer activement au développement du trafic fluvial et des modes massifiés ;
- Promouvoir des actions de développement des modes alternatifs, favorables à l’économie régionale.

Trois projets emblématiques au Port de Lyon

Au-delà de la réflexion prospective en cours sur le Schéma directeur du Port et sur les évolutions qu’il convient d’y mener d’ici 2030, le Port de Lyon reste fortement ancré dans le présent. À ce titre, il
poursuit une politique d’investissements massifs en faveur à la fois de l’implantation de projets innovants (Quai des énergies et Hôtel de logistique urbaine) et d’un renforcement de sa vocation de lieu de massification pour le transport de marchandises (acquisition d’un nouveau portique).

1/ Quai des Énergies

En 2015, CNR s’est engagée, au travers de sa stratégie d’entreprise CNR 2020, à être une « entreprise-laboratoire des énergies du futur ».

À cet égard, CNR souhaite associer l’ensemble de ses agents et partenaires dans une large démarche d’innovation globale et ouverte pour contribuer à l’émergence des nouvelles technologies qui façonneront le paysage énergétique européen de demain.

Résolument tourné vers l’avenir et la construction de la ville de demain, le Port souhaite donc continuer à déployer des projets innovants au service du développement du territoire. C’est dans ce cadre que le projet de Quai des énergies a été élaboré.

CNR dispose en effet, à l’entrée du Port de Lyon et à l’interface avec la ville, d’une parcelle de 7 000m². Situé au sein du quartier en pleine mutation de Gerland, cet espace bénéficie d’une très bonne visibilité. CNR souhaite mettre à profit les atouts de cet espace pour valoriser les énergies du futur et leur rôle dans la ville de demain.

CNR, en collaboration avec le cabinet d’architecture lyonnais LFA, a imaginé une parcelle contenant :

- Une station de recharge multi-carburants verts (électricité, GNV, hydrogène) permettant de recharger des véhicules électriques, à hydrogène ou fonctionnant au gaz naturel ;
- Un espace pédagogique sur les énergies de demain qui permettra de sensibiliser les utilisateurs de la station de recharge multi-énergies et le grand public aux enjeux de la transition énergétique et des énergies renouvelables. Il s’agira d’une salle couverte avec des démonstrateurs de technologies innovantes développées par des partenaires tels que l’INES. Les clients de la station mais aussi des visiteurs ou groupes scolaires pourront ainsi s’informer sur les techniques de production et de stockage des énergies renouvelables d’aujourd’hui et de demain à travers des panneaux explicatifs et un outil interactif.


La station multi-énergies vertes, d’un montant de 3.5 M€, bénéficie de subventions :
- de la Région Auvergne Rhône Alpes
- de l’ADEME
- du Fonds européen FCHJU
- et du Fonds NOE

Les partenaires techniques du projet sont MAC PHY fournisseur des électrolyseurs à hydrogène et ENGIE-GNVert en charge du process GNV et de l’exploitation de la future installation.

2/ Hôtel de logistique urbaine

L’État, la Métropole de Lyon et CNR ont signé en 2005 une Charte du Port de Lyon, qui place la logistique urbaine comme objectif prioritaire du développement du port.

La croissance économique et démographique des métropoles, ainsi les problèmes d’espaces disponibles, de congestion et de pollution expliquent également cet intérêt croissant.

En effet, on estime que les transports urbains génèrent 25 % des émissions de CO2. Ces émissions deviennent une préoccupation grandissante dans les villes, que ce soit tant pour leurs impacts sur le dérèglement climatique, que dans le cadre du respect des limites légales fixées par l’Union Européenne. Pour maximiser l’efficacité globale de la logistique et minimiser son impact environnemental et social, les différentes parties prenantes de la logistique urbaine (collectivités locales, chargeurs, commerçants, logisticiens, et consommateurs) doivent désormais développer des nouvelles formes de collaboration. Aussi, un hôtel logistique est destiné à être implanté dans les zones denses des grandes agglomérations, où le foncier est rare et cher relativement aux capacités contributives des activités logistiques.

C’est dans ce contexte que CNR a lancé un appel à manifestation d’intérêt (AMI) pour la création d’un hôtel de 48 000 m2 favorisant la mixité des activités logistiques sur le site du Port. Aussi, une parcelle y a été réservée afin d’accueillir un tel équipement permettant de répondre à plusieurs objectifs :

- apporter une réponse aux problématiques de transition énergétique, de congestion routière, de pollution de l’air, de nuisances sonores générées par le transport de marchandises en ville ;
- construire un paysage urbain en cohérence avec son environnement ;
- garantir la pérennité du projet ;
- accompagner le développement économique de la métropole ;
- faciliter les conditions d’émergence d’une logistique urbaine alimentée par des modes massifiés (amont/aval).

Cet hôtel de logistique urbaine doit s’installer d’ici fin 2021 sur le port de Lyon pour verdir la logistique du dernier kilomètre, en desservant le cœur de l’agglomération en marchandises à partir d’une flotte de véhicules propres voire par la voie d’eau.

3/ Acquisition d’un portique au Port de Lyon Edouard Herriot (PLEH) pour l’activité de manutention fluviale des conteneurs

Le transport des conteneurs par voie d’eau est de l’ordre de 80 à 90 000 Equivalent Vingt Pieds (EVP) par an sur le bassin du Rhône. Il y a dix ans, il était de l’ordre de 60 000 EVP.

Le Port de Lyon capte à lui seul plus de 90 % de ce trafic fluvial. La manutention de ces conteneurs au Port de Lyon est réalisée par la société LYON TERMINAL, filiale de CNR à 64 %.

L’activité de manutention des conteneurs est assurée sur le Terminal 2 par un portique de 40 tonnes dont l’investissement a été réalisé en 2007. La capacité brute du Terminal 2 (10 ha de surfaces de traitement disponibles) permettrait de soutenir un accroissement de ce secteur pendant 10 ans. Cependant, la capacité du Terminal 2 se trouve limitée par la disponibilité d’un unique portique. En outre, il n’existe pas de solution de secours satisfaisante en cas de panne ou de maintenance lourde de celui-ci. En effet, le Terminal 1 n’est pas adapté à la manutention de conteneurs en raison de la nature de sa plateforme et du vieillissement de son portique à colis lourd non adéquat pour la manutention de conteneurs.

Il a donc été décidé d’acquérir un nouveau portique, plus moderne, afin de moderniser les infrastructures fluviales du Port et, ce faisant, de soutenir le développement du transport de conteneurs par voie d’eau, depuis et vers le Port de Lyon, d’optimiser l’exploitation de la manutention fluviale du Terminal et d’accroître l’activité.

Les caractéristiques du nouveau portique :

- Productivité : 20 à 30 conteneurs par heure ;
- Taille : 35 m de haut par 30 m de large et 84 m de long ;
- Poids : 463 tonnes (spreader et charge comprise) ;
- Force de levage nominale : 41 tonnes.
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Development of the Port of Barranqueras and its role in the Paraguay – Parana Waterway

Abstract:

Introduction

The Paraguay – Paraná Waterway is a natural inland waterway located in South America and flows through five countries: Brazil, Bolivia, Paraguay, Argentina and Uruguay. It is considered the most important integration corridor of MERCOSUR. Its hinterland has a population of more than 40 million inhabitants, connecting the most populated and industrialized areas of South America. Furthermore, between 2010 and 2018 cargo transport doubled freighting, from 17.4 million tons to more than 36 million tons.

![Image 1: Location of Port of Barranqueras](image)

Within this system, it is of special importance the small Port of Barranqueras which is located on the right bank of the Paraguay - Paraná Waterway in the province of Chaco, Argentina, at around 1,000 km North of Buenos Aires city. Historically, this is a marginal area of Argentina in terms of investment and development, with large infrastructure deficiencies. However, the Port of Barranqueras has unique advantages like its location on the geographic center of
MERCOSUR with good road (RN11 & RN14) and railway (Belgrano Cargas) connections; unique possibilities for sustainable growth as it is not constrained by large urban areas and for being a multimodal port with facilities for container and general cargo handling as well as grain storage.

To profit on from this advantages, in the year 2016 the Port Authority developed the “Port of Barranqueras Reactivation and Reconversion Plan”. The main objective of The Plan is to transform the Port of Barranqueras into a logistic center for the interconnection between the Paraguay – Paraná Waterway with the Northern and Central Argentine provinces. The aim of this abstract is to share the experience gain in the execution of The Plan and the tools used, which have proven their effectiveness despite the adverse context and can be applied by other ports.

**Description**

The Port of Barranqueras is a public port administered by a Port Authority depending on the government of the province of Chaco. It is an historical port, having his first operation dated at 1906.

The typical freight of the Waterway consist on the convoy of 16 (4X4) or 12 (4X3) barges “Mississippi” or “Jumbo” type, moved by a tugboat. Each barge could carry 1500 tons. There also are container and oil tankers vessels.

The usual goods that the Port works are: soy, wheat, sunflower and salt by bulk and containers of coal, wood and cotton. Project cargo as railway are also transported. The transfer of container and bulk cargo between river barge and sea ship is done at Ports located at the beginning of the Paraguay – Paraná Waterway where the draft allows the traffic of sea ship like Panamax and Handy Size. The port of Barranqueras works specially with the ports of Rosario and Buenos Aires, Argentina, and the ports of Nueva Palmira and Montevideo, Uruguay to do this transfers.
Implementation of Reactivation and Reconversion Plan and its keys

The Reactivation and Reconversion Plan to modernize and improve the efficiency or this historical Port was made during 2015/2016 by technicians of the Port Authority, with the support of an external advisor. In order to ensure the success of The Plan we concentrated in six axis:

1) Simple and direct
The best plan is the one that can be pulled out successfully. At first we focused on solving specific problems in areas where results could be show quickly, so The Plan has a scope of just 3 years. This was fundamental to gain the support of the provincial government. Once this support was obtained, it was possible to work on more complex problems.

2) Take advantage of the multimodal resources to change the business model
Although the Port of Barranqueras is completely multimodal, this characteristic was not fully exploited. The business models of the Port were based only on a ship - dock relationship, being just a first generation port. One of the objectives of The Plan was to change this approach, implementing the concept of a logistics center. Nowadays, the Port's business model is based on the selling of stawring services, consolidation and deconsolidation of containers, storage and fractioning of the cargo, being the client the one who chooses among the type of transport available (truck, barge and train). We also take advantage of the fact that we have offices for phytosanitary control and customs "in situ", which greatly simplifies any international trade operation.
Thanks to this new concept of work it was possible to assure the clients that their goods will arrived at destination. During the periods of downpour of the Parana river when the fluvial transport is complicated or downright impossible, trains or trucks can be used to transport the cargo. This have an extra cost that is talked with the client, but we always arrive to an agreement.
Nowadays The Port Authority is working hard on the tendering of dredging access to the port at a depth of 12 feet for 5 years.

3) Use the existing infrastructure
In a national context of budget constraints, with a high devaluation of the national coin “Peso”, it was just possible to acquire only three forklifts used in the consolidation of the containers. To solve this serious problem we performed an exhaustive analysis of each existing infrastructure and equipment, giving priorities of maintenance and define the specifics operations that can be done with that equipment. Furthermore the operators were trained for the correct use of the machinery, increasing its availability.

4) Stressing a commercial vision and professionalizing the port authority
A new commercial department was set up, in order to search for further cargo-related business. This new department also redefined the hinterland, simplified the tariff scheme and participated in different port events, promoting the services of the Port. Because a high percentage of our client is new the department also advise on international and national trade, logistics network and customs documentation.
Additionally, training of the Port Authority in the use of modern management tools was emphasized.

5) Involving all the actors and respect at their idiosyncrasy
Bearing in mind that The Plan would have a great impact within the workers, since it would modify entrenched customs and bring new ways of carrying out operations, the correct communication of The Plan was critical. Several meetings were held explaining the scope of the plan and involving the workers in it. In many cases, through the contribution of the workers, modifications were made to The Plan, having the support of the Unions during its application. It
is important to highlight that The Plan was made mainly by technicians of the Port Authority, with the support of external local advisors that understand the idiosyncrasy and the bureaucracy of the region, this synergy made possible the successful implementation and of The Plan

6) Participation of private capital
The Port Authority changed from a Toolport model to a Mixed port model. The trade of grains was concessioned to the company Diaz & Forti. This company made an initial investment of 4 million dollars in the improvement of existing facilities, with an investment horizon for a total of 14 million dollars and started the operation at December of 2017. For its part, the Port Authority charges a fee for the use of land and services. This allowed the Port Authority to focus on the handling of the project cargo, general cargo and containers, as well as administering the canon. This amount of money is used on the modernization of equipment and facilities of the public dock.

Social aspects of the implementation of the plan

During the development of the proyect we used many well known management tools and techniques such as S.W.O.T. analysis, statistical standarization, CRM impletion, Pareto principle analysis and many others well known by the port management comunity. But at the beginning of the project we realizad that working from a technical perspective alone would not be enough to ensure the success of the Plan. We can say that a technical perspective is a necessary but not a sufficient condition to pull off a plan successfully. The understanding of both the local idiosincrasy and bureaucracy is crucial. Other Plans for the port did not take these items into account and thus they failed. We would like to tell in a few words the approaches that were used to understand and work on these “human “issues.

1) Local Partnership
The failure of previous developement Plans for the port caused an understandable mistrust to our proposal. To avoid this we made a partnership with technicians from the Port Authority. This “local partners” with the important support of the Port Unions interviewed the workers, obtaining their opinions. Those opinions and comments were analized developing a double entry matrix that helped us to make changes to the Plan and its implementation.

<table>
<thead>
<tr>
<th>Fecha reunión:</th>
<th>Responsable:</th>
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<tbody>
<tr>
<td>Temática:</td>
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<tr>
<td>Dirección</td>
<td>Excelente</td>
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<td>MKT</td>
<td>Excelente</td>
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<tr>
<td>Operación</td>
<td>Excelente</td>
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<tr>
<td>Administración</td>
<td>Bueno</td>
</tr>
<tr>
<td>Legal</td>
<td>Regular</td>
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<tr>
<td>Otros</td>
<td>Excelente</td>
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</table>

Image 5: Double entry matrix

2) Bureaucracy
Argentina it is a federal country that has three levels of regulations: National, provincial and local. Besides its public administration has descentralized organism (customs, IRS, etc) with their own regulations. Just to give an example the province of Chaco has a law of “local suppliers”, meaning that the local companies have priority to be a supplier. This “maze” of laws and regulations greatly complicated the design and implementation of the Plan.
In order to understand this complex system we developed a concept map with all the laws and regulations and their relations.
3) Education and skills of the employees

One of the aims of the Plan was that it had to be implemented by actual workers of the Port, so it was fundamental to know the level of education and skillfulness they had. With the help of the Union and by having personal interviews with the workers we developed a table with the information collected.

With this matrix we determined how many and what kind of training we have to provide to the employees. To order to do this this we classified those trainings into “Urgent”, “Necessary” and “Desirable” categories. By doing this, we were able to develop the necessary stages in the Plan implementation.

4) Public Port

The port of Barranqueras is a public port, so it depends directly from the Provincial Executive Branch and it only has a limited autonomy. Like others public bodies the port has the pressure of active forces of society such as political parties, legislative commissions and even NGOs to show results and answers to their demands. In order to handle this issue we first had meettings with this driving forces to hear their demands and questions. After the meetings, we established a mixture of short-term objectives on specific problems to show quick results, with long-terms objectives involving in-depth changes that are more complex to explain or justify to a non technical audience.
Results

Despite its implementation is taking place in a context of budget constraints, limitations of existing infrastructure and human resources, the Port Authority is making great achievements like:

1) Income

![Income Graph]

The income of the Port Authority grew 7 times at nominal terms and 3.7 in real terms, without the inflation. This graphic included just the income of the Port Authority, the income of Diaz & Forti is not included.

2) Cargo throughput

![Cargo Throughput Graph]

The cargo throughput increased 15.6 times. This included also the cargo move by Diaz & Forti

3) Teu’s throughput and truck entry

![TEU’s Graph]

In this two items also a great increase can be observed.
Conclusion

This paper describes the success of the “Port of Barranqueras Reactivation and Reconversion Plan”. It is important to highlight that in the year 2018, during Argentina’s huge economic crisis - with a currency devaluation of more than 100%, an overall economic contraction of 2.5% and the rise of the unemployment from 7.2% to 9.1%-, the Port of Barranqueras was one of the few public-sector bodies that can show positive figures.

This paper also shows the vital importance of the correct handling of management tools as well as the understanding of the local idiosyncrasy and bureaucracy when implementing a plan. We consider that the failure of previous reform plans on the Port of Barranqueras (and other ports as well) were due to the underestimation of the importance of those two items.

The Port Authority is nowadays working on the second part of the Plan.
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Keywords:  
activities, actor collaboration, inland waterway transport, logistics solution, modal shift process

Title:  
The modal shift process – ways to achieve an increased use of inland waterway transport

Extended abstract:

Introduction
A modal shift from road to water is a prioritized strategy outlined in national strategies (such as Sweden and Netherlands) as well as part of EU goals. Main motivation for this modal shift derives from the need to use more energy efficient transport mode, and consequently reducing green house gas emissions, as well as congestion on roads, local pollution and noise from trucks in urban areas. Inland waterways (IWW) are in several geographical areas underutilized, in particular, for domestic transportation. In Sweden, less than 1% of the goods are transported using IWW, which is a contrast to the Netherlands’ figures of almost 20%. Even though Netherlands’ figures are high in comparison, there is a challenge of competing with attractive road solutions, and a negative modal shift to road is a trend to reverse. Thereby, there is a potential in both increasing the usage of inland waterway transport (IWT) as well as preventing a negative modal shift to road, while also contributing to reach long-term national sustainability goals. However, to achieve a modal shift from current flexible road solutions to IWT is a challenging task, which requires several actors to take action. The purpose of this paper is therefore to identify and structure necessary activities for key actors in order to better understand how such a shift can take place. A conceptual model of the modal shift process is proposed.

Method
Necessary activities for key actors were identified based on case studies covering two separate geographical regions. Case A consisted of starting up IWT of containers between the port of Gothenburg and the Göta Álv river and lake Vänern in the south-western part of Sweden. Case B consisted of IWT from Drachten community in Smallingerland, in northern part of Netherlands. Key actors (goods owners, ports, shipping companies, forwarders, municipalities and authorities) were involved in activities related to modal shift trials during 2017-2018. Interviews, meetings and workshops with the involved actors were performed.
continuously. In case B, meetings with goods owners were organized every sixth week. In case A, two workshops with the involved actors were conducted every six months. Activities in the two cases described at interviews, meetings and workshops have been categorized into six topics. The six topics and sub-activities have been discussed with actors aiming for a modal shift to IWT in other geographical areas and were found relevant also to other contexts.

**Findings**

As challenges varied in the two cases, the roles of the actors and the timing of necessary activities differed. In case A, two logistics entrepreneurs initiated the process of a modal shift, while in case B the municipalities had a leading role. The lack of governmental support in case A was evident and made the process slow.

Activities in the two cases centered around six topics: stakeholder involvement, goods flow potential, identification of challenges, IWT promotion, problem solving, and modal shift realisation, see Figure 1 for an overview. These topics are not sequential; rather the activities are interrelated and can be performed in parallel.

![Figure 1. Main topics to achieve a modal shift.](image)

**Stakeholder involvement** was crucial in terms of identifying, connecting and convincing stakeholders of IWT. As a first step it is important to understand which stakeholders need to take action. These stakeholders need to be connected, for example establishing contact between goods owners and ship owners. For example, in case B regular meetings with goods owners were conducted. In case A the entrepreneurs made contact with the other stakeholders to jointly find ways forward. Further, to succeed with modal shift, stakeholders need to be committed, therefore motivating them is important.

**Goods flow potentials** includes identifying companies with type of goods and supply chain suitable for IWT, and for such companies analyse possibilities for IWT, e.g. suitable goods flows. In case A, the theoretical potential of import and export goods flows using IWT was mapped for the regions near lake Vänern using national statistics. Further, the two entrepreneurs made personal contact with companies identified in the geographical area along the IWW in order to identify goods flows and possible customers to a new setup of IWT of containers. In case B, a direct contact was established between the municipality and 16 goods owners with continuously meetings discussing IWT issues.

To take an initial step towards **realisation** of modal shift to IWT, both cases performed a pilot, which was proven successful to show the concept, learn about challenges and promote the IWT service towards stakeholders. In case A, this activity took place early in the process, demonstrating that transport on the river Göta Älv and transshipment in ports could be conducted, even though the containers were empty rather than loaded with goods at this stage. In case B, using the return flow of a bulk barge that had unused capacity between Drachten and Amsterdam, it was demonstrated that goods flows with various goods flow characteristics and from several companies located next to the IWW could be consolidated on the barge. To take the next step and implement IWT in a larger scale requires viable business models.
Apart from showcasing IWT with pilots, other promotion activities took place, such as creating information/learning material, arranging workshops and seminars to discuss challenges and lobbying towards regulatory actors. In case A, a lot of effort was put into marketing the potential of IWT, since the general knowledge of IWT, e.g. concerning inland barges, was very low within the region and the national regulatory actors. In case B, a marketing video was constructed after the pilot to attract more companies to use IWT and to make sure waterways are on the agenda for local government, provinces, national government and the EU.

Further, challenges with a modal shift to IWT were identified. Such challenges included the waterways (need for upgrade to class V IWW in case B), port/terminal operations (lack of transshipment equipment in both cases, and high port handling fees in case A), regulations (costly piloting fees in case A). In both cases, the high investment costs and difficulties in securing sufficient volumes for the IWT service were raised as two main challenges.

Knowing about these challenges the next step was problem solving, identifying solutions to handle the challenges. In both cases, negotiation with stakeholders (goods owners, shipping companies, ports and authorities) was key to create an attractive service offer towards goods owners. In case A, bargaining with ports about reduced handling fees was necessary as well as lobbying with authorities to find exemptions to the costly pilot regulations. In case B the problem solving involved finding solutions to handle and load the goods while avoiding damage. The promotion video from the pilot in case B was used to influence local government, provinces, national government and the EU to receive funding that could cover part of the costs.

Despite large efforts in the two cases including performing activities related to the topics described above, there are still no new long-term IWT solutions in place neither in the studied area of Sweden nor Netherlands at this date. It is apparent that several actors need to collaborate and take action in order to realise a modal shift and that such a shift will not happen overnight. Long term endurance and initiatives from several actors are necessary for a large-scale modal shift to be realised.

Contributions for research and practice
While earlier studies have described various barriers for a modal shift, including regulatory, financial, service and market related barriers, this paper focuses on activities to realise a modal shift. It provides concrete examples of how to deal with various challenges. This paper contributes with increased understanding of the modal shift process, categorized into six topics with sub-activities, exemplified from practice in Sweden and Netherlands. Authorities can learn from the results that the modal shift process is complex. Policies may be directed towards specific challenges identified and towards the six topics. Actors aiming for a modal shift, including ports, shipping companies and goods owners, can apply the activities outlined under the six topics. While the sub-activities may require different focus depending on the prerequisites of different situations, the main topics are important to consider and the sub-activities described can act as a toolbox. Finally, the case studies have shown that actors can take a larger responsibility and action towards using IWT. In particular, when starting up new IWT services many actors need to interact and the various actor types need to take an active role.
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Keywords:  
Freight transport, uncertainty, management, work

Constraints suffered and resources developed by a carrier

Abstract: This communication concerns the activity of a road and river transport operator. Our observations were conducted in the operational room. We observed the activity of management and regulation of agents in charge of the routing of seaports to customers (importation) and shippers to seaports (exportation). By clarifying the tasks of the managers and by defining the field of constraints to which they are subjected and by identifying the strategies developed to satisfy the objectives of production, the results underline the conditions for the development of smart rivers from the point of view of management. From the analysis of the activity in situation, the results highlight the strong interdependence of transport operations and the necessity to share and master the chain of information. The management of a terminal combines all the constraints of the modes that feed it. But the temporalities are uncertain. Performing in shared open environments, each operation is subject to the hazards. Modes are not only selected on the basis of the accessibility of the loading or unloading sites, the volumes to be transported, distances and time constraints, but also according to the need to maintain, develop or restore their flexibility and their reactivity.

Introduction
The transport of goods is highly exposed to uncertainty. If sometimes, the use of external capabilities can be a solution to reduce its effects, it can increase the organization's exposure to external variability. Added to this is a incidental variability (Guérin et al, 1991), which concerns in particular the production apparatus ensuring the transshipment operations. Often preventive maintenance gives way to corrective maintenance. One of the objectives of the study presented in this paper was to specify the necessary conditions for a sustainable flexibility of the transportation system, which is essential for dealing with permanent uncertainty.

Context
This study focused on the activity of regulating the agents of an intermodal operator in an operational room. On the terminal, two teams were under the direction of the site director: the handling team composed by six agents and the operational room team constituted by seven agents, whom four mode managers and one transport manager. Under the supervision of this last, there were two operators in charge of trucking and two operators responsible for river transport. These agents organize the delivery of the containers to the customer in the case of the import or to the seaport for the export. To this end, they have road and river transport capacities that they mobilize according to the requirements, the availability of resources (some are internal or under a one-year contract but most are chartered on a daily basis), constraints and internal and external variability. In order to ensure the routing, the operators have at their disposal means of transport and workers (in addition to boatmen and drivers of the various subcontractors, three road drivers were employees of the terminal). The transshipments were made with a gantry and two reach stackers, one of which unloads the barges. During 2016, the company handled 90,000 containers.

Method
As a first step, we conducted exploratory observations, supplemented by an interview with the site director to familiarize ourselves with the characteristic of the site and the production process. The first observations made it possible to emphasize the preponderance of the transport chain over transshipment activities in the
regulation of the overall process. We therefore privileged the observation of the activity of the operational room.

Systematic observations were made over two three-day cycles (Day 1: day before the biggest and most demanding from the point of view of the activity of regulating the terminal; Day 2: day with the strongest activity, Day 3: day after with potential recovery). The first cycle was jointly conducted with an economist researcher wishing to evaluate the performance of the terminal (Nièrat, 2017). In addition to seeking understanding of the production process from the point of view of the operational room agents, our observations focused on “stories”. An agent was observed in the course of his activity for more or less half a day. From time to time, we focused on the organization of a routing by him or one of his colleagues who had questioned him. Particular vigilance was given to external solicitations. The observations were sometimes supplemented by informal explanations in situ with the operators concerned with the aim to obtain details on the situation that had necessitated intervention, on the choices of action and the possible alternatives.

Results

The results highlight the strong interdependence of transport operations. In this respect, the management of a terminal combines all the constraints on the modes that feed it. The temporalities of the routes are far from being controllable. Performing in shared open environments, each operation is subject to the hazards inherent in the weather conditions, the infrastructure or the present or future situation of the terminal. In the first case, high-water and low-water lead to a limitation of the barge loading, strong winds prevent the use of gantries and bad weather can result in disruption of the traffic conditions on the road (heavy rains, frost, heavy snowfall…). In the second case, infrastructure can reduce transport capacity or degrade the performance, such as during the maintenance operations or just because of their characteristics (lock chambers, bridge height or navigate in the direction of the current or against, and the crossing of urban area, or not, presence, or not of motorway, number of lanes…). In the third case, the situation of the terminals concerned by a delivery may also impact overall performance (strike notice, congested terminal, incident on handling equipment, container damaged…). Whatever the mode considered, the high exposure to uncertainty makes temporalities difficult to master, while one of the demands of the operators’ task is to ensure deliveries in specific time slots, especially in the case of just in time supply chain.

Each day, the operational room agents are confronted with technical incidents, delays and disputes, which thwart the program defined the day before. Each event causes a disturbance whose propagation in the general process is very variable. Of different durations and intensities, these events are always likely to modify the conditions of realization of the operations by altering more or less the capacities and / or the resources. One of the tasks of the operational room agents is to alleviate these unforeseen events and reduce their effects. Combining operational planning, control of past or current operations and forecasting of those that remain to be achieved, the operators perform a dual time management (diachronic and synchronic) of transport operations. On the basis of the determinants of the situation, each prepares a circumstantial representation from which it assesses the production capacities and the deviation from the expected situation. This sometimes results in regulation both during operational planning and during the execution of operations. They involve adding new resources or rescheduling operations and reassigning capabilities. When this is no longer possible, a negotiation is initiated with the recipient to define new conditions.

For this, the operating room agents have a fleet of boats and road carriers, who are their resource agents. Those ones are far from being permutable. The resource management juxtaposed with operations management. Beyond his skills and his territorial knowledge, the solicitation of the resource-agents by a mode manager is carried out according to the knowledge that he elaborated on him, on the basis of the history of their interactions (his performances, his responsiveness, his speed, his ability to avoid problems and to get by, his level of acceptance of unexpected requests). If the attribution of the missions and the regulation process rely on this interpersonal knowledge, the repeated resort to the flexibility of the resource-agents can cause a wear, a loss of reactivity even resistances. The resilience of the production system may be altered. It is therefore important to maintain or even restore these resource-agents taking into account their specific constraints provided that those does not interfere with the production objectives. This consideration leads in particular to facilitate their own regulation by acting on other variables of the transport system.

In the end, if the waterway is preferred for the transportation of the seaport to the terminal, the route is not restricted to the routing of the terminal to the customer. Time constraints can also cause agents to favor this mode to transport containers from the port to the terminal. Thus, this mode is not assigned to a particular path but constitutes a variable of adjustment and catch-up.
Conclusion
As long as it is shared, secure and with compatible management systems in place, data networking can contribute to better anticipation. But this will not allow in any case to have all this informal information that the law prohibits to record when they are too personal and which are so essential to the good management of the resources and the sustainability of the transport system.

Références
Assessing the robustness of Dutch Inland Ports

Introduction
In the present turbulent environment highlighted by energy transition, disruptive technology, and climate change impacts, adaptability and robustness are essential in long-term planning of infrastructures. This also applies to inland ports, which play an important role in the Dutch transport system. Inland ports have three major functions, i.e., transfer of goods, storage of goods, and eventually, facilitating (industrial) production of goods. A well-functioning inland port can contribute to efficient supply chains by offering multi-modal capabilities and value-added services, and importantly, contribute to a modal shift from road to environmentally friendly inland shipping.

Planning an inland port for the future depends on anticipating change and answering questions such as, is the plan robust, i.e., can the port fulfill its functions in the face of (uncertain) future changes, in a cost-effective manner? Are the current activities likely to be threatened in the future? Are there sufficient opportunities in the future? Can the port adapt to seize these opportunities? Creating a strategic and long-term view requires us to draw on tools, techniques, and methodologies from other fields. SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis is commonly applied to develop both long and short term strategies for a port through identifying factors, trends, and events internal and external to the environment of the ports. In this paper, we present a method combining the well-known SWOT analysis with a method for anticipating the future from the futures field (Van Dorsser, 2018b), and an approach for dealing with uncertainty from the field of policymaking (Walker, 2013).

Proposed Method
The method constitutes the following steps. First, an analysis of the external environment is carried out to anticipate a wide range of plausible long-term developments of significance for the port. Subsequently, a Meta-trend analysis (Van Dorsser, 2018a), which is a foresight method associated with level 3 uncertainty (Van Dorsser, 2018b) is carried out. This results in a narrower and more manageable set of plausible developments significant for the port. Next, an internal analysis is carried out to identify the characteristics of the port. Special attention is paid to flexibility and adaptability in keeping with the recommended approach for dealing with level 4 uncertainty (Walker, 2013). These characteristics equip a port to reduce its vulnerability to potential future threats and seize new opportunities, for instance, through investing in new activities and services (Taneja, 2013). Finally, the robustness of the port can be assessed by examining if the
identified new services or activities can be established by using or adapting the existing infrastructure and facilities of the port. The method is applied to a case study for illustration.

**Case study**
The selected case study was the cargo-handling Dutch port of Wageningen and the steps described above were applied systematically to assess the robustness (detailed analysis can be found in Dekker (2018)). Though various information sources were approached, e.g. port authorities, Nederlandse Vereniging van Binnenhavens, Centraal Bureau Statistiek, and Eurostat, a qualitative approach was adopted due to lack of monitored data, such as port performance indicators.

The inland port of Wageningen (Rijnhaven) is located on the northern bank of the Nederrijn. There are five terminals located in the port: two agro-bulk terminals, one concrete plant, one dry bulk terminal for sand/gravel, and one liquid bulk terminal. It has no train connection, is less accessible by road, but well accessible by inland transport. The port has a reasonably large hinterland with the nearest inland ports at a distance of 25 km. The strengths and weaknesses of the port were investigated in detail, including the space for expansion (terminal area, quay length, quay equipment), activity type and demand throughput, and the type of quay equipment. There is flexibility to expand the existing activities or create new ones: the area can be increased 2.25 times, and the quay length can be doubled. Large inland vessels can access the inland port which can be seen as a strength.

An analysis of the external environment helped to arrive at a set of trends/long-term developments significant for inland ports. These included: relocation of low-value industrial processes, specialized industries, economies of scale in small inland vessels, gradual stagnation of demand growth, energy transition, transition to sustainable and recycled resources, increasing number of construction activities, increasing supply of food from the Netherlands, climate change impact, big data sharing, synchronomodality, autonomous shipping, energy transition, smart-infrastructure and equipment, and 3D-printing. The potential impacts of the developments relevant to the port of Wageningen were examined to distinguish them into threats and opportunities. The small number of companies established in the inland port makes it vulnerable to the departure of (a few) companies. More than 50% of the throughput volumes are dedicated to agro-bulk activities, making it vulnerable to reduced demand for this activity. The port has the opportunity to produce and/or handle more sand, gravel construction materials since the demand is anticipated to increase until 2050. The decrease in liquid bulk activities due to the transition towards sustainable energy sources and raw materials poses a threat. The identified opportunities included facilities for containers, break-bulk, neo-bulk or special goods, renewable energy production, and recycling.

It could be concluded that the inland port of Wageningen is robust since there is a possibility to attract and accommodate new activities, in order to deal with potential future threats, such as a decline in of liquid- or agro-bulk.

**Conclusions**
This paper presents an extended SWOT analysis that combines methods from the futures field, and from the field of policymaking in order to assess the robustness of inland ports. Anticipating upon uncertain future developments which could be of significance for a port, examining the strengths and weaknesses of a port, and subsequently, strategising to seize opportunities, can make an inland port more robust, so that it can fulfill its functions in the face of (uncertain) future changes, in a cost-effective manner.

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Keywords:  
Inland and maritime port partnership, Intermodal, European corridor, Sea-Waterway connection,  
Logistic efficiency, Safety, Mass Traffic Development

**Medlink Ports : Port Cooperation as a Key Factor  
of Modal Shift in Freight Developments**

Medlink Ports federates 8 inland ports (Pagny, Chalon, Mâcon, Villefranche, Lyon, Salaise, Avignon, Arles),  
3 seaports (Sète, Marseille Fos, Toulon) and the mass transport networks managers Voies Navigables de  
France (VNF), la Compagnie Nationale du Rhône (CNR) and SNCF Réseau. It connects 160 countries in the  
world through 500 ports. Medlink aims to boost and promote this harbour system and its multimodal services  
in order to develop massive traffics, placing itself in a broad vision of corridor, from Europe to the  
Mediterranean. The consortium also brings together some 30 partner members on the Mediterranean-Rhône-  
Saône axis, transport and logistics operators, stevedores, shippers, etc. to help build door-to-door solutions  
focusing on modal shift, all trade – import/export or domestic – concerned.

It is a major logistic tool at the scale of the Committee of interharbour and logistics coordination of the  
Mediterranean-Rhône-Saône axis that the French government set up in 2017 to increase the attractiveness of  
its first seaport Marseille Fos and the dynamism of this port system hinterland territory, confirming it as a  
main southern gateway to Europe.

**A bit of history**

Created in 2008, Medlink Ports formed a non-profit organization in 2015. The partnership has become more  
intense over the years, both by welcoming new members and expanding its scope. Initially for promotional  
purposes, it has gradually opened up to a finer work by sector and to the establishment of customer services  
as well as to the pooling of means to get its ports up in quality. The railway in a global corridor vision also  
completed the river, its first DNA acting on nearly 600 km of high gauge waterway. Medlink aims to address  
ecological transition issues in a logic of port competitiveness and sustainable development of territories.

**A specific partnership**

Unique banner, branding strategy, to unite the harbor and logistics actors of the axis, Medlink Ports is :  
- a real economic influence : major fluvio-harbour entity in France, all freight sectors concerned with more  
  than 103MT handled / year.  
- innovative : the cooperation partnership was the first of its kind and develops on a strong collaborative  
  management  
- representative : major operational actors of the four regions along Mediterranean-Rhône-Saône axis  
  belong to it  
- open and pragmatic : private actors and stake holders (shippers, terminalists, freight transporters…) join  
  the Agency since 2016, convinced by our operational “bottom-up approach”
• based on intermodal connections: first of all barge but also synergies with rail on inland ports, to offer
customers modal shift performing solutions, both for sea traffics and domestic flows
• a living ecosystem; the “Medlink galaxy” regularly welcome new members (transport operators, freight
forwardsers…).

Our key services and actions

Medlink Ports is at the service of supply chain professionals (shippers, industrialist, freight forwarders,
shipping companies, etc.) in order to facilitate modal shift for them. All goods are concerned, any sector, any
segments (containers, bulk, conventional, heavy lift…). We aim to develop added value customer services for
the users on the corridor, in order to increase performance of their transport and logistic chains. These
services are built in cooperation between our members, first based on the sea and river ports
complementarity. They are a cement of our partnership.

Three main customer services are available on the network: Medlink Business (through the vision of the
whole supply chain by our free logistics advisor and our thematic workshops), Medlink Safe (for the highest
operational standards on our ports and an innovative process to boost containers of dangerous goods on
river) and Medlink + (focused on IDE, traceability, e-customs procedures…). Here comes a focus on them :

➢ Medlink Business: Economy, simplicity, efficiency

- Free logistics advice for shippers

The improvement of the clients’ knowledge about the logistics, and barge and rail offers is a major vector of
development of business and use of alternative transport modes. The first employee recruited by Medlink
was its logistics advisor who offers personalized support to clients. Of its approximately 150 annual actions,
more than half relate directly to shippers or freight forwarders.

- Prospecting by sector

Medlink applies a marketing approach by lines of goods. Various actions are undertaken to understand the
needs and to confront the possibilities of supply. These approaches are either directly carried out within the
Medlink network or through partnerships of its members, such as the 2019 study by France Chemistry of
how to turn to waterway chemical flows of the Rhône Valley – that study will be the starting point for
operational tests. Dedicated promotional materials are created, such as brochures by traffics: wood
(concerning almost all our ports), containers (a major maritime development axis), heavy lift (which exempts
itself from the constraints of road gauge), dangerous goods (out of general road traffic), etc.

- Labelling shippers involved in modal shift

The labelling system created by Medlink aims to promote and retain these customers. It offers them
additional visibility and can give them access to economic benefits under condition. New shippers are being
labelled each year for container or bulk. Their number is up to 27 mid-2019. They will form the basis of the
shipping club that Medlink will set up to create a circle of economic actors with privileged information, etc.

- Organization of thematic workshops (by trade, territory)

To reach its “targets”, Medlink works by trade and organizes workshops reserved for shippers (on business
issues: customs, digitization, etc.) or, since 2016, for freight forwarders (where the Medlink Safe export
process was implemented).

- Promotion of port and multimodal transport services

Medlink has a strategy of presence in targeted trade fairs, chosen by all its members as vectors of
business. In 2018, Medlink organized stands on 10 events, including 3 international ones. It optimizes its
presence by means of Press actions and more widely mobilizes all means of communication to increase its
awareness and publicize its services (website, social networks, media plan, newsletters, flash infos …).
Medlink Safe: Safety, security, reliability

- Medlink Safe export process

Launched in mid-2016, it is very successful (+65%TEUs in 2018). Its objective is to reinforce the use of barges on the Rhône for export of containerized dangerous goods. It goes through the Medlink Safe accreditation of providers who, in exchange for their commitment to obtain before arriving at the maritime terminal all the authorizations necessary to the docking of the container (thus guaranteeing its unloading and the reliability of transport), benefit from the free overnight stay on the port of Lyon and an additional day of parking allowed in Fos. To be accredited Medlink Safe, the joint agreement of the ports concerned and the barge operators is necessary; this is the case of 22 companies at present, a number that is steadily increasing, and that beyond the profession of freight forwarders has opened to the shipping companies. This highlights the relevance of this process, which is particularly timely in the chemistry valley. Suggestions for its extension (geographical, etc.) are being studied.

- Cooperation to upgrade the harbours competence

The sharing of good practices and the pooling of expertise work between Medlink ports to harmonize and modernize practices, and provide high-level logistics on the axis, ever more reliable and safe. An expert on dangerous goods is thus at the disposal of the network platforms and their customers; technical cooperation in the operation of materials handling equipment is also active; and on the same principle, a collective QSE (Quality Environmental Safety) approach is being implemented in 2019

Medlink+: Speed, fluidity, traceability

- Digitization and improvement of the multimodal supply chain

Digital technology is a vehicle for the fluidification, acceleration and securing of logistics chains for the transport of goods. Medlink will focus on capitalizing on the technological advances being deployed and facilitating the IT networking of the axis with its members and stakeholders. Key to this, is the facilitation of river operations in ports, etc. Great attention will also be paid to innovations such as the blockchain project on the Mediterranean-Rhône-Saône axis or to the devices of tracing of connected containers.

- Customs simplification and dematerialization of procedures

The marine cargo community system becomes a foundation of the new customs procedure of mass transport between marine and inland terminals under the Union Customs Code, which takes over the fluvio/ferro maritime procedures.

- Demonstration of environmental excellence via ecocalculator

Some Medlink members are developing this type of tool to value the environmental performance, in terms of greenhouse gas emissions, of mass routes via Medlink Ports.

Medlink Ports is a living partnership; its original organization supported by an operational committee, working force and source of proposals towards the governance of the association, its rotating presidency (currently entrusted to Mr. Gayssot who wants to see the river and maritime ports actively play together the card of modal shift and development towards Europe and the Mediterranean), the “galaxy” of actors that it federates (partners, labelled, accredited...) enable it to be proactive and capable of driving “green” and relevant logistics and transport solutions that meet the major challenges of tomorrow.
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Keywords:  
Inland waterway transport, inland shipping, city logistics, distribution planning, logistics training, public awareness  

Title:  
Waterborne city logistics: Bringing together inland shipping, logistics education and urban development  

Summary  
The promotion of inland waterway transportation (IWT) can be facilitated by urban uses of small barges backed up by an integration of IWT-related skills into logistics curricula. The development of those skills follows the route of “modal shift through mind shift” amongst logistics decision makers. According to interviews we conducted, IWT has a perceived image of inappropriateness for today’s logistics requirements geared around fast moving consumer goods (FMCG). As such, a shift of mind can be initiated by “surprising” logistics decision makers with IWT solutions where they least expect IWT to work. One of those fields is urban logistics. There are various examples of IWT usage across central Europe hat focus on distributing FMCG in inner-city locations. Any form of logistics education to facilitate IWT can draw on those examples instead of highlighting the often repeated advantages of IWT of moving large volumes of (raw) material at good prices over long (river) distances.  

#IWTS 2.0 – Innovation and Competence Delivered  
The Interreg-funded project #IWTS 2.0 integrates elements of this strategy: In Ghent, a small-barge application is being developed to deliver construction material to various inner-city sites along canals. Flanking this, bremenports, the public infrastructure managers of the Ports of Bremen and Bremerhaven, develops an online training inventory to bring IWT to the logistics community. Additionally, the Maritieme Academie Harlingen, in the Netherlands, simulates safe and economic barge traffic along small waterways.  

This approach, which might sound a bit far-fetched, becomes clearer when we consider the objectives of IWT-usage in the context of city logistics. It aims at decongesting urban areas and addressing current revitalisation efforts of traditional harbour areas in many European cities. The immediate benefits of IWT become clear for everybody to see in their local environments. However, we need to find smart logisticians to transfer those potentials of IWT to wider logistics and to integrate IWT into appropriate distribution systems. This is where logistics curricula in higher education come in. What begins with logistics students as first, albeit a niche target group, gets extended to urban planners, and finally to the general public, discussing IWT-usage options for their cities.  

Modal shift is mind shift  
The modal-shift-is-mind-shift paradigm takes up the surprise element in this strategy. By employing IWT in city-logistics, a field dominated by trucks, and showing the potential of IWT shall encourage decision
makers to consider IWT as a transport mode for other, non-urban distribution systems. Some waterborne city-logistics initiatives even consider IWT as floating warehouses going beyond transportation.

Putting IWT onto the mental radar screens of logistics decision makers is – at least in Germany’s higher education – a necessity. IWT is rarely an element on curricula of university programmes in logistics. Nevertheless, apprenticeships for freight forwarders at least foresee 120 theoretical hours of tuition out of a total of 880 hours over three years of instruction. Topics include

- Transport mode comparisons:
  - 80 hours out of 320 hours in 1st year training,
- Specialisation in one additional transport mode, which might include IWT:
  - 40 hours out of 280 hours in 2nd year training,

thus, providing in total 120 hours out of 880 hours (3rd year: 280 hours but without any transport-related topics) of instruction geared around modal choice. However, the coverage of modal choice is wide including road, rail, ocean freight, IWT and pipelines. The specialisation should cover a typical mode that is relevant for the region where the practical phase of the apprenticeship takes place. In areas far from any river or canal chances are that IWT loses out.

In interviews we conducted amongst lecturers and industry professionals for the training-related workpackages of #IWTs 2.0 interviewees complained about the paltry image of IWT of being slow, old-fashioned and unsuitable for modern logistics. Further, IWT is perceived to be confined to the River Rhine with smaller waterways being out of the focus. This is where #IWTs 2.0 with its several work streams kicks in. #IWTs 2.0 integrates three distinct themes of IWT-usage of revitalisation of infrastructure, innovation in IWT and training as follows:

**Revitalisation of IWT only with innovation and training**

Revitalisation of infrastructure - Enabling IWT from scratch

- **Aire & Calder Canal between Leeds and Hull, UK:** Bulholme Lock on the Aire & Calder Navigation is one of the bottle necks that should be modified to accommodate larger ships on this waterway. The University of Hull (#IWTs 2.0-Partner) is also undertaking an audit of all businesses whose premises are close to the waterways in the river Hull, identifying goods volumes, transhipment potential and investment that would be needed to implement a modal shift.

- **Lake Vänern and river Göta Ålv, Sweden:** SSPA (#IWTs 2.0-Partner) has analysed AIS data to map current traffic patterns on the inland waterways which features a dedicated legislation since 2014 enabling the usage of inland barges rather than sea-going vessels.

Innovation in IWT

- In the UK, researchers at the University of Hull are developing software tools to visualise and simulate potential benefits of using IWT, for example with regards to CO2 emissions.
- One of the challenges for small inland waterway transport is **loading and unloading of freight**; #IWTs 2.0-Partner POM (Development Agency East Flanders) business development manager, is facilitating the development of special loading/unloading equipment for concrete beams and paper rolls.
- As already mentioned, in Ghent, a small-barge application is being developed to deliver **construction material to various inner-city sites along canals**.

Training

- The Lead-#IWTs 2.0-Partner Maritieme Academie Harlingen, in the Netherlands, simulates safe and economic barge traffic along small waterways to train crews in appropriate vessel handling along small canal stretches. The aim is to shift 80 TEU per day from the road to IWT covering a first-mile inner-city transport haul of containerised milk power.

Flanking the above, #IWTs 2.0-Partner bremenports, the public infrastructure managers of the Ports of Bremen and Bremerhaven, develops an online training inventory to bring IWT to the logistics community. It
shall serve as an online reference guide to showcase the potential of IWT. By working with this online tool participants will develop competencies required to initiate successful modal shifts to IWT.

These efforts add to various recent local initiatives across Europe to use IWT in urban areas. These include the beer boat in Utrecht, barges in Paris and DHL delivering parcels by boat in Amsterdam. Since 1996, Utrecht uses the Beer Boat to supply drinks and food to restaurants located along the canals of the city. In Amsterdam, DHL developed a Floating Distribution Centre which is a dedicated vessel that floats through the canals of Amsterdam from where cargo bikes are employed for the last leg of delivery.

An analysis of various case studies shows [Janjevic/Ndiaye, 2014] that those projects are driven by public and private stakeholders. They use existing waterways and contributing towards a positive image of IWT amongst the general public, as such raising public awareness. However, the aim of #IWTS 2.0 is to add another driver by firmly anchoring IWT-related training in logistics curricula of higher education.

**Conclusion**

Concluding the reasoning behind this strategy is to reach out to future decision makers, who today might enjoy a cold drink along one of those canals, to get reminded of inland shipping all the way through their professional career. As such, #IWTS 2.0 puts successful city-logistics with IWT at the heart of training to achieve a modal shift through a mind shift. Thus, an innovative picture of IWT is being put to the target group at places where it at least expects it; the positive connotation of IWT is underpinned by the irritation it creates when a “beer boat” delivers highly loved cold drinks to your favourite venturing place.

This encourages unconventional thinking and – hopefully – a break with the dismal image of IWT. It might extend to other stakeholder groups. Only by those positive connotations will it be possible to facilitate future modal shifts from road to inland shipping. The presentation will elaborate in detail how the various elements of IWT, city logistics and training interact, leading to a self-reinforcing process.

**References**

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Mots clés: Logistique, transport fluvial, ville, supply chain

Du vrac au colis: le méritoire ajustement du transport fluvial aux besoins de la cité contemporaine

A partir des années 70, en France, l’image du transport fluvial est celle d’un moyen de transport en voie de disparition, malgré le maintien du trafic de certaines marchandises en vrac, comme celui des céréales. Les caractéristiques du transport fluvial semblent ne plus répondre à l’évolution de la demande des chargeurs, qui lui préfèrent la souplesse et la disponibilité permanente du mode routier1. En effet, pour plusieurs raisons économiques (première crise pétrolière en 1973, conversion à l’énergie nucléaire, niveau élevé des taux d’intérêt notamment), la demande pour le transport de masse laisse la place à une demande pour des envois plus fractionnés. Or, grâce à la capacité d’emport des péniches et des barges, le transport fluvial est, traditionnellement, un transport de masse, apte à minimiser le coût de transport unitaire ; aussi les clients capables de remplir toutes les cales d’une péniche sont généralement des industriels et des commerçants en gros. D’ailleurs, la péniche ou la barge fait l’objet d’affrètements pour l’acheminement de lots complets de tonnages importants.

Tableau 1 Les filières expéditions de lots complets importants, trafics 2018 (VNF)

<table>
<thead>
<tr>
<th>Filière matériau de construction</th>
<th>Nomenclature Statistique des Transports (NST)</th>
<th>Milliers de tonnes</th>
<th>Millions de tonnes-kilomètres</th>
<th>% tonnes</th>
<th>% t kms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filière agricole</td>
<td>0+1</td>
<td>12 954,70</td>
<td>1 967,50</td>
<td>25%</td>
<td>29%</td>
</tr>
<tr>
<td>Filière énergie</td>
<td>2+3</td>
<td>4 851,10</td>
<td>654,30</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Filière métallurgie</td>
<td>4+5</td>
<td>4 083,30</td>
<td>618,70</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Filière engrais-chimie</td>
<td>7+8</td>
<td>3 511,80</td>
<td>525,10</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Conteneurs, colis lourds, automobile</td>
<td>9</td>
<td>3 921,60</td>
<td>621,60</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>51 688,60</td>
<td>6 691,30</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>


1 En dehors d’événements climatiques défavorables.
Les trafics présentés dans le tableau 1 s’insèrent dans des flux commerciaux de consommation intermédiaire, et, majoritairement, concernent du fret non conditionné, chargé tel quel à l’intérieur des cales. Les exceptions notables sont les marchandises en sacs (comme les farines, le sucre, certains engrais, des matériaux de construction en big bags), en fûts (comme certains produits chimiques) et les marchandises en conteneurs. Colis lourds et automobiles sont des cas particuliers de « vrac ». Ces marchandises, après chargement dans un port, sont acheminées, sauf exceptions (distribution des conteneurs), vers un autre port unique, selon un itinéraire direct sans escales. En effet, la ligne régulière fluviale, avec ses escales fixes, adaptée à la cueillette/distribution du fret de chargeurs multiples, n’existe pas (ou plus) à la fin du XXème siècle\(^2\).

Les flux concernés s’insèrent dans des chaînes logistiques de niveaux international, national, régional, ou, le cas échéant, local. Les envois de petite taille, comme par exemple ceux d’une céréale donnée, correspondent généralement à la capacité d’une petite péniche Freycinet, qui, en port en lourd, est de 250 tonnes. De toutes les filières présentées dans le tableau 1, la filière historiquement habituée des sites portuaires urbains, tout particulièrement en Ile de France, est celle des matériaux de construction (granulats et autres matériaux de carrière).

C’est alors que, à partir des années 2000, le souci d’un développement durable conduit à redécouvrir les atouts écologiques du mode fluvial. Pour contribuer à réduire le nombre de véhicules en circulation, la congestion routière, et les rejets nocifs associés, la politique de transition écologique portée par le gouvernement français suscite des initiatives de fluvialisation à la fois de vrac agro-alimentaires ou industriels sur de nouveaux parcours, et de palettées/colis destinés au cœur des métropoles fluviales. Pour la fluvialisation des vrac sur de nouveaux parcours, on retrouve les caractéristiques évoquées ci-dessus. En revanche, la fluvialisation de caisses mobiles, palettées, colis destinés au cœur des métropoles fluviales, soulève des contraintes propres à la «pulvérisation» des tailles des envois, notamment sous l’influence des pratiques du commerce électronique. En effet, la demande urbaine exige des organisations logistiques autre chose qu’une capacité d’emport importante : elle exige l’aptitude à assurer des livraisons (ou des enlèvements) de détail. Dans la quasi-totalité des cas, il s’agit, pour le transport fluvial, de relier des entrepôts implantés en périphérie des grandes villes et un ou plusieurs quais urbains. L’échelon géographique de l’organisation logistique à mettre en place est donc l’échelon régional : par exemple, pour Franprix, il s’agit de relier l’entrepôt de Chennevières sur Marne à Paris intra-muros, via le port de Bonneuil sur Marne et le quai de la Bourdonnais, dans le 7\(^\text{ème}\) arrondissement. Nous focalisons l’analyse sur ce dernier segment de chaîne logistique. Dans ce contexte, d’épineuses questions techniques, commerciales, organisationnelles, économiques, surgissent. Le tableau 2 fournit quelques indications sur les quantités que la logistique urbaine fluviale actuelle peut avoir à traiter.

### Tableau 2 Quelques caractéristiques des offres de services actuels

<table>
<thead>
<tr>
<th>Nom du service</th>
<th>Nombre de contenus/paniers</th>
<th>Capacité</th>
<th>Tonnage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Franprix (par jour)</strong></td>
<td>26 caisses mobiles, 48 prévues</td>
<td><strong>480 tonnes</strong></td>
<td>reachsteaker</td>
<td>CETE Nord Picardie</td>
</tr>
<tr>
<td><strong>Blue Line Logisticks</strong></td>
<td>198 palettes par niveau</td>
<td>2 niveaux</td>
<td>300 tonnes</td>
<td>grue de bord</td>
</tr>
<tr>
<td><strong>Vert chez vous (par jour)</strong></td>
<td>2000 à 3000 colis</td>
<td>144 m(^3)</td>
<td>14 tonnes</td>
<td>grue de bord</td>
</tr>
<tr>
<td><strong>Màdis</strong></td>
<td>3000 colis par jour</td>
<td>700 m(^2)</td>
<td>information non communiquée</td>
<td>grue de bord</td>
</tr>
</tbody>
</table>

Si la taille d’une petite péniche/barge peut rester pertinente pour un service comme Franprix et Blue Line Logisticks, il ne s’agit plus de chargement en vrac. Franprix transporte des caisses mobiles à la

\(^2\) L’acheminement de conteneurs maritimes au départ et à destination des ports littoraux est l’exception notable de la fin du XXème siècle.
manière de conteneurs maritimes intercontinentaux ; le volume d’une cale « vrac » reste utilisable. Quant à Blue Line Logistics, les palettées sont chargées sur un catamaran spécialement conçu pour cet usage. On sait donc innover, par rapport à l’usage traditionnel de la péniche. Les deux autres services révèlent l’entrée dans le monde du détail, sinon de l’extrême détail (colis type e-commerce). Suivant les traces de Vert chez Vous (qui préparait déjà les commandes à bord de la péniche), Fludis finance la construction d’un entrepôt navigant, qui, outre la préparation des commandes assurée à bord, transportera également les outils de la livraison finale : 30 «cyclofret». La comparaison des services fluviaux urbains révèle que le gréement du moyen de transport fluvial pourrait être une des solutions contribuant au succès commercial et économique de ce type de logistique. En effet, un des éléments technico-économiques difficiles à gérer de l’expérience Franprix est l’ajustement entre la taille de la barge (barge 80 mètres et pousseur), la surface du quai (de la Bourdonnais), et la masse du chariot élévateur de quai sur un espace réduit.

D’un point de vue technique, peut-on utiliser les barges classiques en groupant un maximum d’envois de chargeurs différents, et alors, dans cette éventualité, qui pilote le groupage au départ des entrepôts ? Est-il pertinent de concevoir des mini-péniches adaptées au transport de palettées/colis (ou de conteneurs d’un nouveau type, en transposant le modèle maritime) ? Même la plus petite des péniches Freycinet s’avère inadaptée à de nombreux nouveaux trafics urbains. Le volume journalier que pouvait livrer « Vert chez vous », 144 mètres cubes, ne représente approximativement, que 30 à 40 % d’une cale Freycinet, ce qui laisse entrevoir les difficultés de rentabilisation d’un tel service. La solution adoptée par Blue Line Logistics, celle d’un catamaran, ne convient pas aux colis, qui doivent être protégés des intempéries, contrairement aux matériaux de construction. La solution de l’entrepôt flottant projeté par Fludis ajoute à la barge la fonction « préparation de commandes ».

D’un point de vue commercial, on a affaire à deux types de consommateurs : des consommateurs intermédiaires et des consommateurs finals. Quels éléments de choix logistiques en dépendent ? Les deux grandes catégories de consommateurs sont—à priori—indifférents au type de véhicule utilisé pour la livraison à leur porte, qu’il s’agisse d’un porteur routier classique (Franprix) ou d’un vélo électrique (Vert chez Vous, Fludis). Toutefois, les consommateurs intermédiaires seraient-ils en mesure d’imposer le recours à l’un de leurs transporteurs routiers privilégiés ?

D’un point de vue organisationnel, quel acteur est le mieux placé pour offrir le service fluvial, pour piloter le groupage des lots à livrer, au départ des entrepôts ? Quelles modalités de coordination de la chaîne logistique sont privilégiées ? Pourquoi ? De ce point de vue, les expériences observées restent trop peu nombreuses pour livrer un quelconque enseignement. On peut seulement pressentir, que, d’un point de vue commercial et juridique, un commissaire de transport (coordonnateur de prestataires avec obligation de résultat) comme l’est Dentressangle, promoteur de l’expérience Franprix, est l’acteur le mieux «armé» pour tester les solutions de livraisons de détail incluant un transport fluvial. D’un point de vue économique, les chargeurs n’adoptent pas une solution logistique avec mode fluvial à n’importe quel niveau de prix ; de fait, les acteurs actuellement impliqués dans la logistique fluviale urbaine peinent à atteindre leur seuil de rentabilité privé, et bénéficient de subventions publiques. Quels autres arguments seraient à développer pour emporter leur adhésion ?

La présentation vise à faire le point sur les évolutions observées, et à mettre en perspective les aspects majeurs de cet ajustement du transport fluvial aux attentes de la clientèle urbaine en matière de petits envois. Fondée sur des expériences de logistique urbaine fluviale vécues en France et en Belgique, l’analyse menée met en évidence des leçons à retenir pour de futures initiatives.
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Title:
Sourcing the city by inland waterway transportation, under which conditions?

Full Paper:
Sourcing the city by inland waterway transportation, under which conditions?

Context

The rising concerns regarding sustainable development drive cities authorities to take action to fight pollution and traffic congestion. In this context, could the river play a role in freight delivery within the city? If so, which conditions should river transportation meet to represent a sustainable and desirable alternative to road haulage?

There are successful examples of urban logistics using the river, mainly transporting building materials and waste. Regarding manufactured goods carried in containers, there are only a few European examples, mainly in Belgium, Germany and the Netherlands (Janjevic, Ndiaye, 2014). On the Seine in the Paris area, Franprix is the only company operating a daily urban delivery in partnership with the carrier XPO Logistics. Every day, the company delivers drinks and dry goods in its 300 shops located in Paris and its near suburbs.

From these examples, a generalization is proposed, based on spatial economics.

Method

Using the market area theory (Niérat, 1997) one can compare the competitiveness of an intermodal and a road only supply chain (both described on Figure 1), given a specific context. This context integrates various parameters describing the location of important places (warehouse, multimodal platform, urban port) as well as the supply chain (volume, vehicle type, number of round trips per vehicle).

Fixed and variable costs of each solution define a market area for the intermodal supply chain against the road. This market area is the set of points served at a cheaper cost by the intermodal solution.

We generate a standard scenario, inspired by the observation of existing solutions and interviews with actors from the French river transportation sector. Figure 2 summarizes our assumptions for both supply chains in this scenario. Road costs come from the Comité National Routier, the price of the inland waterway path (barge and handling) is estimated after discussions with carriers. Varying one parameter at a time, one can bring to light the evolution of the intermodal market area and parameter thresholds delimiting the competitiveness of the intermodal solution to serve the city.
Results

Among the variables affecting the profitability of the intermodal solution, we first consider the volume. Volume is defined as the number of containers carried per day from the warehouse to the city. River transportation enables economies of scale, thus is adapted to mass transportation. As a shipper can hardly increase demand, his first restriction for using river transportation is the size of his daily supply.

We only modify volume, starting from the standard scenario. The shipper pays the entire daily price of the boat whatever his load ratio. The comparison of the total costs to serve the city by road or river enables the computation of a threshold volume above which the intermodal solution is cheaper than the road. For the standard scenario, the threshold volume is 34 containers, which represents a load ratio of 71%.

The determination of a volume threshold to reach in order to have a cost effective use of river transportation is a useful tool to target the shippers that could use the river in a given context.

The volume, the type of vehicle (its capacity) and the number of round trips per vehicle determine the competitiveness of a supply chain compared to another. Given these parameters, the number of vehicles needed to deliver the volume for a chosen supply chain can be computed. The number of vehicles thus appears to be one of the major factors influencing the costs of each solution.

Let’s detail as an example the influence on the intermodal market area of the number of round trips per vehicle during the urban delivery step in the city. We consider the warehouse to be far from the city so that road solution vehicles can only realize one round trip during the day. For the intermodal solution, two 44t-trucks realize the pre-haulage (from the warehouse to the multimodal platform).

In the standard scenario, urban delivery vehicles realize on average 3 round trips per day. All other things being equal, the less the number of round trips per vehicle, the smaller the intermodal market area around the city (Figure 3).

![Figure 3 - Market area as a function of the number of round trips made by the delivery vehicles in the city](image-url)

Indeed, the more round trips per vehicle realized during the day, the less the number of vehicles needed to ensure the delivery. And the size of the fleet plays a major role in the estimation of the fixed costs for the intermodal solution. Therefore, when vehicles realize 3.2 round trips, the market area gets wider compared to the standard scenario (in black). On the contrary when the number of round trips decreases, the market area diminishes, and disappears when the number of vehicles needed becomes too large and the fixed costs too high. Thus there is a threshold number of round trips per vehicle above which the intermodal solution is less competitive for all potential points of delivery.

In the case of a small number of round trips per vehicle (2.8), the market area shows the intermodal solution is not competitive in part of the city. Anyway, the shipper may choose to make use of the intermodal solution to serve the whole city, because its global cost is better. However, this is a sign of fragility for intermodal transportation.
The size of the market area is also determined by a time constraint, added to the economic constraint. The greater the number of round trips per vehicle gets, the longer the duration of each round trip. Therefore when the number of round trips per vehicle increases, the economic constraint gets looser and the time constraint gets stricter, limiting the size of the market area.

Moreover, the geographic constraints of the territory have an impact on the logistic solution. These constraints are even more important for intermodal river transportation, limited to the river and highly dependent on ports locations. Three geographic parameters influence the river’s competitiveness: the locations of the warehouse, of the multimodal platform and of the urban port. Depending on the locations of these three places, we determine the existence or the non-existence of a market area. One must not forget that even for a very large market area, the crucial issue is that it covers the final destinations that the shipper wants to deliver.

For the urban port, depending on its location, the market area covers the whole city or only part of it (Figure 4). When the urban port is closer to the multimodal platform, the intermodal solution is more stable because it is more profitable on the whole set of covered points. We see that the market area is located towards the right of the urban port: moving to the left of the figure, the delivery costs of the road solution decrease whereas the urban delivery costs of the intermodal solution increase.

![Figure 4 - Intermodal market area as a function of the urban port location](image)

**Conclusion**

The economic relevance of the river depends on the geographic parameters as well as the logistic ones. A volume threshold must be reached by the shipper for the river to be competitive. Then, the use of the river can help reduce road fixed costs, which constitute a major part of the logistic costs. This modelization enables a visualization of the market area of the intermodal solution in order to determine the influence of logistic and geographic parameters.

This modelization relies on assumptions made about the different costs, data collection being a sensitive topic within the highly competitive sector of river transportation. For a shipper or a carrier with a strong knowledge of the specific settings of a logistic solution, this modelization is an interesting decision-making tool. For local authorities, it can also be used to examine actions promoting the use of river transportation. The sharing of ships between several users where each one of them would pay according to the capacity it uses is an option that could be further examined.

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Title:  
Modeling tidal propagation in Guadalquivir Estuary (Spain). Model output application to vessel navigation.  

Abstract:  
The Port of Seville is an inland harbour located in the Guadalquivir Estuary at 80 km from the river mouth and is the unique Spanish inland port. The estuary is a semi-enclosed body of well-mixed water where tidal force provides enough energy to rise and fall sea level 3,2 m to 1 m at Sanlucar de Barrameda during spring/neap tides and to generate a wave that progresses 110 km upstream. The port operability and vessel traffic in the estuary need to cope with the semidiurnal variability (M$_2$, S$_2$, and N$_2$ make up approximately 75% of the tidal signal) that change the minimum depth of the navigation waterway. The vessel draught and vessel navigation safety can be optimized and improved if tidal dynamics are taken into account.  

A 3D hydrodynamic model has been implemented using an estuary bathymetry and forced by the oceanic tide at the mouth and freshwater discharges. The model has been satisfactorily validated and predicts tidal oscillations with high accuracy (less than 4 cm in amplitude and 20 min in phase everywhere in the estuary).  
The model outputs of tidal heights and currents and several tools developed in MATLAB have been used to develop a Vessel Traffic Decision Support System (VTDSS). This VTDSS tool assesses the effects of tidal propagation on simulated navigation time of several virtual vessels: upstream navigation is favoured around high water as the tide progresses at 12 knots, which is comparable to the vessel speed, thus allowing greater vessel draughts; oceanwards navigation of heavy vessels, on the contrary, is hampered by the tide because a low water level is unavoidably met when heading downstream. This VTDSS also test different traffic scheduling scenarios and different management policy scenarios related with maintenance dredging that support vessel navigation safety.
The computational grid was extended over the entire estuary with 48456 triangular elements (see Table 1 and Figure 1 for more setup details). The model is forced by the oceanic tide at the platform and freshwater discharges controlled mainly by an upstream dam at the head. The meteorological forcing has also been applied.

Table 1. Parameters used in the barotropic model calculations.

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<td>Wind</td>
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</tr>
<tr>
<td>Atm pressure</td>
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</tr>
</tbody>
</table>

Figure 1. Bathymetry of the study area and the high resolution finite element mesh used for the Guadalquivir estuary model, which used 7000 nodes in 9 vertical layers based on Z vertical coordinate.

Figure 2. A comparison of modelled (black line) and real values (dots) of tidal amplitude and phases of M2 (harmonic tidal analysis Matlab toolbox T_tide of Pawlowicz et al., 2002) at several distances (km) from the estuary mouth.

The barotropic model has been satisfactorily validated (Figure 2) and predicts tidal oscillations with high accuracy, less than 4 cm in amplitude and 20 min in phase everywhere in the estuary (see Figure 3). The application developed allows the final users to test different traffic scheduling scenarios in order to assess the effects of tides on navigational patterns. The system is composed of a georeferenced database (Figure 4), a voyage simulator (Figure 5) and data post-processing tools that help to find the suitable departure time (temporary windows). Voyage simulator use a reliable information and forecasts on water levels and currents for an entire route, simplifying output provided by the 3D hydrodynamic model. This tool can also be used to display currents or include them as a parameter that modify the real speed of the ship.
Figure 3. Observed water levels (red line) at the entrance of Seville port (upper left panel) and Bonanza, entrance of Guadalquivir estuary (upper right panel). Water level hindcast (blue line) from Guadalquivir barotropic model. Below, location and details about observation-model differences.

Figure 4. Snapshot of the georeferenced thickness of the water layer database written in matlab. Basically this program stress if there is more depth than a threshold in a specific moment of time in the estuary or not. The panel on the left summarizes the situation in an entire area, while the panel on the right represents the situation in more spatial detail. A binary color code labels with red/green locations with less/more depth than the specified by the user. Water levels at Sevilla, Bonanza and selected area is also displayed.

Figure 5. Snapshot of the voyage simulator that use the spatio-temporal tidal information modelled, mainly thickness of the water layer. Upper panel present the longitudinal position of a vessel that travel at constant speed from Seville to the Gulf. Lower panel stress the thickness of the instantaneous water layer that the ship would find during navigation through the estuary.

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Title:
Navigation with Nature

Full Paper

1 Navigation with Nature

Natural capital assets, such as, rivers provide people with free goods and services, often called ecosystem services. Two of these (clean water and fertile soil) underpin our economy and society and enable human life [1]. Rivers connect places and facilitate waterborne transport. To improve and maximize this service rivers are often trained by structures that regulate the water quantity to suit our needs. The downsides of costly river training works, however, have become eminent as sedimentological processes and biological processes are disrupted, leading to long term effects on ecosystem functioning and ecosystem services. Studies have indicated that less than 20% of the European rivers are still in its pristine state [2].

Recently, the World-Wide Fund for Nature and the Institute of Zoology published the Living Planet Report describing the astonishing decline in the size of wildlife populations in riverine and coastal systems [3]. Amongst the reasons cited are damming of rivers, agriculture and contamination. Clearly, to maintain the socio-economic value of rivers, the necessity to do things smarter increases by working together with nature rather than against it.
In 2008, the World Association for Waterborne Transport Infrastructure (PIANC) published the position paper Working with Nature (WwN) [4]. The new philosophy calls for an important shift in thinking, in the approach to navigation development projects, to help deliver mutually beneficial, ‘win-win’ solutions. It promotes a proactive, integrated philosophy which focuses on achieving the project objectives in an ecosystem context rather than assessing the consequences of a predefined project design and focuses on identifying win-win solutions rather than simply minimising ecological harm.

The same philosophy is reflected in the Building with Nature (BwN) innovation programme of Ecoshape [5]. A Dutch public-private initiative which takes the natural system as a starting point and uses ecosystem services to meet society's need for infrastructure and encourages the development of nature at the same time. Other key elements in its philosophy are sustainability, adaptability and stakeholder involvement. Their knowledge development is through pilot projects. A parallel development has been the Engineering with Nature (EWN) initiative of the US Army Corps of Engineers [6]. Its core objective is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative processes.

Advances in technology that can be applied today, using mobile devices, smart sensors, “big data” and Internet of Things (IoT) are key to enable the implementation of the nature-based solutions that are advocated by WwN, BwN and EWN. They can help us understand the natural processes much better by continuous and online smart monitoring and modelling and they can connect the users and make the users part of the development. Based on these initiatives and thoughts the concept of “Navigation with Nature ®” has been developed. It aims to adapt the means of navigation of vessels to the changing river conditions, rather than adapting the river to the navigation needs using river training works. New sensor technology, smart devices, numerical modelling, and data assimilation techniques allow for the acquisition and integration of data, enabling a dynamic operational management of a fairway. A forecast of the available river depth is made based on actual day-to-day measurements collected by vessels already sailing along a certain route. With this continuous feed of information, ships can follow the deepest part of the river experienced by ships who just navigated this particular route, allowing safe and effective navigation and better planning. Such a solution minimises the need for river training works (e.g. river training woks like groynes and guide bunds or dredging), reduces the dependency on aids to navigation (e.g. buoys) which are very costly and have to be frequently relocated, particularly in a dynamic river, and reduces fuel consumption (by sailing along the deepest parts). It enables WwN, BwN and EWN concepts to be employed and reduces the need for regular maintenance as part of an overall integrated approach. This solution is directly beneficial to both the fleet operators and river managers responsible for investments and maintenance. Fleet operators can reduce their transport costs and river managers can reduce the maintenance costs, by focussing on those areas that matter most and by better planning through increased insight into erosion and sedimentation patterns, as well as achieve their strategic target of improving navigation.

In places were growth is emerging and rivers still have their pristine character, this philosophy can inspire new options for waterborne transport. Such that ships and infrastructure in the supply chain are adapted to the river instead of adapting the river to the waterborne transport.

2 Inland waterway transport Myanmar

Historically, in Myanmar, major cities have developed and expanded along large rivers because access to waterway transport enabled both cargo and passenger movements during a period when
major roads and railways were yet underdeveloped. The largest transport route, economically speaking, is from the river delta of the Ayeyarwady River in the south of the country, from Yangon, following upstream to the confluence with the Chindwin River in the north of the country, continuing to the town of Mandalay and further upstream, with a total length of 1000 km from the sea. The Ayeyarwady and Chindwin rivers have a valuable role in the socio-economic development of Myanmar. They connect cities such as Kalewa, Monywa, Mandalay and Yangon and further north, massive southern China is part of its hinterland. Myanmar is a resource-rich country, most of which, can be transported via water.

The rivers of Myanmar still have a relatively pristine character and due to the extreme differences in discharge during the monsoon and long periods of drought, the rivers are very dynamic. This is characterised by significant variability in water levels (up to more than 10 m) and fairway channel configurations. Resulting in fast and unpredictable channel migrations (see figure 1 for an example of channel migration near Monywa in the Chindwin River, where the river is 1.3 km wide). Due to frequent changes in the navigation channel position, stationary aids to navigation (e.g. buoys or bamboo sticks) and warning signs are difficult to install and relocate. Hence, the risk of vessel grounding is high. This makes navigation on these rivers a complex, unreliable and an unsafe operation and has led to many accidents.

![Aerial images through time of the Chindwin River near the Chindwin bridge at Monywa](image1.png)

**Figure 1** – Aerial images through time of the Chindwin River near the Chindwin bridge at Monywa
From information of the Myanmar Directorate of Water Resources and Improvements of River Systems (DWIR), it can be concluded that in the years between 2004 and 2014 there were 16 accidents per year on average in the inland waterways of Myanmar, with 10 vessels sunk and 21 humans reported dead or missing.

Unsafe navigation and inaccessible ports are impacting operations of national operating shipping companies and fleet operators. On a policy level this concerns two departments within the Ministry of Transport, the DWIR and IWT (Inland water Transport). To unlock the potential of inland waterway transport in Myanmar, improvement of navigation is necessary. By upgrading navigability in the upcoming years, the country can benefit from this transport mode, leading to positive impact on regional economic development.

There are studies ongoing supported by amongst others the World Bank and the Dutch Government focussing on improvement of inland navigation especially on the Ayeyarwady River and although the Chindwin River is until now not the main focus part of those studies, the Ministry of Transport of Myanmar also wishes to improve navigation on the Chindwin River. This is where the research pilot Navigation with Nature® has its focus.

3 The research pilot

The main problem is an unknown water depth combined with an unknown channel location due to channel migration. It is questioned if the traditional solution to completely fix a navigation channel using river training works, including dredging and an aids to navigation, would be the most optimal, sustainable and economically efficient solution to ensure safe navigation. From lessons learned, inspired by WwN, BwN and EWN initiatives, is opted for a solution to control the navigability of the dynamic river through a sustainable hybrid solution, where the river’s dynamic behaviour is untouched and smart crowdsourcing of data is used to provide real-time and forecasted water depths. These forecasted water depths are used to indicate danger and safe zones which allow for safer and more optimal navigation. The “Navigation with Nature®” concept is now implemented by CDR International B.V., in partnership with Deltares and CoVadem from the Netherlands and Mandalay Technology from Myanamar a pilot project on a more than 400 km river stretch from Hkamti to Maolike along the Chindwin river in Myanmar. The pilot project is funded by the Netherlands Enterprise Agency (RVO) and aforementioned parties and supported by DWIR.

In the pilot, echo-sounders and GPS are installed on board of multiple inland vessels. These measuring devices are linked via an onboard universal multiplexing device, the so-called CoVadem box that collects data every second and transmits them to a cloud-service. The data collection and processing techniques, including the data authorisation and security build on experience that has been obtained in an ongoing CoVadem project with about 50 pilot ships along the river Rhine.[7]. Independent of the water depth measurement a hydrodynamic model is set up running in operational mode to obtain real time predicted water levels along the navigation route. The measured real-time water depth, together with the forecasted water levels are used to estimate the water depth for future time steps up to the next 3-5 days. This key information is transferred to a dashboard on a computer and/or smartphone, which ensures easy interpretable visualisation of the information. The skippers in the pilot can access the dashboard through their smartphones, which they currently use to determine their location. Fleet operators can access the information in their offices to use it for planning of shipments. The mobile coverage in Myanmar is sufficient, also along the Chindwin River.
4 Expected results

It is expected that as a result fleet owners can more efficiently plan their journeys and that the service enables them to improve their load factor, due to less uncertainty about the available water depth. The resulting reduction in transport costs enables a business case for the service. Preliminary exploration of the situation already indicates a willingness amongst fleet operators to pay a small fee for the service. In the pilot, the business proposition will be further examined and developed. It would become even more attractive when other parts of the Myanmar waterways could be covered after the pilot. Additional benefits are expected for DWIR. The actual information on the condition of the waterway system will support their monitoring programme and thus their management and maintenance operations.

The implementation of the pilot has started with stakeholder meetings and site visits in the first half of 2019. It was observed that the ships do not have echo sounders to measure water depths. They use experienced captains that can read the river, using gauging sticks, reading waves and water movements and follow other vessels when navigating the shallow parts of the river. Some ships are equipped with GPS and record their path to be able to follow the same path on their return journey. This certainly illustrates the leap forward that can be made through the implementation of Navigation with Nature ® supported by CoVadem. Not only with regard to transport efficiency and planning but certainly just as well with regard to the improvement of navigational safety.

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Optimizing tidal window using ship data records at the mouth of Amazon River, Brazil

The waterway along the Amazon River is one of Brazil’s most important routes for bulk cargo exportation. However, there is a severe draft limitation at the mouth of the river. A mud belt is formed by the deposit of a huge load of fine sediments carried along 1700 km, from the Andes to the mouth. Depths (referred to the mean low water springs - MLWS) are of the order of 10 m at this crossing and vessel draft is limited to 11.5 m.

Water level along the navigation route varies according to the tides. Tidal range varies from three to five meters (Gallo & Vinzon, 2005), with changes also in tidal asymmetry. In order to have 11.5 m of water depth, navigation follow the tidal window. Nevertheless, the knowledge of the tidal amplitude, phase and asymmetry along the waterway is still poor. Navigation without grounding is still possible due to the thick fluid mud bottom layers existing along the cross. The current tidal prediction is made based on a coastal station, “Ponta do Céu”, located more than 100km from the critical crossing area. Information of differences in tidal amplitude and phase referred to this coastal station are provided in the Nautical Chart for a “H Point ”, located about 17km from the critical crossing area in the mud belt.
Information about the draft, speed and UKC reported by ships were preliminary analyzed and it was a first indication that an increase in the draft could be possible. Thus, Brazilian Maritime Authority authorized a draft increase of 0.2 m for bulk vessels with mandatory pilot assistance (MB, 2018). However, that study used tidal information estimated at H Point, without considering the whole tidal propagation complexity. This study aims to extend that study, using a numerical model and a new available data set, improving the tidal prediction along the route and identifying the best timing for the vessels (Baltazar, 2013).

Data of about eighty ships have been analyzed, crossing the mud belt from May 2016 to June 2019. Reports were collected from ships with the previous draft of 11.5 m and the new allowed draft of 11.7 m, and also with lower drafts, up to 6 m. The geographical coordinates, time, the vessel draft, the vessel speed and the recorded UKC, were available. Vessels take approximately 200 minutes for crossing the mud belt. Most of the data consisted of vessels leaving the continent, against the tidal propagation direction.

The numerical model covers a large area, approximately 920 by 1000 km, from the ocean boundary to the last riverine stations. The grid has 22407 elements, with resolutions varying from 94 m to 10725 m. Delft3D numerical code was used in its vertical averaged mode (2DH module) (Deltares, 2014). 17 tidal gauge stations along the coast, including Ponta do Céu station, were used for calibration. However, tidal data along the path was missing for calibration. As a result, the model results were only used to obtain the relative tidal phase among the ship navigation path and reference tidal amplitudes (springs or neaps).

The model was set up in order to cover the time span of ship passages, from 2016 to 2019. From the numerical model results, the high water levels were identified at each grid point and corresponding time. From this information, the time difference between the vessel position and the high water occurrence was calculated. This information is shown in Figure 1 for five examples. It illustrates how the observed depths along the path depend on the tidal window (Figure 1.b).

In general, vessels start crossing the path before the high tide occurring in the middle of the path, as passage 29. However this appears not to be the best strategy. In fact, vessels entering the mud belt near the high tides had higher available depths than vessels sailing with high tides at the middle of the region. Another important factor is the tidal amplitude. Data also showed some consistent trends.

Concluding Remarks

The analysis of this low cost data set pointed out the importance of a better understanding of the tidal propagation. The analysis of the passages indicated a possible further increase of the draft and, consequently, an increase of the ship loading. Data pointed a possible strategy to improve the tidal window optimization. However, there is a large dispersion in the data, with significant amount of inconsistencies in the reported depths. Thus, it was recommended further data collection, using some of the ships that already navigate the path, frequently, installing an external ecobathymeter. This strategy is also including other measurements for obtaining the behavior of the ship when crossing the muddy bottom.
Figure 1: (a) Time difference between the occurrence of the high water tide along the path and the position of the ship (zero means occurrence of the high water tide at the ship position), and (b) ship reported depths along the route.

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The cost of missing depth and depth-related performance metrics

Every day, and every voyage, inland vessels leave behind valuable cargo revenue, experience excess fuel consumption. And what’s more: IWT contractors asking for more detailed performance (environmental) metrics are no longer seldom. Confronted with an increasing demand for improved and motivated insights into climate impact performance, vessel owners experience a growing need to support this.

To optimise operational efficiency, increase cargo revenue and responsibly reduce climate impact; however, the traditional focus is on hard tech innovation. These traditionally come at high investment costs, unclear ROI's and suffer a substantial lack of adequate historical operational metrics to assess and implement effective innovations optimally.

Anticipating conservative revenue damage of 2% in missed cargo revenue, and excess fuel consumption of 5%, this situation would cost a typical Rhine vessel roughly € 25,000. In terms of climate burden, IWT in NW Europe using 5% more fuel than necessary makes for an annual excess climate burden of over half a billion kilogrammes of CO2 each year.

But there is also benefits for other stakeholders. Fairway related stakeholders such as fairway maintenance and monitoring are, in their mainly reactive operations, confronted with increasing costs to maintain service levels. If only there would be a means of efficient continuous additional data collection, their services could transform into a highly service-oriented, proactive approach.

The bottlenecks

The amount of cargo a vessel can take is heavily depending on the minimum available water depth on the intended route. Also, energy efficiency depends on the continuously varying and vessel-specific interaction between the vessel and the river depth profile along the route. The basic requirements for optimisation are, therefore:

Lack of adequate available water depth information;

Available depths are heavily subject to the ever-changing nature of the river bed. Although there is water level information, water depth information is generally missing along the main corridors of the EU IWT network.
- Lack of adequate water depth forecasts;

Existing forecasting models provide forecasts on water level development. They are not targeted on providing water depth information, and thus do not account for the continuous variations of the river bed. Forecasting models have, in general been developed to serve as a means to monitor risk in high water level conditions. Existing models are, however, less adequate for shallow water conditions. Also, climate change induces changes in the river characteristics, leaving current forecasting models to be less accurate in general.

- Lack of vessel-specific performance metrics.

Though on almost any inland vessel some form of performance monitoring is maintained, this is seldom based on accurate measurements. Even less commonly, they are performed in close relation to the related circumstantial conditions, leaving operational improvements to be far from optimal.

- Pro-active fairway maintenance: lack of real-time additional monitoring data

As continuous real-time measurements are generally lacking, leaving fairway monitoring and maintenance to determining the critical spots primarily based on their own measurements. As vessels used for monitoring have no other business model than 'to measure', these measurements come at high costs. And, with a measurement fleet small in number, they cannot provide a real-time fairway covering system for adequate monitoring.

The Origin of CoVadem

From an infrastructure stakeholder perspective, the development of River Information Services (RIS) have seen strong coordinated development. A development of smart technology to support optimisation from a vessel operator’s perspective, however, has been left merely to developments on an individual vessel basis. Parallel to the development of RIS, a robust cooperative system for IWT optimisation developed from a vessel owners’ perspective could enable major improvement in terms of IWT and enhance additional future benefits by supporting further RIS developments.

In 2012, a consortium was formed to challenge the current situation in operational optimisation of inland vessels. That consortium was based on market demand and on a unique combination of a variety of stakeholder perspectives, all feeling restricted by the status quo. Determined to find a solution, a highly qualified team combining both river morphologists (Deltares), vessel hydrodynamics expertise (MARIN), sector organisations, shipping companies and service providers formed to accept this challenge. After successful feasibility studies, they brought together their expertise to develop a working prototype.

Anticipating a shift from a situation where the primary question was merely a feasibility question towards a scale-up problem, in 2018, CoVadem transformed into an independent service provider for inland shipping, and registered as an SME. Although being a separate entity, strong ties are maintained with all partners of the initial R&D consortium, as relevant R&D challenges remain. Incoming data for these partners still provides an exciting 'data field lab' to further develop knowledge and value.

As a company CoVadem aims to support further optimisation of operational efficiency, to maximise on a reduction of climate impact of inland shipping as a whole, and to play a vital role in terms of enabling the introduction of smart, safe and efficient automation in shipping. CoVadem does so by shifting vessel-specific operational knowledge and experience from the crew to the vessel itself in the form of an extensive, ever-growing and vessel-specific, digital set of metrics. CoVadem aims to invest in collaborative research enabling relevant stakeholders to develop, introduce and maintain improved forecasting of river developments.

The idea

Although highly different on almost every vessel, each vessel has several sensors. Up to today, most of these sensors are isolated and for real-time readout only. Each vessel has an echo sounder to provide the skipper with real time information on the available keel clearance.

To anticipate potential grounding risks, timely information is crucial. Having access to the echo sounder of a vessel just ahead of the own vessel would be of more value, as it would allow for the necessary time to
anticipate. If one would have real-time access to a reliable system of the available and forecast water depths at time of departure, vessels would not only be enabled to optimise their path on the river; they would be enabled to optimise their cargo volume as well. In that way, they could save on fuel, optimise cargo revenue and reduce grounding risk from the start of the voyage!

Wouldn’t it be possible to share information between ships in order to realise the needed performance insights in relation to the corresponding fairway conditions? And could we not collaboratively realise an independent, fairway covering platform for actual and forecast water depth information, that allows for more efficient, safer and greener IWT?

The Solution

CoVadem's first aim is to establish a minimum volume of measuring vessels to allow for sufficient continuous coverage (measurement density) of the river in both time and area. To keep introduction barriers as low as possible, CoVadem aims to avoid onboard investment costs for the vessel owner. CoVadem, therefore, provides a device, the CoVadem Box that realises the connection of available echo sounders with a dedicated secure cloud-based data infrastructure.

The CoVadem Box

When a vessel owner agrees to share his echosounder data with the CoVadem network, CoVadem installs a small data acquisition device. The CoVadem Box. The CoVadem Box is developed by CoVadem and allows for easy installation, efficient over-the-air maintenance and secure autonomous operation and data transmission. The Box is designed to provide off-the-shelf compatibility for the vast array of different types of sensors and vessel specific situations seen in inland shipping.

The CoVadem Cloud

Once entering the cloud-based infrastructure, the incoming data are validated, filtered, and uniformed. Then, the data are continuously being enriched with additional data sources and available models. Enriching involves vessel hydrodynamics, river morphology and forecasting models. The raw data are being stored and processed upon request through a straight-through processing procedure, and are then ready for distribution.

Distribution is organised through dedicated API's that allow for application-specific further treatment in the form of analytics and visualisation. As a client, a shipowner uses the platform to find route-specific information on available depths and bridge clearances, generated optimised track information compatible with products as the Argonics TrackPilot. The platform offers the ability to download high-density performance metrics over a selected period, interrelating fuel performance, emission metrics, cargo loads and fairway conditions.

CoVadem Services

CoVadem aims to enable vessel owners to reduce grounding risk, increase cargo revenue, reduce fuel consumption and improve climate performance. The services is continuously available and provides always-up-to-date water depths information throughout the fairway and real time vessel performance metrics. A smart data-infrastructure enables CoVadem and its R&D partners (e.g. MARIN, Deltares) to constantly assess, calibrate data and combine incoming data with both hydrodynamic and hydraulic models describing both vessel and river behaviour. The services consist of the following components, all available on a subscription base (SaaS):

Water Depths information (CoVadem Online)

The CoVadem Online environment is the homeport of CoVadem. Here, the users finds an overview of all relevant water depths, levels and available bridge clearances on the route. Also, the information is presented using a 2D graphical river chart. The information provides forecasts up to six days ahead, besides the real-time information.

ECDIS Integration

To bring its service right there were the skipper needs the information, CoVadem develops real-time ECDIS integration with all major providers in IWT. CoVadem is currently working with Tresco, Periskal, Stentec
and Innovative Navigation to include CoVadem Services in IWT navigation software. CoVadem currently develops a production algorithm that ensures continuous translation of individual measurements into real-time production of standardised bathymetric information layers. (bENC)

Performance Analytics

The service includes real-time and historical performance insights related to vessel and river conditions. These insights enable continuous improvement of operational performance along the route. By relating additional onboard measurements to the fairway condition, and storing these data, CoVadem allows ship owners to translate individual low-value data into hands-on, high-value performance insights that relate to the relevant conditions. In the CoVadem Online environment the user has access to all historic and actual performance values of his vessel(s).

Figure 3 - CoVadem Generated ENC layer

Figure 4 - CoVadem Generated River bed image in ECDIS (Stentec)
Data ethics

Modern technology rapidly shifts towards ‘connected’ models, where user data is acquired and turned into a business by service providers without further involving the initial provider of the data. Although the possession of large amounts of user data provides attractive business opportunities, CoVadem wants his participants to remain in full ownership of their data. With CoVadem, all user-specific data insights are restricted to the participant only.

By participating in CoVadem, a participant consents with a right for CoVadem to use the aggregated, non-user-specific data to provide water depth information. If external stakeholders show interest in vessel-specific data, CoVadem takes position of a facilitator, acting only on behalf of the shipowner. As such, a third party that wants access to specific user data will be relayed to the data owner. Only after the data owner has reached an agreement with this third party, CoVadem can facilitate sharing of the agreed selection of specific data, for an agreed period and with the authorised representatives.

Value development

By continually pushing R&D, CoVadem contributes to a modernised approach enabling reduced risk, higher efficiency, optimised fairway use, smart navigation and minimised environmental impact. For inland shipping, for shipping in general, but also fairway related stakeholders. As to further develop value and unleash the knowledge development potential hidden within its bits and bytes, CoVadem continues its co-operation with the original partners and is constantly looking for new cooperation, both addressing new fields of interest and strengthening the existing service development.

Status Quo

Over the past pre-company years CoVadem gradually increased its fleet of connected vessel from 4 to 40. Converting the R&D driven consortium to a service oriented SME, CoVadem is now growing its fleet to at least 250 measuring vessels on the Rhine in December 2020. CoVadem first targets the Rhine area. When sufficient coverage in both time and surface has been realised, CoVadem will expand to include other rivers. At ships connected to CoVadem are measuring everywhere they sail, CoVadem closely monitors coverage on other fairways. As an example, increasing coverage coverage is seen on rivers like the Maas.
At present, CoVadem collects around million depth records per day, and maintains a valuable database of over billions of records over the past 7 years.

With an increasing customer base and newly started collaborations with fairway authorities, CoVadem already makes for an impressive amount of new data, and aims for further development of both knowledge and derived services, supporting IWT and fairway related stakeholders in their continuous efforts to sustainably improve performance, both in business and in environmental terms.

With a contribution to the Smart Rivers conference in Lyon, CoVadem and partners aim to provide an inspiring insight in the underlying developments, as well as providing an update on the status quo as presented during earlier editions of the conference. Thirdly, being cooperative by nature, CoVadem wants to encourage the realisation of new liaisons strengthening the concept and potential of CoVadem and the data collected.

A word of thanks

Though not directly involved in the realisation of this article, both as a person and on behalf of the company, I would like to say thanks to our great environment of supporters! As CoVadem, we have a great team of people within the own organisation and within partner organisations like MARIN (Arno Bons, Kor Molenmaker and colleagues), Deltares (Rolien van der Mark, Johan Boon and colleagues), Autena Marine, Rijkswaterstaat (Nancy Scheijven, Jan Hendrik Beks and colleagues), BLN (Marleen Buitendijk and colleagues), our clients and many others involved, and always being available to support with their extensive knowledge and inspiration. This article and many of the things we do at CoVadem would not be possible without their involvement.
Contribution of Blockchain-Technology to secure and efficient information sharing in Danube waterway transport

Abstract:

The Danube is a highly important economic area in Europe due to its length and its characteristic to combine ten European countries with the black sea region and through the Rhine-Main-Danube Canal with the ARA region (Antwerp, Rotterdam and Amsterdam). Pre- and end-haulage by other transport modes, causes additional transshipment, leading to higher cost than unimodal transport. In order to compensate these additional costs, Transport on the Danube mostly shows longer distances on average than road transport, which means a high share of cross-border transports on waterways. The fact that not all of the Danube riparian countries are members of the European Union and additionally not all of these countries are part of the Schengen area brings administrative barriers for transport on the Danube when crossing borders. Controls have to be carried out by several authorities in each country at the time a vessel leaves or enters European Union territory. These controls require a lot of manual paperwork, which leads to spending a lot of time and money for all actors participating in international inland waterway transport. Along the Danube, there are 52 forms to be completed manually requesting redundant information. For example the input 'name of ship' is requested about 40 times. Additionally there is no standard in the definition of the terms used in the forms requested by the different authorities and countries, neither within the EU nor beyond. This paper tries to overcome these administrative hurdles in cross-border Danube shipping by implementing a decentralized information-sharing platform based on Blockchain-Technology. Literature review was carried out to gain an overview on the status quo and the possibilities of the Blockchain-Technology. Next we conducted expert interviews to gain insights into administrative barriers and communication barriers in Danube shipping in detail. A qualitative document analysis was carried out to gain a data set diminishing redundant information requested by all parties in form of a minimum of data. We show how a solution for a standardized way of sharing relevant information on ship,
journey, crew, passengers, freight and special cargo based on Blockchain-Technology can be established. Further, we show how information can be standardized along the Danube, within and beyond the European Union in order to establish a common view on the shared data among all relevant Stakeholders in inland waterway transport.
The Danube connects ten countries with each other and shapes one of the most important economic areas in Europe (viadonau 2013). The fact that only a part of the Danube riparian states belong to the European Union or the Schengen area poses the challenge for Danube navigation that border crossings are a time-consuming and costly process due to the different administrative customs and modalities regarding border controls in the individual countries. In addition, border controls are to a large extent also carried out manually in the form of documents to be carried and forms to be completed (Grath et al. 2017).

In concrete terms, the current exchange of information in the form of documents to be presented and forms to be filled in results in administrative expenses, which often mean waiting times for inland waterway vessels at border checkpoints. These administrative barriers, which impair the efficiency and thus the attractiveness of inland navigation in the transport sector, are the focus of national and international transport policy in projects such as NAIADES II, RIS COMEX or DINA. In the course of the JRC Technical Reports to the European Union, processes perceived as particularly inefficient were surveyed in discussions with two major waterway commissions, the NAIADES II Forum, the PROMINENT Consortium and the competent national authorities.

In several processes, a high manual effort through manual information exchange between the authorities was found (Andritsos 2016). All the processes found in the mentioned efforts are laboriously gone through and end with the issuance of certain documents. Information contained in these documents is requested by the various authorities in the form of different forms within the process of controls and inspections at border crossings (Grath et al. 2017). Often these administrative processes are still carried out in paper form and a variety of ways are necessary to obtain all the necessary signatures, permits, etc. These administrative processes lead to delays which are both time-consuming and costly. For this reason, the administrative processes at the border controls are examined more closely.

The individual authorities are also unaware of the inspection status, i.e. which authority has already inspected the ship and for what purpose. As a result, forms with identical contents may have to be repeated, albeit in a different form or listing. By digitally distributing the information in advance in electronic form, the captain's ways ashore and to the individual authorities can be saved and the time spent at the checking border points can be shortened accordingly (Andritsos 2016). As a result, long layovers can be avoided in the course of border controls, which increases the competitiveness of inland waterway vessels.

The length of the Danube and the ability to connect 10 riparian states bring not only advantages but also challenges. The Danube riparian states cannot all be counted among the member states of the EU. Among the Danube riparian states, Serbia, Moldova and Ukraine can be identified as non-EU member states. This means, for example, that the Customs Code of the European Union, which e.g. describes uniform regulations for the levying of import and export duties or the principle of cross-border freedom of movement, cannot be applied in these non-EU member states and controls must be carried out at the EU's external borders (EU Com 2005). In the course of the challenges, the Schengen Agreement and countries that do not belong to the Schengen area must also be mentioned. The Schengen Agreement was created in June 1985 and regulates a common asylum and immigration policy. This agreement abolished checks on persons at the borders of the Schengen states and strengthened the security of borders with third countries. Of the 10 countries bordering the Danube, Croatia, Serbia, Romania, Bulgaria, Moldova and Ukraine are not among the countries that have signed the agreement. This means that at these borders - even if the respective states are members of the EU - personal checks can be carried out, for example on crews. Within the Schengen area, checks are also carried out if, for example, a ship comes from a non-Schengen state (BMDW, status 2017).

We conducted interviews with experts in Danube shipping in order to gain a concrete picture of barriers for a seamless digital information flow in Danube shipping. Within the interviews three barriers for a seamless digital information flow were elaborated. On the one hand, it was seen as a problem in the interviews that the same information was repeatedly queried, which, however, had to be reprocessed again and again in different forms. On the other hand, the willingness of the stakeholders to use a technical possibility for data sharing or data exchange also poses a challenge. Two different points of view were mentioned for this purpose: on the one hand, participants have concerns about the security of sensitive company data when exchanging digital data or when using a common platform for data exchange. On the other hand, due to the complex trades (e.g. resale of the transported goods, which pass through during transport) which occur in international transports by inland waterway, it is sometimes undesirable for authorities to present changes in a digitally comprehensible way. Although these resales of the transported goods are legitimate, they can raise questions with the authorities if, for example, the freight changes ownership several times during transit through Serbia. The national legal provisions, which must permit cross-border exchange of information, were mentioned as a further challenge.
In order to counteract the currently necessary repeated filling out of forms and to be able to represent these processes digitally, it is necessary to generate a uniform, common database. When creating a common database, it is necessary to map all data that is also requested by the individual authorities. As the structures of the forms to be completed and thus the information requested do not yet have a uniform standard, a qualitative document analysis was used to create a data set from the information requested for the currently used forms, which can cover the information requirements of the individual authorities. Therefore, the forms collected and published within the interreg-funded project “DANTE” were analysed. This uniform data set evolving from the qualitative document analysis is therefore intended to facilitate digitisation and the distribution of information.

Within the document analysis, redundancies were identified and eliminated. As an example, the name of the ship can be given, which appears about 40 times in 52 forms. By this reduction of multiple answers, a list was created. This list comprises a number of 134 data fields (= one data field in the evaluation always corresponds to a separate field with information), which cover all information requested by the authorities involved in the border control process. This list is divided into seven superordinate categories:

1. vessel data (43)
2. travel related data (20)
3. data of the team (15)
4. passenger data (15)
5. data on stowaways (7)
6. cargo (18)
7. dangerous goods (16)

We did the subdivision because of the data reference. The individual categories only contain information that can be clearly assigned. Information such as ship number, number of the ship certificate, ship type, ship identification number, etc. are therefore assigned to the category "ship data". The number of information belonging to a category is shown in brackets in the categories. However, the category "passenger data" is not relevant for cargo ships. The category "Data on stowaways" is a category, which contains information which is only requested by Romanian authorities.

This data structure could be the basic standard for an implementation of a Blockchain for a seamless, cross-border, digital information flow in Danube shipping.

As many different Blockchain Solutions for all kind of business processes exist, we tried to elaborate a Blockchain Structure, applying desk research and interviews with experts in the field of Blockchain Technology. We introduced the Blockchain-Experts in the problem field discussed in this paper. There was a common understanding of the problem and how a Blockchain in this case should look like. According to the interviews we divided the properties in four categories. (1) **Blockchain-Type**: Because the Blockchain should run a network of companies and not each participant is allowed to access each information, it has to be a permissioned Blockchain (private or consortium). Whereas it is not important whether this is a Hyperledger-, Ethereum-, Multichain- or other protocol. (2) **Management of permissions**: As economic networks are dynamic constructs there has to be a solution how to manage the permissions of the participants and to manage the adding and dismissing of participants to/from this dynamic network. There has to be a trusted board pre-verifying users in the network using practical or simplified byzantine fault tolerant algorithm (e.g. consensus is $2f+1$ of $3f+1$ where $f$ is the number of faults). (3) **Amount of chains**: In order to ensure smooth operation there should be only one Blockchain protocol. Within a private Blockchain network it is possible to store and share different types of information with authorised participants in different streams. This could probably be a “Freight Stream” or a “Crew Stream” etc. Therefore again, permissions for access the information within the participants of the stream has to be managed. For reading a particular information unauthorized participants in the stream will only see the hash of the information. (4) The European **GDPR**, enforced in May 2018, spells out in clear terms that personal data should be deleted when it is no longer strictly necessary to retain it. In a Blockchain this is not possible because of its immutability. This problem can be solved by only storing the hashes of the information and not the information itself. So the viability of (in this case) the crewmember and its status of certificates, authentification, etc. can be verified in the Blockchain by simply re-checking the hash. When deleting related personal data, the hash still exists but re-checking the hash shows an error.

By implementing a Blockchain for a seamless, cross-border information flow, this structure can work in order to automate and digitize information and create transparency while support trust by a safe information flow.
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Keywords:  
Gyeong-In Ara Waterway, Super-Heavy Cargo, Inland Navigation, Environment-friendly transportation  

Title:  
Sustainable Transportation Using Inland Waterway in South Korea  

Abstract:  
The Gyeongin Ara Waterway was the first canal in Korea. Construction began in 2009 and was completed in 2015, with the waterway commencing temporary operations in 2012. The Korea Water Resources Corporation executed the project. The main functions of the Gyeongin Ara Waterway are flood protection, promotion of green logistics and tourist leisure activities. This study aims at providing suggestions on revitalizing coastal shipping in Korea using the Gyeongin Ara Waterway. For example, heavy cargo cannot be transported over bridges, making the Waterway an ideal solution; the Waterway is also particularly suitable for the transportation of super weight cargo. Further, the social costs of transporting dust-generating cargo from Seoul’s center to its outskirts, can be reduced by switching from road transport to maritime transport. However, in order to exploit the potential of the Gyeongin Ara Waterway project, it is necessary to improve the legal system by introducing a subsidy system for the use of inland waterways, and improving the support available to such eco-friendly logistics systems. 

1. INTRODUCTION  

South Korea (henceforth, Korea) is bounded by sea on three sides, but the inland area is mountainous, and roads are used extensively for domestic cargo transportation. As of 2016, roadways accounted for 91.1% of the total domestic freight transport, as shown in Table 1 [1].

Table 1: Korea's domestic freight transport share (Unit: Thousand tonnes) (Source: [1]).

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Road</td>
<td>1,554,510 (90.7%)</td>
<td>1,546,407 (90.7%)</td>
<td>1,512,700 (90.6%)</td>
<td>1,761,291 (91.3%)</td>
<td>1,799,565 (91.1%)</td>
</tr>
<tr>
<td>Maritime</td>
<td>119,057 (6.9%)</td>
<td>117,860 (6.9%)</td>
<td>117,920 (6.9%)</td>
<td>128,611 (6.9%)</td>
<td>143,227 (7.2%)</td>
</tr>
<tr>
<td>Rail</td>
<td>40,309 (2.3%)</td>
<td>39,822 (2.3%)</td>
<td>37,379 (2.2%)</td>
<td>37,094 (1.9%)</td>
<td>32,555 (1.6%)</td>
</tr>
<tr>
<td>Air</td>
<td>265 (0.1%)</td>
<td>253 (0.1%)</td>
<td>283 (0.1%)</td>
<td>288 (0.1%)</td>
<td>293 (0.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>1,714,141</td>
<td>1,704,342</td>
<td>1,668,282</td>
<td>1,927,284</td>
<td>1,975,640</td>
</tr>
</tbody>
</table>

The Korean economy is manufacturing-oriented; consequently, it was the seventh-largest emitter of greenhouse gases worldwide in 2015, with its per capita greenhouse-gas emission ranking sixth among all
OECD countries. The Korean government has implemented the carbon emission rights system from 2015; in addition, both the government and domestic companies are making efforts to reduce emissions by 37% (25.7% within Korea, and 11.3% in overseas purchases) by the year 2030, in line with the 2015 Paris Climate Accord.

In such a scenario, it becomes necessary to switch from road to maritime transport. The Gyeongin Ara Waterway has also started to realize its potential as a supplier of green logistics. The Hangang River flows through the Korean capital of Seoul, and into the West Sea. However, the political division of the Korean peninsula into South Korea and North Korea, and extensive sedimentation downstream, has limited the use of the Hangang River as a waterway.

![Figure 1: Location of Gyeongin Ara Waterway.](image1)

The Gyeongin Ara Waterway Project is a waterproofing that had been formed for 14.2km from the Gulpocheon water management project, a solution to the frequent flood damage of the Gulpocheon basin, of which a new section of 3.8km connected to the West Sea that is additionally built to form a total of 18km of canal as a basic concept. Primarily, the dual effects of the prevention of flood damage through the formation of the flood control channel and reduction of distribution costs through the freight shipment via the waterway could be anticipated, and secondarily the economic effects from forming tourism and cultural spaces such as waterfront scenery and leisure space can be yielded as well.

![Figure 2: Gyeongin Ara Waterway Diagram.](image2)
The Gyeongin Ara Waterway is mainly divided into three parts: the Incheon Terminal, both a navigation channel and flood control channel, and the Gimpo Terminal. It is composed of a navigation channel starting from Incheon Seo-gu Gyeongseo-dong to Seoul Gangseo-gu Gaehwa-dong, a total of 18km (lower width 80m, depth 6.3m), and Incheon Terminal (approximately 2.8 million m³, 2 lock chamber), Gimpo Terminal (approximately 1.9 million m³, 1 lock chamber), and thirteen bridges connecting the north and south that is traverse a canal. The total project cost of the Gyeongin Ara Waterway is about 2.67 trillion, and it was the starting the construction in June 2009 and completed 2015.

As for the lock chamber which is a vital facility in a canal, the consultation from the DHV Company of the Netherlands and the Dutch national program SIVAK was used to make a simulation of the progress of vessel's passage to examine the appropriateness of the lock chamber size. Korea's indigenous history was reflected to the lock chamber regulating station so that it planned as a landmark with a unique design of a royal robe mast. For main facilities like the Incheon Passenger Terminal the waterfront facilities and rooftop viewing deck are built, and it was planned that the idle land of the lower part of the crossing bridge are made into parks so that it could contribute to enhancing the quality of life of the local residents. In particular, elevators are installed on major bridges, bicycle roads and pedestrian network are connected, and observation towers are built so that the space is provided where citizens can regularly observe the foreground of the Gyeongin Ara Waterway.

In addition, efforts are made to make the Gyeongin Ara Waterway a space which is equipped with environmental and cultural functions that can raise the value of Korea's national brand. Many endeavors are being made so that the waterfront area that is formed from the West Sea to the Hangang River's Gyeongin Ara Waterway is created as a waterfront/cultural space that harmonizes the multiple functions of an environmental, cultural, leisure, tourism functions. Moreover, through the bicycle lands and parkways, by connecting the Soo Hyang eight sceneries in a fan shape, the waterfront complex area that includes the pedestrian network (bicycle, in-line skate, walking trail, pocket park) provided to the local residents.

The Gyeongin Ara Waterway started as the Gulpcheon water control project, has already reduced the flood water level 2m during localized heavy rain of 353mm in the Gulpcheon basin in July 2011, yielding effects that prevented the area prone to floods from getting flooded. Besides these basic achievements, the Gyeongin Ara Waterway was born as a new cultural space since the capital Seoul will be connected to the West Sea, and could provide various regional attractions such as the parkway, Soo Hyang eight sceneries, etc. Also is producing synergy effects that contribute to activating the region's tourism.

The Gyeongin Ara Waterway waterfront scenery plan for the creation of a new waterfront culture, through the waterway from the Hangang River to the West Sea, will introduce a scenery that can enhance waterfront amenities, accessibility which considers various circulation systems that anyone can easily enjoy and usage.
efficiency, and various spatial composition through the introduction of historic symbolism and cultural contents as well as facility programs.

2. OPERATION STATUS

The Gyeongin Ara Waterway is composed of Gyeongin Port, a logistics complex, and the inland waterway. Gyeongin Port consists of the Incheon terminal on the West Sea coast, and the Gimpo terminal on the Hangang River side.

![Incheon Terminal (Gyeongin Port)](image1)

Figure 4: Incheon Terminal (Gyeongin Port).

![Incheon Terminal Logistics Complex (Gyeongin Port)](image2)

Figure 5: Incheon Terminal Logistics Complex (Gyeongin Port).

Incheon terminal, in particular, has a flood gate. The northern and southern logistics complexes of Incheon terminal are both in active use, and the cargo largely consists of products such as steel and wood, parcel
services, machinery, LED appliances, ceramics, and used cars for export. On the other hand, Gimpo terminal, which is adjacent to the capital city of Seoul, has an additional marina (194 berths). There are bike lanes, scenic roads, convenience facilities, and waterfront scenery facilities on both sides of the Ara Waterway.

Figure 6: Gimpo Terminal (Gyeongin Port).

Figure 7: Gimpo Terminal (Year 2017).
Gyeongin port has handled 4.38 million tonnes of maritime freight in the period between its opening in May 2012 and 2018 [2]. The major regular shipping routes from Gyeongin port include China's Tianjin and Qingdao ports, Hong Kong, and Korea's JEJU Island. On the other hand, the irregular service lines are used to transport goods such as wood, stone, iron, and scrap iron from China and Southeast Asia. Ever since the Gyeongin Ara Waterway became operational, special cargo such as heavy weight cargo is being transported through the inland waterway, rather than by road. Between May 2012 and 2018, about 377,108 tonnes of cargo were shipped after a similar switch in transport mode. At present, there are not many vessels in Korea that can pass through the Ara waterway, unlike the situation in Europe. General cargo ships, except barges, need to be renovated. In other words, it is necessary to create freight volume through the introduction of suitable vessels that can pass through the Ara Waterway. In addition, along with the logistics complex behind Gimpo Terminal, which has already become a distribution and logistics centre, Ara Waterway is also expected to create a successful business model as one of the logistics routes in the private sector.

Table 2: Freight Volume of Gyeongin Port (Unit: Thousand tonnes) (Source: [2]).

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
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<tbody>
<tr>
<td>Total(R/T)</td>
<td>3,980</td>
<td>310</td>
<td>537</td>
<td>551</td>
<td>832</td>
<td>828</td>
<td>728</td>
</tr>
<tr>
<td>Container(R/T)</td>
<td>2,620</td>
<td>223</td>
<td>440</td>
<td>364</td>
<td>565</td>
<td>557</td>
<td>371</td>
</tr>
<tr>
<td>Container (TEU)</td>
<td>163,734</td>
<td>13,961</td>
<td>27,446</td>
<td>22,778</td>
<td>35,322</td>
<td>34,802</td>
<td>23,203</td>
</tr>
<tr>
<td>General Cargo(R/T)</td>
<td>1,360</td>
<td>87</td>
<td>97</td>
<td>187</td>
<td>267</td>
<td>271</td>
<td>357</td>
</tr>
<tr>
<td>Cargo of Modal Shift (R/T)</td>
<td>377</td>
<td>13</td>
<td>21</td>
<td>123</td>
<td>103</td>
<td>30</td>
<td>59</td>
</tr>
</tbody>
</table>

3. CASE STUDY: Excavated Soil and Rock Transport Process

The first power plant in Korea, the Dangin-Li Seoul Power Plant, was scheduled to be decommissioned; however, a new proposal was floated to rebuild the power plant underground—the first of its kind in the world—with the above-ground structure being repurposed as an urban regeneration park that was open to the public. The project required excavation, and the underground soil to be transported to a landfill outside the metropolitan area. Seoul has a population of ten million and suffers from severe road congestion. The excavation area is also densely populated, with the riverside and north roads showing extreme road congestion.
Transporting the excavated soil through dump trucks would cause a lot of dust, environmental pollution, and traffic congestion. After a temporary berth was set up near the construction site at the centre of Seoul, the excavated mud and sand from the power plant project was taken there, passing through the Hangang River, the lock chamber of the Hangang River, and the Gyeongin Ara Waterway, before finally being unloaded at Incheon Terminal, where it was loaded into dump trucks and transported to a landfill. A one-way trip took approximately four hours. The route was as follows: Dangin-Li (1) ~ Hangang River (13 km) ~ Hangang River Lock Chamber (2) ~ Ara Waterway (3, 18 km) ~ Incheon Terminal (4) ~ SUDOKWON LANDFILL SITE (Metropolitan Reclamation Area) (5, 5 km). The transport cost of goods moved through inland roads instead of the Gyeongin Ara Waterway, is USD 10,737,445 (over ten million dollars).

Figure 9: Underground Power Plants.

Figure 10: Transport Routes of Excavated soil and Rock.
Table 3: Expenses for Mud and Sand Inland Transport.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Detail</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Seoul Combined Cycle Power Plant (Dungin-Li Power Plant) → SUDOKWON LANDFILL SITE (Metropolitan Reclamation Area)</td>
<td>38 km</td>
</tr>
<tr>
<td>Quantity of mud and sand</td>
<td>1,219,331 tonnes in total; 5,040 tonne a day; 242 days; 630 tonne per hour; 10.5 tonne per minute, Dump truck capacity: 24 tonne/unit; 210.53 units/day; 26.32 units/hour; loading time: 2.28 min/unit</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>35 km/hr.</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>65.14 min</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Quantity: 1,219,331 tonnes × unit price USD 8.81 (€ 8.03) (24 tonne dump truck) = USD 10,737,445 (€ 9,791,562)</td>
<td></td>
</tr>
</tbody>
</table>

When Gyeong-In Ara Waterway is utilized, the total expense amounts to USD 11,068,147.

Table 4: Expenses for Mud and Sand Maritime Transport.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dump Truck Transport (24 tonnes): L=0.1 km</td>
<td>1,219,331</td>
<td>Tonne</td>
<td>USD 224,365 (€ 204,600)</td>
</tr>
<tr>
<td>2. Access Road: H=7.0m, L=11m, B=7.0m</td>
<td>77</td>
<td>m</td>
<td>USD 82,803 (€ 75,509)</td>
</tr>
<tr>
<td>3. Hopper Base: Plain Concrete 10*10</td>
<td>50</td>
<td>m</td>
<td>USD 3,269 (€ 2,981)</td>
</tr>
<tr>
<td>4. Conveyor: L=126m (800 tonne/hr.)</td>
<td>1</td>
<td>set</td>
<td>USD 855,563 (€ 780,195)</td>
</tr>
<tr>
<td>5. Hangang (River) (water stream) use rates: 11 months + 2 ships</td>
<td>22</td>
<td>vessel</td>
<td>USD 2,802 (€ 1,899)</td>
</tr>
<tr>
<td>7. Stop work in barges (excavator): 2/3 of the total quantity</td>
<td>812,887</td>
<td>Tonne</td>
<td>USD 348,493 (€ 317,794)</td>
</tr>
<tr>
<td>8. Dredging of lighters wharf</td>
<td>88,000</td>
<td>Tonne</td>
<td>USD 172,058 (€ 156,901)</td>
</tr>
<tr>
<td>9. Berth facility construction</td>
<td>1</td>
<td>set</td>
<td>USD 1,442,798 (€ 1,315,699)</td>
</tr>
<tr>
<td>10. Offices, safety maintenance fees, etc.</td>
<td>11</td>
<td>month</td>
<td>USD 400,308 (€ 365,044)</td>
</tr>
<tr>
<td>11. Dust-proof film, sludge</td>
<td>1</td>
<td>set</td>
<td>USD 430,145 (€ 392,252)</td>
</tr>
<tr>
<td>12. Unloading in the metropolitan land after dump truck loading (5 km)</td>
<td>1,219,331</td>
<td>Tonne</td>
<td>USD 1,748,878 (€ 1,594,816)</td>
</tr>
<tr>
<td>13. Shock-proof material: Gangbyeon Expressway bridge, berth facility</td>
<td>14</td>
<td>set</td>
<td>USD 27,701 (€ 25,261)</td>
</tr>
<tr>
<td>14. Bollard</td>
<td>2</td>
<td>ea.</td>
<td>USD 826 (€ 753)</td>
</tr>
<tr>
<td>15. Silt protector</td>
<td>1</td>
<td>set</td>
<td>USD 73,985 (€ 67,468)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37,710</strong></td>
<td></td>
<td><strong>USD 11,068,147 (€ 10,093,132)</strong></td>
</tr>
</tbody>
</table>

Assuming that the temporary berth facility at Hangang River is not demolished and instead put to permanent facility use, maritime transportation would result in cost savings of USD 1,112,095 compared to inland road transportation. According to an estimate by the Korea Shipping Association [3], savings in ‘social’ and transportation expenses could be as high as USD 899,414. ‘Social expenses’ include costs generated due to road damage, car accidents, traffic congestion, etc. A study by the Korea Maritime Corporation (2014) shows that, when land transportation is replaced by sea transportation, various social costs such as high road transport cost, traffic congestion cost, traffic accident cost, road breakage cost, air pollution, and noise damage cost are reduced; the study also concludes that it is necessary to consider such social costs in addition to simple transportation costs.

The social cost above has been calculated by multiplying the cost saving of 123.3 won/tonne-km—which is the difference between the cost of road (139.2 won/tonne-km) and coastal shipping (15.9 won/tonne-km)—and the total cargo volume of 1,219,331 tonnes—which is the difference between the road (782.79 won/tonne-km) and coastal shipping (48.67 won/tonne-km). The resultant reduction in costs is USD 899,414. The economic analysis of the Korea Shipping Association estimates the reduction in transportation cost to be USD 9,625,349, assuming general maritime transportation conditions such as normalization. In addition, because there was an excavation point in the centre of Seoul, it was decided to use Gyeongin Ara Waterway for marine transportation due to traffic congestion and environmental pollution.

4. CONCLUSION
The Gyeongin Ara Waterway project is the first artificial canal in Korea, and has a complex function; however, it lacks the proper features for maritime transportation. Through this study, we have tried to find cargo that can be transported over water, rather than land, to establish the waterway as a sustainable, ‘green’ transportation route. There has been a steady increase in traffic volume since the construction of the Ara Waterway; it has become a transportation route for cargo from the metropolitan area, such as heavy weight cargo, which is difficult to transport over bridges.

In this study, we also examined how soil excavated from beneath the Seoul power plant was transported to the metropolitan landfill through the Ara Waterway, assuming that the commercialization of temporary dock facilities on the Han River can greatly reduce socioeconomic costs, including the reduction of social costs such as traffic accidents, CO2 emissions, and traffic congestion. To cope with the increase in traffic costs and environmental pollution due to rapid urbanization, it is necessary to find an active use case for the Gyeongin Ara Waterway as an eco-friendly transportation route in Korea.

To this end, South Korea should review social funds (IWTF: Inland Waterways Trust Fund [4], CF: Cohesion Fund, TEN-T: Trans-European Transport Networks [5], ERDF: European Regional Development Fund [6]), improve legal systems, subsidize coastal freight, increase subsidies for modal shift, and expansion supplying non-taxable oil. Especially, if the redevelopment of the metropolitan area in Seoul, which is a Mega City, continues, the Ara Waterway will facilitate the transportation and discharge of the mud and sand from the Han River to the Yellow Sea.

REFERENCES

Title:
Les enjeux logistiques pour la réussite du projet de canal Seine Nord Europe

Les principaux chiffres du chantier
Le projet du Canal-Seine-Nord-Europe au gabaret européen Vb entre Compiègne et Aubencheul-au-Bac est le maillon central de la liaison Seine-Escaut. Long de 107 km, il ménagera un rectangle de navigation de 38 mètres x 4 mètres, et une hauteur libre sous les ponts de 7 mètres. Les 6 écluses de 195 m de longueur utile et 12,50 m de largeur séparant les 7 biefs de l’ouvrage auront une chute allant de 6,40 m à 25,71 m. Elles seront conçues de manière à permettre la construction d’un deuxième sas pendant la phase d’exploitation.

Le schéma d’alimentation en eau du canal prévoit que seules les pertes par évaporation et infiltration seront compensées par des apports, l’eau nécessaire aux écluses étant réutilisée après remontée par pompage de bief à bief. L’objectif de perte maximum par infiltration a été fixé à 0,66 m3/s.

L’alimentation en eau du canal sera assurée par un prélèvement dans l’Oise et par un bassin réservoir d’une capacité de 14 millions de mètres cubes.

Figure 1: CSNE maillon central du réseau fluvial européen
Figure 2: escaliers d'eau du projet

Le projet générera 57 millions de mètres cubes de mouvements de terres, nécessitera la construction d'un pont-canal de 1.330 ml, de 61 ouvrages de réétablissements routiers et ferroviaires, et sera, pour le secteur du BTP, le plus important chantier de construction en Europe dans les années à venir.

Les enjeux logistiques nécessaires à sa construction sont à la hauteur du gigantisme de ce projet :
- 10 à 13 millions de tonnes de fourniture de granulats pour la fabrication des bétons, pour les besoins en terrassement, en étanchéité et en voiries ;
- 1,5 million de tonnes de besoins en matériaux pulvérulents (chaux, ciments, liants);
- 200 000 tonnes d’armatures et de structures métalliques pour la construction des ouvrages;
- 5 à 10 millions de tonnes d’évacuation de déblais excédentaires.

La répartition temporelle des flux des fournitures projet et des déblais excédentaires à évacuer a été estimée ci-dessous :

Figure 3: flux prévisionnel de matériaux pour la contraction
La réflexion sur les enjeux logistiques de ce projet tient compte de nombreux critères dont le maillage et les caractéristiques des infrastructures de transport connexes, la disponibilité en unités de transport, la concomitance avec d’autres grands projets d’infrastructure consommateurs en ressources (Grand Paris Express, Mageo…), l’impact des flux logistiques sur les riverains, la prise en compte de critères environnementaux etc.

**Les limites du transport routier**

Le projet du Canal Seine Nord Europe intercepte une soixantaine de voies routières mais en dépit de ce maillage, l’accessibilité du chantier est contrainte dans certains départements par le nombre limité d’axes routiers structurants à proximité de la trace (qui font porter un risque important de saturation du trafic) et par des limitations de tonnage sur les ponts existants.

D’autres paramètres extérieurs contraignent également l’usage des axes routiers. C’est notamment le cas des tronçons situés en zone périurbaine, sensibles aux nuisances.

**Le report modal : contexte et enjeux**

Dès lors, le recours à des modes de transport alternatifs à la route s’impose pour permettre la réalisation du projet dans des conditions favorables.

De plus, la configuration du projet se prête à cette stratégie de report modal en raison notamment de :

- la proximité du chantier avec les canaux existants et leurs réseaux de quais (le chantier longe le canal du Nord sur 90 km) ;
- La construction de plusieurs ouvrages importants, très consommateurs en matériaux et proches de la voie d’eau (écluses, ouvrages d’art non courants, grands confortements) ;
- La proximité des sources d’approvisionnement avec le fer ou la voie d’eau (carrières de granulats, cimenteries…).
Cette stratégie répond par ailleurs à l’objectif de redynamisation du transport fluvial en particulier dans le bassin Seine-Escaut et préfigure les ambitions d’augmentation de trafic à l’ouverture du canal. Elle répond enfin à l’objectif de réduction de l’impact environnemental porté par la société de projet qui s’est engagée dans une démarche de certification HQE.

Figure 4: proximité du projet avec les voies d’eau et les voies ferrées
Cette stratégie répond par ailleurs à l’objectif de redynamisation du transport fluvial en particulier dans le bassin Seine-Escaut et préfigure les ambitions d’augmentation de trafic à l’ouverture du canal. Elle répond enfin à l’objectif de réduction de l’impact environnemental porté par la société de projet qui s’est engagée dans une démarche de certification HQE.

Pour relever ce défi, la SCSNE a identifié un certain nombre d’actions prioritaires à mener. Ce sont en substance :

- la sécurisation de la chaine logistique (plateformes, zones de stockage, quais) ;
- l’anticipation des moyens à mettre en œuvre en matière d’offre de transport en coordination avec les acteurs des filières logistiques et les fournisseurs ;
- l’introduction de dispositions d’incitation au report modal dans ses marchés travaux.

**Sécurisation de la chaine logistique**

En concertation avec VNF et SNCF Réseau, la SCSNE a initié une stratégie de sécurisation de la chaine logistique en vue de créer les conditions favorables à l’utilisation de la voie d’eau et du fer. Les actions consistent :

- à s’assurer, en accord avec VNF, de la disponibilité des quais existants pendant les travaux (convention AOT/OSP) et de leur adéquation aux besoins du chantier ; à ce titre, une étude a été menée pour identifier les capacités portantes des quais existants et les besoins d’aménagements nécessaires ;
- à compléter l’offre de quais dès le début de l’opération en anticipant la construction des infrastructures neuves prévues dans le cadre du projet (cas où le nouveau canal est un élargissement du canal existant) ;
- à s’assurer auprès de VNF de la disponibilité de plateformes bord voie d’eau et initier des actions de maîtrise foncière de zones de stockage ;
- à réserver, en partenariat avec la SCNF, des plateformes embranchées fer qui permettront l’acheminement des matériaux de fourniture extérieure (en particulier, les matériaux pulvérisants).

**Disponibilité de l’offre logistique**

Les objectifs de la SCSNE en matière de report modal fluvial ne pourront se concrétiser que si l’offre logistique est adaptée en nombre (unités de transport) et en flexibilité (approche multimodale). Or, on assiste depuis de nombreuses années à une mutation de la flotte marquée par la diminution du nombre d’unités de transport et par une proportion accrue de bateaux de grande capacité. La disponibilité de l’offre logistique et son adéquation avec les besoins du projet apparaissent donc comme les contraintes majeures dans un contexte de raréfaction de la cale adaptée au canal du Nord.

Pour y remédier, les différents engagements pris par la SCSNE seront accompagnés de points d’information auprès des chargeurs et opérateurs fluviaux en amont de l’attribution des marchés travaux. Ces réunions permettront d’échanger sur les objectifs de report modal envisagé, les volumes en jeu et le planning prévisionnel afin de permettre à ces acteurs d’anticiper la structuration de leur offre (construction de nouveaux bateaux, recherche d’innovation…).


Le projet Multiregio a 2 composantes : un volet barge et équipements portuaires mobiles et un volet infrastructures et équipements fixes portuaires complémentaires sur certains sites.


*Figure 6: prototypes de barges Multirégio*
Enfin, la SCSNE travaille en partenariat avec VNF dans sa recherche de synergie entre les flux de transport sortant du chantier et les besoins des industriels et des chargeurs régionaux. A ce titre, elle participe à la démarche d’identification des flux préférentiels des matériaux (évacuation et approvisionnement) nécessaires pour le chantier.

**Incitations au report modal**

L’enjeu de cette réflexion consiste prioritairement à fixer des objectifs quantitatifs de report modal réalistes qui permettront de garantir la faisabilité du projet dans des conditions financières acceptables. Concrètement, la SCSNE définira au cas par cas dans ses marchés travaux des objectifs de report modal sur la voie d’eau ou le fer. Parmi les critères qui entreront en ligne de compte, citons notamment :

- Pour les évacuations de déblais excédentaires : la proximités et la disponibilité des exutoires ainsi que leur positionnement par rapport à la voie d’eau et au fer ;
- Pour les approvisionnements en granulats et en structures métalliques : l’existence d’ouvrages très consommateurs en fourniture proches de la voie d’eau, les besoins inhérents à leur construction et la localisation des carrières et usines préférentielles ;
- Pour l’approvisionnement des matériaux pulvéruents : la disponibilité de plateformes ferroviaires à proximité du site et l’éloignement du chantier par rapport aux sites fournisseurs .
Container logistics in Paraguay, Terport case

Abstract:
Paraguay is a landlocked country that is connected to intercontinental trade throughout shallow natural waterways with hydrological regime, which limits river transport to barges and inland vessels. Despite this, most of the 3,500 barges that navigate this waterway system transport grains, which is a core economic driver in the region. However, container throughput has experienced a very significant growth in Paraguay during recent years. In 2011, container throughput was around 145,000 TEUs while in 2018 this number rose to 220,000 TEUs, which implies 50% growth in 7 years. Such is the growth of this type of cargo in the Parana-Paraguay waterway that, in December 2018 arrived, by means of cabotage transport, containerized cargo to Bolivia for the first time ever.

In order to keep its leading position, Terport, top one private port of Paraguay (according to Paraguayan customs), has decided to invest 40M US$ in a new inland port in the city of Villeta, located around 40 Km downstream of Asunción, capital city of Paraguay. Its first phase is developed in an area of 17 ha, however it accounts for expansion possibilities up to 150 ha. It has 200 m quay wall (deck on piles) with two berthing positions for one barge plus 104m-length vessel with the chance to expand up to 300 m. The initial capacity of this port is 45,000 TEUs up to maximum of 150,000 TEUs in 20 years.

The case study refers mainly to Terport’s new port design criteria, execution design of special civil works, construction challenges and its logistic position in the container throughput in Paraguay and the region.

1 INTRODUCTION
Analyzing the road transport maps, the no-existence of railway and the inland condition of the country, we can assure that containers transportation through Paraguay/Parana waterway is a convenient alternative. Although only 2 rivers are navigable in Paraguay, they pass through the most important cities of the country.
The main objective of this paper is, on one hand, to describe the main characteristics of the waterway and the container logistics of Paraguay, and on the other hand, to identify the strengths and weaknesses of the system as a whole.

2 PARAGUAY/PARANA WATERWAY

As an inland country, the Paraguay/Parana waterway is the only waterway corridor for the import/export of products in Paraguay. This waterway link five countries: Bolivia, Brasil, Paraguay, Argentina and Uruguay. From Km 0 (located in Buenos Aires Port) to Km 1238 (Confluence) is mostly Argentinian jurisdiction. The guaranteed depths in this length are the following:

- Buenos Aires to Rosario (Km 416): 34 feet
- Rosario to Santa Fe (Km 580): 25 feet
- Santa Fe to Confluence: 10 feet

Argentinian government have a concession carried out by a private company that maintains the mentioned depths shown and the aids to navigation.

![Figure 1: Parana/Paraguay waterway](image1.png)  ![Figure 2: Containers Ports in “Central” state](image2.png)

In the confluence point, the river is divided in two main branches, the Paraguay River and the high Parana River. The Paraguay River is navigable all the way to Bolivia and the Parana River up to hydroelectric Itaipu, located near the city of Hernandarias. The Paraguay/Parana waterway treatment stipulates that the Paraguay River from confluence to Apa River must offer 10 feet of guaranteed depth and from there on 8 feet. The same happens in the Parana River, which it’s supposed to have 10 feet depth from confluence to Itaipu.

The Paraguay River, that is more important than Parana in terms of container transport, has 6 critical zones for navigation from Pilar to Asunción. Paraguayan government does not have a concession for dredging these critical zones, but every two or three years call for tender for these works. This process sometimes is not quick enough regarding the high sedimentation process observed downstream the Bermejo and Pilcomayo river outlet.

Taking into account these facts, we can infer that is necessary to enforce dredging maintenance plans and aids to navigation.

3 CONTAINER LOGISTICS

Since the approval of the Nº419/94 Law (Paraguay) the container logistics has experienced a great growth.
All the data shown below was provided by the “Asociación de agentes maritimos del Paraguay” (ASAMAR). From 2011 to 2017 the total TEU movement (FULL+MTY) has increased by 60,502 (42%), from 145,412 to 205,914. As it is common in some countries in South America, the number of returned empty containers are usually high. They represent 30% of total container movement, which raise the transport prices. This high percentage is due to the relation Export/Import, which rounds 40%.

Most of container logistics is centered in Asunción, only 2% of the total movement is done through Pilar and there are no container ports on the Paraná River (on Paraguayan side). In 60 km of the Paraguay River (Figure 2), are located 7 container ports. These ports are feeders of two main ports, in order to do global shipping, which are Buenos Aires port and Montevideo Port.

Buenos Aires and Montevideo Ports attend almost the whole vessel and barge fleet. There are 25 small size vessels and 18 barges belonging to 14 shipowners. This fleet has the capacity of 16,118 TEU.

The inland shipping companies obviously have trade agreements with global shipping companies, of which who tops the list is MSC with 37%, Hapag Lloyd in second place with 16%, Hamburg sud with 13%, Maersk 10% and the 24% remaining is composed by 8 companies with less than 10% each.

The container movement is very small in comparison to other countries in the region. However, the experienced growth has shown that Paraguay has great potential.

4 TERPORT CASE

According to customs statistics, the custom office located in Terport is the Nº1 collector in terms of tax income in 2017. It exceeds its main competence by 60%, which is also a container port (Caacupemi). In order to keep its leading position, Terport has decided to invest 40M US$ in a new inland port in the city of Villeta. The Phase A, which has been inaugurated in October-2018, consists in a 200m quay wall and two dolphins for two berthing positions for the vessels and barges mentioned before (Loa max: 130 m). Two fixed cranes 45x33 m and two additional anchor rings for future expansion. Cone defenses with frontal steel pile driven into the ground.

The container yard is divided in a 5-hectare for FULL containers with two RTG’s, and enough remaining width for the installation of 2 additional units, and a 2.5-hectare for MTY.

A 7000 m2 consolidation area next to a 1700 m2 warehouse. A 6-lane gate with two truck scales, one for import and one for export.

The port has the actual capacity of 45,000 TEUs, which is 25% of the actual container market in Paraguay.
<table>
<thead>
<tr>
<th>Owner</th>
<th>Vessel Name</th>
<th>Built/Rebuilt Year</th>
<th>Flag</th>
<th>Type</th>
<th>Loa (m)</th>
<th>B (m)</th>
<th>Capacity in TEUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ava Payagua</td>
<td>2009 PY</td>
<td>TUG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PAR 6001</td>
<td>2007 PY</td>
<td>BARGE</td>
<td>85</td>
<td>24</td>
<td>382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clara B</td>
<td>2011 PY</td>
<td>TUG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PAR 10002</td>
<td>2010 PY</td>
<td>BARGE</td>
<td>100</td>
<td>27</td>
<td>511</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raul D</td>
<td>2012 PY</td>
<td>TUG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PAR 10001</td>
<td>2012 PY</td>
<td>BARGE</td>
<td>100</td>
<td>27</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carmen S</td>
<td>2016 PY</td>
<td>TUG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PAR 10003</td>
<td>2016 PY</td>
<td>BARGE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Explorador</td>
<td>1970 PY</td>
<td>VESSEL</td>
<td>114</td>
<td>20</td>
<td>486</td>
<td></td>
<td></td>
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<tr>
<td>Nautic Twin</td>
<td>2016 PY</td>
<td>VESSEL</td>
<td>120</td>
<td>30</td>
<td>728</td>
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<td></td>
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<tr>
<td>Doña Veronica</td>
<td>1991 PY</td>
<td>VESSEL</td>
<td>109</td>
<td>15</td>
<td>320</td>
<td></td>
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<tr>
<td>Doña Magda</td>
<td>2007 PY</td>
<td>VESSEL</td>
<td>132</td>
<td>17</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAP 6001</td>
<td>2007 PY</td>
<td>BARGE</td>
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**Figure 7: Container ship fleet**
One of the advantages of the site of the port is that has plenty of expansion area. Around 17 hectare occupies Phase 1 of the port, but they have 150-hectare to expand the yard and consolidation areas. In addition, the quay wall can be expanded to 280 m, which represents an additional berthing site. It has been estimated that the capacity of the port in Phase 3 rounds 150,000 TEUs.

Another advantage is directly related with the type of human activities in the zone. Many of the ports in Paraguay are usually installed in places surrounded by residential areas. Over time, the commercial activities and the cars traffic hinder the arrival of trucks to the ports. In the same way, trucks destroy city’s pavement because they aren’t design for that type of loads, product of a poor coordination between the government and the ports. As Terport is located in an industrial zone, none of these problems exists, so the port activities are carried out without major inconveniences. In fact, over time more and more ports are moving to this type of areas, such is the case of Puerto Seguro and Caacupemi (in project execution).

In conclusion, the container ports in Paraguay, especially Terport, are preparing for future demand.

5 CONCLUSIONS

The Parana/Paraguay waterway is essential for container transport. As an inland country, the containers need to do transshipment in Argentinian or Uruguayan deep water ports. From confluence to Rio de la Plata (Argentina), the guaranteed depth and the aids to navigation are well maintained through a concession. From confluence on, there is no regular maintenance of the guaranteed depth and the aids to navigation. Besides the dredging necessity, there is no coordination between the authorities and the private ports, leading to a disordered growth. This usually hinder ports activity in terms of port accessibility and the noises of port operation might cause discomfort in nearby homes.

Despite all mentioned, container logistics in Paraguay has shown that it has great potential due to developments in terms of container movement. Besides, there are many private ports willing to make investments to continue the development in this area.
Title:
USING AUGMENTED REALITY TO TRANSFER KNOWLEDGE ABOUT INLAND WATERWAY LOGISTICS

A typical capacity building process covers the development of abilities, structures, strategies, establishment of an organizational attitude and the acquisition of skills and competence to allow effective transfer of knowledge. The capacity building process – also used within the project REWWay (Research and Education on Inland Waterway Logistics) and RETrans (Research and Education on Transport Logistics) - has been defined to guarantee a harmonized level of knowledge by using an interactive and innovative augmented reality learning app called “Logistify”. The goal of this paper is to show how an augmented reality gaming app can be used to transfer knowledge and create awareness about inland waterway transport.

The augmented reality application ‘Logistify’ aims to train people who are currently doing a training on logistics or who are working in the logistics sector. Previous studies found that information about inland waterway transport hardly transferred in logistics education (e.g. Putz & Schauer 2014). The results of these studies indicate that few teaching units deal with the topic transport in general. Whereas most of these units focus on road, only few describe and discuss sustainable alternatives such as inland waterway or railway. To tackle the lack of knowledge of inland waterway logistics, innovative teaching methods and (gamified) online applications are intended to attract students (e.g. Kapp, 2012; Putz et al., 2018).

Therefore, the augmented-reality app Logistify\(^1\) was developed to increase knowledge about inland waterway transport in a gamified way. The app has successfully been used within the projects REWWay and RETrans

\(^1\) For a short video introduction see also: https://www.youtube.com/watch?v=7K0n5qlBf8
to train various age groups with different educational backgrounds. Augmented reality has been frequently applied in educational settings (Wu et al, 2013). The main advantage of ‘augmented reality’ is that it allows users to merge the real with the virtual world in a playful manner, particularly when it comes to complex logistics solutions with a focus on inland waterway transport. In addition to a comprehensive background information on different means of transport and the illustration of job profiles in the logistics sector, the promotion regarding modal shift towards sustainable modes of transport was given a high priority.

Figure 1 shows the game plan for the first game. The gamers have to decide which transport mode is the most appropriate based on the length, the type of goods and the amount.

Figure 1: Game plan for game 1 “Choose the transport“

Figure 2 illustrates how the view changes with augmented reality compared to the static view of figure1.

Figure 2: Augmented reality from game 1 “Choose the transport“

The use of the tablet with the game plan is presented in figure 3.
Figure 3: Students gaming and learning using LOGISTIFY

Figure 4 demonstrates the correct results of the transport chain in the second game.

Figure 4: Augmented reality from game 2 “Transport Chains”

The third game is designed similarly to a WhatsApp-chat and introduces different types of jobs in the transport sector. Also the boatman is presented.
By using augmented reality technology, as part of the modal shift process towards the use of inland navigation, the necessity to increase the knowledge and competence of the users for being capable of providing information on how to integrate inland navigation into transport logistics solutions will be boosted. By promoting inland navigation, persons with a connection to the logistics sector should become aware of inland waterway transport as an environmentally friendly transport alternative. This should lead to a shift towards inland waterway.
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Acknowledgement

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Keywords:  
Cybersecurity, cyberpreparedness, digitalisation  

Cybersecurity in Inland Navigation  
PIANC Task Group 204  

Since the end of the last century, the number and the complexity of navigational and information equipment on inland navigation vessels and for inland navigation infrastructure have increased dramatically. Information and Communication Technology (ICT) is transforming shipping, bringing enhanced monitoring, communication and connection capabilities and thereby facilitating the development of new generations of intelligent transport systems, including automated inland navigation vessels.  

While there is already substantial activity on cybersecurity, which is understood as the protection of the aforementioned ICT enabled environment, in maritime navigation (relating to management of shipping companies, vessels, ports, etc.), important inland navigation stakeholders may even not be aware of the cyberrisks for the functioning of the inland navigation system.  

PIANC Task Group 204  

Therefore, PIANC, via its Inland Navigation Commission, established Task Group 204 to produce an Awareness Paper on Cybersecurity in Inland Navigation. This paper, published in January 2019, provides an overview and stimulates feedback on the cyberrisks for inland navigation including its infrastructure, and on mitigating measures, taking into account work in neighbouring fields, such as maritime transport and ports management. The pursued objective is to raise awareness for cybersecurity in inland navigation among practitioners in the management of inland waterways, ports, as well as shipping companies.  

Content of the Awareness Paper  

The paper deals with the following:  
• Wider context: cyberpreparedness across industry (in the economy as a whole, organisations are not considered adequately prepared to deal with cyberthreats; shipping industry behind others; complexity of ICT systems within the shipping industry is a recurrent theme – preference for risk-management approach; a fragmented governance/regulatory picture; growing concerns regarding data protection)  
• Systems currently in use (vessel control; navigation; infrastructure control systems), cyberrisks and mitigation measures  
• Possible future technologies (such as automated/autonomous vessels) and risks  
• Recommendations for follow-up.
Important findings and conclusions of the Awareness Paper

The most important findings and conclusions of the Awareness Paper could be summarized as follows:

- Experts evaluate cyber security awareness in the maritime industry as ‘low’ with ‘automation so far not accompanied by corresponding security protection’.
- High ICT complexity and the use of industry-specific technologies are a particular challenge to security. The long life in service of vessels (compared to typical service life of e.g. computer software) and the consequent rolling replacement of parts, but not the whole of, on-board systems is also causing difficulties to efforts to secure vessels against the cyber threat.
- Rapidly changing technologies and threats make it difficult to address cyber risks through technical standards alone, calling for a risk-management approach evolving as a natural extension of existing safety and security management practices.
- Many national authorities are working up approaches to cybersecurity in the maritime sector and/or in inland navigation. A telling example is the China Classification Society’s Guidelines for Requirements with the aim to standardise the construction of ship networks and effectively evaluate the cybersecurity. The EU has taken action for a coordinated governance, with a specific directive1, which provides a legal framework to boost the overall level of cybersecurity in the EU.
- In common with other industries, there are several mitigation strategies useful to the inland water transport sector and related areas that can be applied to a range of technologies and systems or generally, across the board.
- Supervisory Control And Data Acquisition (SCADA) systems and Controller Area Network (CAN) bus technology are used commonly on board, in particular for vessel control, and for waterway infrastructure, such as locks. Due to their architecture, they are particularly vulnerable to cyberattacks.
- Navigation systems such as Inland AIS and ECDIS can be easily manipulated from outsiders, as has been shown by many cyberattacks. For strictly regulated systems, such as Inland ECDIS in navigation mode, mechanisms to prevent cyber-attacks can be implemented on a mandatory base.
- Radar systems are at risk of cyberattack. However, these attacks are harder to perform, and they would tend simply to render radar equipment inoperable rather than plant false readings.
- Cybersecurity risks increase with interoperability of RIS systems and data sources, and many systems have been developed without sufficient consideration of cybersecurity.
- Initiatives aiming at a much greater integration of information across all modes of transport and between shippers and logistics service providers and inland waterway transport operators lead to greater interconnectivity of systems, which in turn comes with greater risk that cyber vulnerabilities will be overlooked.
- Shipboard networks which allow different on-board and on-shore systems to communicate with each other become increasingly common. Once unauthorized access to a shipboard network is obtained, attackers could well be able to interact with everything to which it is connected.
- Pilot projects are underway to extend the use of radio-frequency-enabled technologies, including the development of new e-tools on-board, for example, to update the boat master service record book and vessel logbook. These technologies may well also be potentially vulnerable to hackers.

Recommendations for follow-up

Considering the context of cybersecurity across the industry and the review of current and future technologies currently in use in the inland water transport sector and associated risks and mitigation, The Awareness Paper examines recommendations for follow-up.

If the increase in occurrences and intensity of attacks is not met with improved defences, a backlash against digitalisation could occur, with large negative implications for inland navigation.

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Risk assessment and need of guidelines

An adequate cyberrisk assessment in shipping companies and by infrastructure managers is encouraged. Of highest priority is the support for common standards for secure technologies currently used in the area of inland navigation. The significance of cyberrisk analysis and assessment lies in evolving to a traditional technology-driven security architecture design and development of security solution. Based on severity, impact and likelihood evaluation, this approach allows prioritised, targeted and thus effective measures. For small companies (e.g. single boat owners), a minimum understanding and awareness of the risks are necessary.

The risk assessment could be performed by the company or with the help of a consultant, but some guidelines appear to be helpful to address the specificities of inland navigation and the impact on the exposure to cyberrisks.

General legislation as lever

Increasingly, national and international legislation demands the implementation of cybersecurity mitigation measures. This legislation addresses the issue often in a cross-sectoral approach including or even focusing on networks (energy, transport etc.), the EU Directive concerning measures for a high common level of security of network and information systems across the Union being a telling example. This legislation may require the operators of inland navigation vessels and inland navigation infrastructure to take mitigation measures against cyberrisks. If this legislation does not oblige the inland navigation sector to become active, perhaps to its small size, the sector may still take some of the foreseen measures on a voluntary basis.

Data protection as lever

The implementation of mitigation measures against cyberrisks will become more urgent and important in the light of EU data protection regulations and similar legislation. The rising concern for protection of personal data, as well as the corresponding national/international regulations stresses the need of mitigation measures against cyberrisks. This context will stimulate the willingness of shipping companies to address cyberrisks and adopt mitigation measures.

Insurance premiums as lever

Companies face an increasing number of new scenarios due to cyber incidents which do not cause damage, but high financial losses. Cyber incidents are the most feared business interruptions. Proper implementation of mitigation measures for cyberrisks might help to reduce insurance premiums.

Training of crew members as well as onshore operators

Inadequate training and a lack of awareness around cybersecurity both on-board and onshore elevates the likelihood of incidents caused by human error. This requires establishing a comprehensive training and awareness program, conducting threat and risk assessments, and performing vulnerability assessments of individual ships to ascertain main vulnerabilities since installations and the connection of systems vary from ship to ship. The training might help to develop a minimum knowledge for all crew members, even if the training programme would differentiate between the management and operational level. The same conclusions apply for onshore operators.

Automated navigation

Increasing use of automated systems is exposing the sector to a greater risk of cyberattacks and potential navigation mistakes leading to unsafe situations. Insurance companies will demand that systems on-board automated ships would be cyber hardened. However, emergency manual override to prevent disastrous outcomes should remain possible and will heavily rely on the ability of the crew or shore operator to detect unexpected behaviour. Experience gained in the road sector shows the need to establish comprehensive cybersecurity principles for automated driving.
General conclusions

In general, the application of ICT in inland navigation offers tremendous opportunities. At the same time, it creates new and very profound risks to all aspects of inland navigation. Therefore, all feasible measures for mitigating these risks need to be implemented and continuously improved. These measures have to include contingency plans with procedures on how to manage situations where the integrity of ICT systems has been compromised due to cyberattacks. For a ship, this may even require discontinuing a journey, for the management of a waterway this may mean the discontinuation of certain services. In most instances cyberattacks may result in economic damages only. However, it should not be forgotten that people's lives and the wellbeing of the environment can be at risk as well.

The enormous economic risks of cyberattacks on transport companies became apparent in June 2017, when Danish container firm Maersk was one of many businesses hit by a ransomware attack. After the attack, the company had to reinstall “4,000 new servers, 45,000 new PCs, and 2,500 applications”, according to the company’s chairman, in order to become fully operational again. Its container business was severely crippled and, as was later reported, even container transport on the Rhine was negatively impacted.
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As part of the Corps of Engineers’ Navigation Economics Technologies Program, the Global Grain Model (GGM), a spatial optimization model, was specifically developed to help assess the impact of world grain (corn, wheat, and soybeans) flows on U.S. waterway and harbor projects. Specifically, the GGM analyzes the flows between grain-producing regions and grain-consuming regions with, in linear programming-speak, objectively minimizing costs of world grain trade, subject to the demands at importing countries and regions, the available supplies and production potential in each of the exporting countries and regions, and given the costs and capacities of supply channels in terms of the waterway transport network (inland and coastal ports). One immediate adaptation involved the Corps performing scenario analyses oriented towards grain flow and congestion on the Mississippi River. Another use of the model was to forecast the grain traffic throughout the year 2025 and to identify the critical hotspots and bottlenecks in the river system.

In recent years, given the Panama Canal Expansion, changes in grain production in Ukraine, Brazil, Russia, and other developing countries, volatility of oil prices, and other significant changes in world grain markets, including recent disruptions brought on by protectionism, the Corps needs to make decisions on its long-term investments to the inland river system in short order. Rather than solely rely on political influence, physical bottlenecks, or generalized tonnages, the GGM will allow the Corps to quickly examine multiple forecasts and scenarios, resulting in more strategic, robust and publically-approved decisions.

Background:

In 2004, the Corps oversaw the development of the GGM which analyzes a host of inputs in minimizing costs of world grain trade, subject to the demand for grain at importing countries and regions, available supplies and production potential in each of the exporting countries and regions, and currently available shipping costs and technologies.

The existing GGM encompasses 13 exporting countries and 26 importing countries with each grain type having different sets of exporting and importing countries. The model also contains 16 ports in the exporting countries and 32 ports in importing countries. Transportation modes includes trucks, rail and barges for inland transportation and deep-draft vessels for ocean transportation. The model then optimizes an equation subject to a set of linear constraints, which include arable land, demand constraints in consuming regions in both exporting and importing countries, among others. The main optimization involved minimizing production costs in
producing regions in exporting countries and shipping costs from producing regions in exporting
countries to consuming regions in importing countries.

With data made available through Wharton Econometric Forecasting Associates (WEFA) (now
absorbed by I.H.S.-Global Insight) and the US Department of Agriculture, the model analyzed
production costs for each grain in each exporting country and region, interior shipping and
handling cost for each grain in each exporting region and ocean shipping costs and tolls for
shipments through the Panama Canal for each of the 6 grains which include barley, corn, rice,
sorghum, soybeans, and wheat. Figure 1 shows the inputs required for the spatial optimization
model. As you can tell, many factors impact world grain trade and the spatial distribution of
shipments and demands for specific routes and modes.

Figure 1: Global Grain Model Inputs

The GGM also contains an economic reporting tool to post-process the results of a hypothetical
run and displays it in an Excel spreadsheet. The sheets in the workbook present analytics for
transportation, production, and storage in the modelled process of global grain production and
distribution. Users can directly create pivot tables or then create custom analysis of the data.

The Corps initially used the GGM to examine the expected impacts of demand for corn given the strong
push as using ethanol as an alternative for energy. At the time, the model predicted most of the US export
growth passing through the US Gulf barge system, with negligible growth through the Pacific Northwest
and the Great Lakes. Based on this analysis, the Corps of Engineers publicized this trend and
recommended funding additional improvements on the lower Mississippi River System (which was
further compounded by a drought and rock pinnacles impeding traffic). Another analysis was related to
the rapid growth in soybean production in Brazil. Once concentrated in the Southern provinces of Brazil,
there was heightened awareness of intermodal infrastructure developments in Brazil’s Northeastern region,
which could make that country’s soybean market more competitive worldwide and alter trade flows. As a
consequence, ports on the US Gulf and Southeast Coasts were made aware of the potential competition
from Brazil. Prior to that, the Corps relied many on historical cargo trends and even political pressure at
times. Budget priorities can be heavily influenced by pursuative stakeholders, one data point or the
aftermath of an incident.
Another use of the model was to examine the rapidly growing economy of China, with its increasing clout, large population and strong gains in income and output. Though China had been a large grain and oilseed producer, their productivity growth rate was not expected to keep pace with demand through the year 2025. Finally, spatial equilibrium models similar to the GGM were used to examine the effects of proposed waterway use taxes on U.S. grain flows for corn and soybean sectors. They found increases in barge fuel taxes would divert as much as 10.6 million tons from inland waterways, 70% of which would be diverted from the Upper Mississippi/Illinois River System. This informed the Inland Waterways User’s Board of the impacts and helped shape policy as well as the appropriate degree of tax hikes. In the middle of 2015, the tax was raised from $0.20 per gallon to $0.29 per gallon, thereby increasing annual revenues to the trust fund, something which had been sorely needed (Figure 2).

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Figure 2: Inland Waterways Trust Fund Annual Revenues
¹ Full year fuel tax collection at 20 cents per gallon.
² Half-year fuel tax collection at 20 cents per gallon and half-year at 29 cents per gallon.

While the GGM was not implemented Corps-wide as initially envisioned, namely due to Army restrictions on firewalls as well as learning costs, it had been used repeatedly for special studies such as Dr. Wilson’s “Impacts of Lock Capacity Expansion on Delay Costs for Grain Shipped on the Mississippi River”, which made the case for expansion after calculating delay costs by $1.08 per metric ton by 2020 without an expansion. There were also occasions when the when the model was calibrated with real market behavior. In advance of the proof of concept model, contractors and the Corps imported production costs, cargo volumes, trade flows and other parameters to refine the model in identifying relative strength of variables as well as accommodating additional variables made possible through increased computing power.

Over the past few years, the Corps has continued to propose additional improvements to the GGM, not only to make it contemporary and user-friendly (thus increasing its acceptance and application), but to also include additional refinements such as: (1) Seasonality; (2) Over-season storage at producing regions; (3) Explicit inclusion of ports; (4) Tolled and non-tolled routes between ports; and (5) Farmer’s behavior (e.g., planting multiple crops or having multiple options of transporting their goods). At the same time, there have been some notable changes in the economic and political landscape, all of which impact the trade flows. Some of these include:

- Expansion of the Panama Canal and adoption of Neo-Panamax vessels;
- Growth in production in the Former Soviet Union (notably Ukraine and Russia), and Brazil. The Former Soviet Union now accounts for 40% of world trade in wheat, and 50% is sold as feed; and Brazil soybean, and corn production is increasing rapidly with development in northern regions;
- A more compressed marketing season for crops in the United States (notably soybeans);
- Continued proliferation of genetically modified crops, albeit varying across producing countries;

- Tariffs and other trade barriers, volatility of oil prices and other economic uncertainties, which were not on the radar a decade ago.

GGM is an annual model so its inputs were annualized and results were reported annually. However, demands for logistic capacity has become highly seasonal, particularly given the growth in South American production and competition, which makes demands for shipping capacity in the US highly seasonal. As a result, assuming annual capacity, and sub-annual seasonal demands, the model will underrepresent the impact of congestion and traffic diversion; and as a result, underestimate the benefit of increased capacity.

Implications:

In an era of constrained budgets and uncertainty, the Corps of Engineers will like to use the model to make more robust decisions. Increased computing power and use of scenario-based planning will allow the Corps of Engineers to quickly examine all of the major differences in production and logistical costs, all of which will impact the future spatial distribution of grain trade. All told, an upgraded GGM could easily accommodate additional producing and consuming countries, resulting in greater precision in an uncertain world. There is even greater potential to incorporate additional cargo categories to the GGM, capturing a more realistic portrait of the trade on the inland navigation system.

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Keywords:  
cruise, pier, call, cold ironing  

HAROPA - PORTS DE PARIS  
CRUISE DEVELOPMENT ON THE SEINE: A NEW CALL ON A  
CLASSIFIED HERITAGE SITE IN “LA ROCHE-GUYON”  

INTRODUCTION  
Nowadays, several cruise lines carry about 90 000 passengers on the Axe Seine from Paris to Honfleur, in Normandy. 18 vessels, from 110 m to 135 m long, operate in this area.  
The Seine is the second place in France for the inland cruise (behind Rhone/Saône).  
This activity has grown thanks to the city of Paris and the natural landscapes in the Seine-Maritime.  

As the cruise provides significant socio-economics benefits for the hinterland where the call is located, this sector of activity remains very fragile and needs all the time new developments. Providing attractive destinations is obviously essential in order to maintain the growth of the cruise sector.  
The “la Roche-Guyon call” has been created in 2018.  

DESIGN A COMPLEX WHARF ON A CLASSIFIED HERITAGE SITE  

The Ambition of this development  
The infrastructure has to be calculated for berthing long cruise vessels (about 135 m long with 200 persons) but also smaller boats for passengers (about 40 m long). The main aim is to allowed tourisms to reach this exceptionnal site by the River without disturbing environment (biodiversity), landscape and inhabitants.  

This call is located in The Regional nature Park of “French Vexin”.  
The wharf has been built on the remains of the Roche Guyon Bridge which has been broken during the second world war.  
The call is closed to the classified castle with his famous vegetables garden.
The design has to:
1. Respect environnement. In order to reach this aim, artificial elements have to be hidden in the landscape with dark elegant design;
2. Integrate old constructions which are on the site like the historic wall;
3. Use specific materials: steel and wood;

The final design is a floating dock with piles guides. The wharf can follow the water level of the Seine, in order to reduce visual incidences. Berthing and mooring are allowed by dolphins which are located in front of the wharf.
The landing for the passengers is realised by a discret steel ramp and passengers can join entrance by an historic allee which has been renoved.

The Design
The berthing is calculated with 2000 T displacement and a velocity about 0,25 m per second. The calculation leads to build four dolphins in order to have a large mooring stretch to accomodate vessels. The performance of the dolphin at mooring is 20 T.

The wharf has been designed in order to be operate from the low water to high level of water expected on this site. The pile has a diameter of 916 mm for a thickness of 19 mm. The grade of steel is 430 Mpa. Piles are driven to 22 meters deep. In order to follow the level of the water, several bollards have been placed on the dolphins.

Boarding is realized on floting wharf which is independant of the mooring front. This conception limits the efforts on the dock. The dock has a length of 10 meters and a width of 6 m. The infrastructure is compone of 3 caissons. The dock in steel has been constructed according eurocodes Standards and France Regulations.

Regulation about the risk fo flooding
As the installation is in riverbed, the wharf can prevent the flow of water during a flood. Modezation has shown an insignifiant variation of the waterline due to the installation during a flood (debit of 3000m³.s⁻¹). it’s been considered that jams can be created by the wharf.
Ecologic and classified Heritage Site

The site of building is located in “Natura 2000” emplacement and in a natural area. The operation has required several compensatory measures:
- A massive tree has been kept. Project has been reviewed to integrate this tree (entrance);
- “Pariétaire officinale” has been conserved and shifted;
- A lot of plant species have been identified by a botanist in order to be protected during the building;
- A botanic area has been created;
- Spawning grounds have been located and followed during the operation, with instrumentation (turbidity du to suspended solids especially).

Operation and Regulation

As the wharf is floting, it’s considered like a boat by the french regulation. Moreover the wharf isn’t operated by only one company but each boat which want to make a call. In order to be flexible with cruise lines and other clients, the wharf has been designed for 12 persons at the same time; meaning that the pier isn’t classified as “a public establishment”. Nevertheless, in order to assure security, all the acess have been closed and many signpost have been put in order to warn people from the risks and in order to respect this special regulation.

COLD IRONING

The energy transition law has to main aim to reduce greenhouse gases and the use of fossil fuels. Cold Ironing shall allow to have energetic neutrality during the call. Cruise vessel needs a lot of energy for providing the kitchen, heating, air-conditionning systems.

Moreover, providing energy during the call is important for the integration of this economic activity in this natural area without noises, vibrations or smoke.

Vessels need two plugs of 240 kVA with 400 A for each one. The system adopted is Powerlock, using TN method. In order to have enough power, a high voltage line has been bring to a special private transformer substation. For the visual incidence, the transformer has been put at 240 m from the waterfront and electric cables at about 400 mm² in order to limit drop in voltage and stay conform to standards and regulation.

Finally, the ramp has been designed considering the weight of the connexions and the necessity to not see them until they reach electric loading post.

CONCLUSION

The global cost of the project is about 1,6 M€. The project owner is Haropa-Ports de Paris. The engineering team is composed of ANYOJI BELTRANDO – ISL – OTCI. The call is operated since the inauguration which took place the 13th september 2018. Cold ironing should be completed at the end of 2019.

Thanks to this call, tourisms can discover an historical monument by an other way without disturbing the environment.
Smart Rivers 2019 Conference  
/ September 30 - October 3, 2019  
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Mots clés:  
navette, fluvial, maritime, transport du quotidien, voyageurs, freins, coût d’exploitation 

Titre:  
Les freins au développement du transport du quotidien de voyageurs par navettes fluviales et maritimes 

L’Article:  
Les résumés ne doivent pas dépasser 1 page ni 1500 mots. Pas de graphique, pas d’image incluse. (Times New Roman, 11pt).
Depuis longtemps en France, en agglomération, et plus particulièrement dans quelques ports maritimes (Lorient, Marseille, Nantes, Toulon), des navettes fluviales et maritimes assurent des services de transport du quotidien de voyageurs. Le nom commercial des navettes reflète parfois explicitement leurs fonctions de service public de transport du quotidien à l’image du Bus de mer à La Rochelle ou du Navibus à Nantes. Ces services de navettes se développent et évoluent notamment en acquérant une fonction de transport collectif public plus affirmée (au regard de l’usage touristique et de loisirs) et une meilleure intégration dans les réseaux de transport urbain. Le Parlement européen s’est récemment prononcé pour le développement des services de navettes. La résolution du Parlement européen du 22 novembre 2016 sur l’exploitation du potentiel du transport de voyageurs par voie d’eau précise : « Le Parlement européen ... estime que l’intégration du transport de voyageurs par voie d’eau dans les réseaux de transports publics urbains et régionaux permettrait d’accroître considérablement l’efficacité de la mobilité, les performances environnementales, la qualité de vie, l’accessibilité économique, la fluidité des réseaux de transport terrestres et le confort dans les villes ».

Le transport du quotidien de personnes par navettes fluviales et maritimes a fait l’objet d’une étude nationale (Certu, Transport collectif par voie d’eau en milieu urbain, mars 2013) ayant pour objectif de donner une première approche de son potentiel de développement et de diffuser la connaissance correspondante. Des informations ont également été collectées à l’échelle européenne auprès de quelques services.

De nombreux aspects restent à approfondir, notamment les freins au développement de ces services. Il s’agit de les identifier, de mieux les connaître afin ultérieurement de voir dans quelle mesure il serait possible de les réduire en vue d’en favoriser le développement.

Des freins au développement des services de navettes fluviales et maritimes ont été identifiés, caractérisés et formalisés à l’aide d’une enquête par entretiens auprès d’acteurs des systèmes de transport c’est-à-dire les autorités organisatrices de la mobilité (AOM) et leurs exploitants. Ces acteurs ont été sélectionnés pour leur implication dans les services existants récents mais aussi dans des projets de (d’évolution de) service, à l’étude, suspendus ou abandonnés. Les entretiens en face-à-face ou au téléphone ont été menés à l’aide d’une trame d’entretien (il s’agit d’entretiens ouverts et semi-ouverts). Une étude sur les coûts d’exploitation a été menée en parallèle à l’aide d’une enquête auprès des exploitants des services. La définition des différents postes de coût d’exploitation a été élaborée à partir de différentes sources d’information (enquête nationale, compte d’exploitation et étude antérieure) puis a été consolidée. La principale limite à l’analyse (des freins au développement et des coûts d’exploitation) est à la fois le nombre restreint de services et la diversité de ces services en termes notamment de caractéristiques des navettes. L’étude a été menée à partir des réponses données par les acteurs (AOM et exploitants) sur les (projets de) services de navette(s) des villes suivantes : Ajaccio, Bordeaux, Calais, La Rochelle, Lille, Lorient, Marseille, Nantes et Toulon.

Avant d’aborder successivement les freins réglementaires et techniques puis les coûts (exploitation essentiellement) il est important de noter que les AOM organisent les transports collectifs terrestres mais connaissent peu, ou ne connaissent pas, le transport de voyageurs par navettes fluviales ou maritimes. Elles doivent s’approprier ce « nouveau » mode de transport dans un contexte difficile. Il existe peu de services en France et les acteurs du monde fluvial ou maritime doivent aussi acquérir des connaissances sur le transport collectif urbain de personnes. Cette méconnaissance réciproque engendre de nombreuses difficultés. La mise en place de tels services apparaît donc complexe. C’est parfois une réalité, car le nombre d’acteurs, de procédures administratives, etc. est élevé (cf. ci-après, les freins réglementaires). Souvent, des exploitants spécialisés (navettes touristiques en particulier) appartiennent aux AOM leurs connaissances et leur expérience.

Les personnes contactées ont fait état de freins réglementaires, c’est notamment la conséquence d’un mode de transport encore confidentiel et en voie de développement (manque d’expérience dans l’application de la réglementation, etc.). Il s’agit parfois d’une méconnaissance des dites réglementations. La réglementation qui est appliquée aux services de navettes provient de deux à trois domaines différents : le « transport terrestre régulier de personnes à vocation non touristique », le transport fluvial et le transport maritime. Il s’agit de réglementations conçues dans leur cadre respectif ce qui entraîne des difficultés, des freins au développement des services de navettes. Étant donné la rareté de ce type de services, les administrations qui
instruisent les dossiers de « transport régulier de personnes par navette(s) fluviale(s) ou maritime(s) » ont peu d’expérience sur le sujet et doivent intégrer l’ensemble des textes qui sont applicables, ce qui peut entraîner des difficultés qui ont été mises en avant par les personnes enquêtées. Un autre frein, difficile à réduire, est que des réglementations de différents domaines vont s’appliquer : par exemple la réglementation relative à la protection des milieux aquatiques. Enfin, la formation des conducteurs fluviaux a également été citée, car elle est commune à la conduite de tout type de bateaux, une partie de la formation est en conséquence peu utile aux conducteurs de navette fluviale.

En milieu fluvial ou maritime un service de navettes présente souvent l’avantage de bénéficier d’une infrastructure en « site propre » (au sens où ce milieu est peu utilisé) par exemple, la navigation des navettes n’est pas ralentie par d’autres usagers. Il n’en demeure pas moins que les milieux fluviaux et maritimes sont le support d’autres usages (loisirs et activités économiques divers) et que les services de navettes doivent souvent cohabiter avec ces différents usages. Les ports maritimes sont des lieux qui concentrent une grande diversité d’usage. Ils sont des lieux de développement potentiel des services de navettes mais la cohabitation d’usages sur ces lieux peut constituer un frein au développement de ces services. La houle, la marée, les courants, les vagues et le vent sont des phénomènes naturels qui entraînent des contraintes pour la navigation des navettes. Ces contraintes peuvent être fortes au point de limiter la navigation, de ne pas permettre une disponibilité permanente du service de navettes. Cela peut expliquer une frilosité des AOM à développer un service de navettes puisque le service ne peut être assuré en permanence sauf à prévoir un service alternatifs ou de substitution qui nécessitera des moyens supplémentaires sans garantir la même offre de service. Une voie d’eau peut également voir sa navigabilité entravée par l’activité humaine, c’est en particulier le cas des voies navigables anciennes avec par exemple un pont reconstruit trop bas ou un pont levis qui ne se lève plus. Comme pour tout mode de transport, il existe des contraintes techniques à la mise en œuvre de services de navettes. Il ne s’agit pas à proprement parler de freins au développement des dits services sauf dans le cas où la disponibilité du service n’est pas assurée en permanence.

Les coûts d’investissement et d’exploitation sont réputés élevés notamment en comparaison des réseaux urbains de bus. Seuls les coûts d’exploitation ont été enquêtés (exploitation des données en cours). Le faible nombre de services enquêtés, la diversité des services et des matériels utilisés et les conditions de navigation rendent les données peu exploitables en termes de comparaison entre services. Le premier poste de dépenses est le « personnel ». Par navette (bateau ou navire) ce poste varie du simple au double, ce qui n’est pas étonnant puisque l’équipage est généralement composé de deux personnes (un capitaine et un matelot par navette comparé à un conducteur par bus) mais la composition de l’équipage varie de une à deux (exceptionnellement trois) personnes en fonction de divers critères (nombre de passagers, milieu maritime plus ou moins exposé, etc.). Concernant le poste énergie, l’utilisation de l’énergie électrique permet de baisser sensiblement la facture par rapport à l’emploi du gazole (prix de l’énergie mais aussi de la maintenance plus bas). À noter également, le coût de la mise à disposition des pontons est très variable. Enfin une comparaison des coûts d’exploitation des navettes avec ceux de services terrestres (bus en particulier) n’est pas plus aisée.

En conclusion, il apparaît que la méconnaissance des services de navettes fluviales et maritimes est un frein à leur développement. Réduire cette méconnaissance favorise le développement de ces services. Les présents résultats seront potentiellement une source d’information au bénéfice de la communauté des parties prenantes sur le sujet, à commencer par les AOM qui souhaiteraient développer des services de navettes fluviales et/ou maritimes. La réglementation apparaît également comme un sujet potentiel d’étude en faveur du développement des services. Enfin, les gestionnaires de l’infrastructure fluviale et maritime doivent être sensibilisés à ce mode de transport encore confidentiel afin de ne pas contrarier, voire rendre impossible, de futurs développements.
Cet article propose de mettre en avant la politique clairvoyante de la ville d’Hautmont dans l’utilisation du fluvial sur un territoire en reconstruction et ses effets. Hautmont est coupée de sa rivière depuis le déclin des industries métallurgiques, l’abandon en friche des sites industriels en bord de Sambre et sa coupure à la navigation, en 2006, du fait de la vétusté des pont-canaux de Vadencourt et Macquiny.

La ville a développé, entre 2010 et 2018, un outil touristique, le port de plaisance, et un outil industriel d’importance, le port-à-sec, abrité dans d’anciennes halles industrielles totalement réhabilitées, et couplé à une zone logistique. Le port de plaisance est en exploitation depuis mi-2014 et accueille aujourd’hui une flotte constituant 60% à 75% de la capacité du port. BRLi associé au bureau d’études en bâtiment OTE a réalisé la maîtrise d’œuvre globale du port-à-sec et de la zone logistique. La construction (bâtiment et ouvrages portuaires) est désormais achevée. Les travaux de Voirie et Réseaux divers se finalisent en 2019 pour une mise en exploitation en suivant. Grâce à une action volontariste de la ville et de ses élus, le projet a permis à la ville de se réapproprier sa rivière. Il a également servi de levier à la réouverture de la Sambre, désormais engagée par Voies Navigables de France (VNF), et prévue pour 2021, amorçant ainsi avec anticipation le redéveloppement du canal.

Le maitre d’ouvrage a ainsi pu se prononcer lors de la phase conception:

- sur la position du port, en cœur de ville, pour un attrait optimal et une place centrale dans le développement urbanistique de la ville d’Hautmont autour de sa rivière ;
- sur un haut niveau de service du port et sur le mode d’exploitation conviviale autour de ce site,
- sur la structure du port-à-sec :

Les choix réalisés à cette époque ont permis:
- la création d’une zone d’activité de plaisance dynamique ayant pour effet un regain d’intérêt régional pour le tourisme fluvial,
- la mise en place d’un outil portuaire d’envergure, gage d’attractivité économique,
- la mise en relation des acteurs du fluvial au niveau du bassin desservi par la Sambre et ayant permis, via un réseau d’appui, la reprise officielle et concrète du projet de réouverture de la Sambre jusqu’à Paris.

**La Sambre**

Axe transfrontalier et véritable épine dorsale du territoire, la Sambre apparaît comme un élément structurant de cohérence et de mise en dynamique.

Autrefois, dans le département du Nord, la voie d’eau assurait le désenclavement des industries de la Sambre et de l’Avesnois. C’était un « chemin de vie » qui, malgré le déclin des activités industrielles, avait repris naissance grâce à la plaisance fluviale, jusqu’au jour où, en mars 2006, la continuité de la voie d’eau a été coupée en raison du mauvais état du pont canal de Vadencourt.

Comme le souligne le rapport¹ du Conseil général de l’Environnement et du Développement Durable, « au travers de cette coupure, c’est toute l’activité de tourisme fluvial de la Sambre canalisée et du canal de la Sambre à l’Oise, long de 116 km de la frontière belge à Travecy, qui s’est effondrée, passant d’une moyenne de 700 bateaux à la frontière, à moins d’une centaine. »

Suite aux accords entre l’Etat, VNF et les collectivités locales (Région, Départements, Communautés de Communes, Villes), il est envisagé de remettre en service cette voie d’eau en 2021.

Sans attendre cette échéance, la Communauté de Communes Sambre-Avesnois et la Ville d’Hautmont ont déjà engagé des études pour créer un port fluvial sur la Sambre à Hautmont sur deux anciens sites industriels.

Ce projet va permettre de redonner vie à la rivière en :
- Créant des places à flot (60 anneaux environ),
- Développant le tourisme fluvial sur la Sambre et en favorisant la découverte du patrimoine culturel dans la vallée de la Sambre (Abbaye de Hautmont),
- Développant le transport par navettes électriques fluviales à passagers, en particulier entre Maubeuge et Hautmont.

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¹ Canal de la Sambre à l’Oise et Sambre canalisée, le devenir de cette voie d’eau (Rapport n°006670-01 septembre 2009 du Conseil général de l’Environnement et du Développement durable)
*Itinéraire le plus court* et le plus bucolique pour relier l’Europe du Nord à Paris ;

*Réseau de gabarit Freycinet le plus fréquenté du Nord Pas de Calais avant la fermeture au transit en 2006 ;

*Une voie d’eau avec le plus fort potentiel de développement après le canal du Midi.*


**S’ancrer dans l’histoire pour construire le futur**

L’histoire de la ville d’Hautmont est liée aux industries et à l’eau de la Sambre.

Créé au VIIème siècle au bord de la rivière, par Vincent Madelgaire, « ALTUS MONS » se développe commercialement et industriellement pour devenir dans les années 1860, « Hautmont, la ville aux 100 cheminées ». S’en suit un essor industriel grâce à l’implantation de grandes entreprises sidérurgiques (Cockerill la Providence, Trancel, Société des Treillis et Panneaux Soudés -STPS) en plein centre-ville dans une bande de terrains entre la Sambre et la voie ferrée.

Du feu à l’eau, de l’eau à la terre, cette progression d’un élément à l’autre symbolise le destin de la Ville d’Hautmont et ses ambitions pour se doter de projets structurants.

Le feu, c'est celui des fours de ces aciéries installées le long de rivière, coupant la Ville en deux ; ils ont d'abord créé la prospérité de la région, puis causé son déclin.

Le feu a alors passé le relais à l'eau laissant un grand vide urbain.

L'eau, c'est celle de la Sambre : la commune, depuis 20 ans par un travail conséquent de recomposition urbaine, se retourne progressivement vers sa rivière, avec comme objectif sa réappropriation par les habitants.

Maintenant, l'eau va transformer la terre : moteur d'une dynamique locale qui influence positivement le destin collectif. Il s'agit d'effacer les cicatrices des friches industrielles par l'implantation d'activités innovantes, durables et respectueuses de l'environnement, afin de créer ou de renforcer les conditions nécessaires au développement économique et à l’emploi.

D’autant que le potentiel touristique de l’axe Sambre a été relevé par différentes études (Conseil Général de l’Environnement et du Développement Durable) depuis 2009, estimant un **doubllement de la fréquentation** à échéance de sa réouverture (1 500 bateaux). Et d’un point de vue transport marchandises, la Sambre peut encore accueillir des unités de capacité nominale de 250 tonnes à 320 tonnes (potentiel de 250 000t/an), comme en témoigne l’acheminement des élément de la presse XXL de l’usine Renault Maubeuge le 17 avril 2019 (déchargement de 6 colis au port à sec).

**Un positionnement unique et ambitieux**

La Ville d’Hautmont s’est engagée, dès 2005, dans un projet ambitieux de création d’un espace fluvial sur deux anciens sites industriels (anciennes halles industrielles de l’usine STPS et friches TRANCEL), grâce à des disponibilités foncières et bâties situées en plein centre-ville.
L’espace fluvial d’Hautmont, labelisé Port Exemplaire en 2010 par le Ministère de l’Ecologie, de l’Energie, du Développement Durable et de la Mer s’organise autour de deux infrastructures complémentaires :
- un port à flot en centre-ville à haut niveau de Services : cadre apaisé et sécurisé, accès facilité, club nautique assurant l’accueil et l’intégration.
Doté de 69 anneaux (bateaux de 8m à 15m) et de 3 emplacements pour les péniches, le port de plaisance d’Hautmont est opérationnel depuis le 2e trimestre 2014. Il accueille une quarantaire de bateaux en résidence alors que la Sambre est fermée au transit et propose les services : eau, électricité, Wifi, capitainerie, vidéosurveillance, accès sécurisé par badge.

Autour du port de plaisance, c’est l’ensemble du centre-ville qui se déploie, s’organise et devient un nouveau centre urbain revitalisé et rayonnant.

- un port à sec couvert, unique au nord de Paris. Le port à sec et le pôle de service fluvial réalisés dans le cadre de la reconversion de la friche STPS (emprise foncière de 72 000m², l’ensemble immobilier en tant que tel représente 24 000m² comprenant 5 halles) viennent compléter cette offre en proposant des places d’hivernage couvertes et sécurisées (128), ainsi qu’un ensemble de services à destination de la plaisance fluviale : manœuvre par pont-roulant pour les plus grosses unités, double rampe de mise à l’eau, station d’avitaillement, aire de carénage, atelier de réparation, shipchandler, club house.

Le port à sec constitue une solution à part entière pour le développement des capacités d’accueil de la plaisance, en proposant une offre de services pour les plaisanciers de la zone de chalandise et en itinérance.
Embranché fer, route et rivière, le site du port à sec a également une fonction de hub (pôle multimodal) et permettra l’accueil d’entreprises dans les 9200m² de halles réhabilitées.

Le port à sec et le pôle multimodal soulignent le caractère innovant et les énormes possibilités du recyclage des équipements par changement d’affectation. En effet, les ponts roulants, qui équipaient anciennement l’usine, ont été remis en service. Ils permettront des performances exceptionnelles de levage (2 ponts de 32 tonnes chacun, qui peuvent être couplés) et de mise en cale sèche des bateaux tout en maintenant le prix de revient à un niveau particulièrement avantageux pour les plaisanciers.

![Photo aérienne de la darse en construction du port à sec d’Hautmont – Source: Mairie d’Hautmont](image)

**Cibles**

Une cible plus large que celle de la grande majorité des ports à sec qui accueille surtout des petits bateaux (moins de 10 m et de 3 tonnes) en stockage vertical sur des racks à l’air libre. Le port à sec d’Hautmont vise ainsi à répondre aux besoins d’hivernage, de carénage ou de stockage des bateaux de plaisance jusqu’à 20m qui pourront être sortis de l’eau « facilement » grâce aux ponts roulant et qui ne trouvent pas ou très peu d’offre comparable à l’échelle du « bassin de vie fluvial » transfrontalier.

La chalandise visée est une clientèle transfrontalière qui est de deux natures :
- **Les bateaux « résidents » à l’année** sur la Sambre française et belge et sur une partie des canaux du sud de la Belgique; la clientèle transfrontalière qui est en recherche d’une place dans un port à sec.
- **Les bateaux de tourisme** de nationalités Néerlandaises, Belges, voire Anglaises qui font des boucles de tourisme sur la Sambre et la Meuse et qui privilégient les rivières calmes, comme la Sambre, aux grands canaux.

**Perspectives**

Le port à flot, complémentaire du port à sec, est un formidable outil d’attractivité. En effet, cette nouvelle infrastructure de qualité, véritable pôle de services unique à l’échelle du Hainaut franco-wallon, permet de coupler tourisme fluvestre et tourisme commercial.


Parallèlement, un programme de logements (73 logements de standing en trois phases) est en cours de développement en face du port à flot, avec en rez-de-chaussée l’implantation de cellules commerciales.

Et un promoteur immobilier est en train de se porter acquéreur du site de l’ancienne abbaye pour y proposer une offre hôtelière de standing, complétée par une offre de restauration haut de gamme.
L’acquisition d’un bateau à passagers par la Mairie va permettre l’accueil et le transport des scolaires et des personnes âgées à la découverte de la Sambre nouvellement réinvestie.

L’évolution du feu à l’eau, de l’eau à la terre continue de transformer le rapport des habitants du territoire d’Hautmont à sa rivière et ses abords, sert de levier à une reprise économique du territoire et de la Sambre et trace un chemin, une histoire, pour la ville et ses habitants, celle de la reprise en main de leur cours d’eau, à travers un cadre dynamique, équilibré et respectueux de son environnement.
Recreational Navigation Considerations for the Application of Working with Nature to Waterborne Transportation Infrastructure

Abstract
Large navigation infrastructure projects are increasingly focused on achieving true environmental and social sustainability and improving its resilience to climate change impacts. PIANC’s Working with Nature (WwN) Philosophy provides a key framework to help achieving those goals by improving the planning process. However, recreational navigation infrastructure (RNI) is seldom considered as a tool to achieve those goals.

Recreational navigation activity can be significant contributor to economic development, urban integration and social improvement. RNI is typically compatible with environmental restoration, can be embedded in climate change adaptation design, and often provides a value-added solution to repurposing aging infrastructure. However, recreational navigation opportunities are often overlooked in the conception of large projects, excluded from planning efforts and not funded as part of development plans.

This paper discusses how a multi-purpose planning approach, rooted in the WwN philosophy, can be used to add value to waterborne transport projects by considering recreational navigation.

Introduction
Recreational navigation infrastructure (RNI) should be considered as part of waterborne transport projects, when implementing Working with Nature (WwN), but this is not apparent to most professionals. WwN encourages waterborne transportation infrastructure designers to propose multi-purpose design solutions, as they consider the environment and the people (PIANC 2011, 2018).

RNI encompasses different types of facilities, from docks and ramps for small vessels to large marinas for yachts of all sizes. These facilities serve private recreational boats as well as public-use and tourism vessels. They exist in all types of aquatic landscapes, including inland waterways and marine coastal areas. They can be inserted in maritime port jurisdictions, among inland waterway terminals, and adjacent to waterborne transport navigation channels. For traditional port and navigation transport planners and infrastructure designers, these facilities and the traffic they support are more often a constraint or inconvenience, rather than an opportunity.

Small docking facilities (sometimes a single dock per location) are the type of RNI that probably offers the largest opportunities for inclusion as ancillary elements in waterborne transportation infrastructure projects.
Small docks can be used to board tour boats at urban waterfronts or to disembark in natural areas or parks. The concept of boat destinations is significant in the activity and business dynamic of recreational navigation, as it provides opportunities to be on the water and use the recreational watercrafts. It is also a key to some nautical tour operations. The concept of “day-use dock” is also significant in some waterfront renovation and urban waterways planning projects, and they can also play a role in waterborne passenger transport (water taxis). Additionally, larger marinas can be associated to some navigation or waterfront redevelopment projects.

Despite some successful examples, it is not yet part of recommended planning guidelines to consider recreational uses as ancillary opportunities to waterborne transportation projects. Recreational facilities are sometimes included as part of social mitigation plans, when requested by the stakeholders in jurisdictions where community approvals are part of the regulatory processes. However, there is no guidance for proactive inclusion of recreational navigation project elements, which can arguably both improve the quality of life and the economy of the affected community (Biondi 2014, Biondi and Lara 2015).

**Working with Nature**

The most fundamental description of WwN (PIANC 2011) advocates the following steps:

1. Establish project need and objectives
2. Understand the environment
3. Make meaningful use of stakeholder engagement; identify win-win options
4. Prepare project proposals/design to benefit navigation and nature

The “Guide for Applying Working with Nature to Navigation Infrastructure Projects” (PIANC 2018) adds steps to address construction and post-construction monitoring, however the first 4 steps embody the planning and design process. This Guide is the main available document to interpret WwN, but should not be used narrowly, and other documents are being prepared to show the opportunities that the WwN Philosophy offers.

This paper discusses how to consider recreational navigation project elements as part of the implementation of the WwN philosophy for waterborne transport infrastructure projects. Specifically, recommendations for identifying objectives (Step 1), understanding the “environment” (Step 2), and preparing project proposals (Step 4) are presented.

**Consideration of Recreational Navigation in Waterborne Transport Projects**

**Step 1: Establish project needs and objectives**

This first step recommended by WwN requires the definition of all the objectives of the project, both fundamental and ancillary. In waterborne transportation projects, the primary objectives often evolve after years of analyses or large economic and transportation studies. Obviously, the primary objectives are “centered on the required functions … as well as ongoing economic and operational requirements” (PIANC, 2018). WwN then requires the exploration of a wider view of project objectives, arguably secondary or ancillary. The Guide (PIANC 2018) identifies the following types of objectives:

- Environmental
- Economic
- Social, Cultural and Recreational
- Other site-specific concerns
Recreational navigation infrastructure (RNI) can satisfy a variety of social, cultural and recreational goals, even if not explicitly mentioned in the Guide. Moreover, these facilities can often be added to project elements intended to meet environmental objectives.

One social and recreational objective that RNI can achieve, directly and indirectly, is public access to the waterfront and to marine and river destinations. While access to the waterfront can be achieved by parks and urban waterfront development, RNI offer also unique opportunities for economic activities, including the support of well-paid service and manufacturing sectors.

However, this is not enough. Unless there are special local conditions or a pre-existing vision that encompasses a strong recreational navigation use, the inclusion of RNI in a large transportation infrastructure project may not be apparent. The Guide mentions two additional way to identify objectives (arguably secondary or ancillary): stakeholder involvement and addition and refinement through a dynamic process.

WwN states the importance of involving stakeholders in the identification of objectives. In many locations, yachting groups, marine industry associations, or tourism development agencies can assist with identifying potential objectives that serve the local community and businesses. Groups involved in boating and yachting, nautical tourism activities, and recreational boating industries (boat manufacturers and retail) should be considered: if they are not identified as stakeholders, their input will not be considered.

The Guide highlights that the definition of objectives is a dynamic process. “Whilst project needs and objectives are typically defined during the early stages of a project, as a better understanding of the environment is achieved, new win-win opportunities may be identified, which can support the formulation of new objectives” (PIANC 2018). The feedback from Steps 2 to 4 is critical for the identification of recreational navigation elements, as part of the WwN implementation.

**Step 2: Understand the Environment**

This step includes also the understanding of the “Socio-Economic and Cultural (Human) Environment”. While the Guide does not explicitly discuss the recreational navigation activities and infrastructure, boating, yachting and nautical tourism are clearly part of the “context of existing and future inhabited spaces and the economic and social functions that interact with the existing resource” (PIANC 2018).

The recreational navigation industry can be a major factor, hard to overlook in some projects. However, it can also be a significant opportunity to add value to the project overall. Quick market assessments by experts can unveil opportunities, hidden in plain sight and only apparent to professionals with the right background. Arguably, there is no need for detailed studies, but expert involvement in the early stages of understanding of the context and conceptualization of the project.

In addition to the identification of opportunities driven by the local boating market or nautical tourism opportunities, RNI can be a powerful complement to environmental restoration or climate adaptation project elements. These project elements may require the creation of new physical features in the waterfront, which should be evaluated for potential inclusion of RNI, such as small marinas or day-use destination docks.

**Step 4: Prepare project proposals/design to benefit navigation and nature**

“While the understanding of environmental conditions is necessary and can be considered an important innovation in the design process, the real difference is achieved in this third step: identifying win-win solutions” (Bioni 2017). However, the Guide does not provide insights into the application of this principle to social objectives or recreational project elements.
Environmental features of dredging projects often include the design of habitat creation with dredged material, either as shoreline or island features. These solutions may also be designed as climate adaptation measures, by providing protection (to the transportation project, urban areas or natural systems) against stronger storms impacting at higher water levels in the future due to Climate Change. These new features can easily incorporate day-use docks and minimal destination infrastructure to access the re-created or enhanced natural areas.

Properly designed marinas can provide public access to marine and river destinations through boat tour operators and create public spaces on the waterfront for non-boaters. In waterfront redevelopment or port relocation projects, marinas can proactively include ecological features (Biondi 2017, 2018) to achieve net positive environmental impact. Cultural objectives can be satisfied by cruise and yacht destinations that are designed to highlight local traditions in a way that preserves cultural values of the community, while creating new business opportunities.

Large scale projects often require rearrangements of the shoreline, which can create opportunities for marina developments. Since marinas are a commercially viable business enterprise, in some cases the transportation project only needs to allocate spaces for this use, and investment can be done by a private, public or public-private partnership entity which will obtain a return from the operation of the facility.

**Additional Considerations for the Implementation of WwN**

The iteration of the steps as part of the concept planning is critical for applying WwN as intended. Only after revised objectives emerge from the implementation of the first four steps and strong (but not necessarily detailed) understanding of the environment is achieved, with meaningful community involvement, can the project elements be identified, and the detailed feasibility studies be performed. The final project master plan, prior to initiating the design, has all the validated project components resulting from necessary feasibility studies and environmental impact studies.

For some large-scale transport projects, it is also critical to match project elements with funding sources. Some ancillary project elements, such as RNI, are not allowed for funding by certain sources, so alternative mechanisms should be investigated. However, in some cases it only requires identifying objectives and project elements in the funding application, which can be achieved by applying WwN in the concept planning stage.

**References**


