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INTERNET CONTRIBUTION

Ronald E. Waterman, PhD. MSc. studied chemical engineering, environmental engineering and civil engineering at Delft University of Technology. His life is dedicated to finding answers to the question how can we develop well-balanced and integrated solutions in the fields of space, economy and environment to existing and future challenges as regards (1) sustainable coastal and delta zone development based on the principle of Building with Nature®, and (2) the sustainable use, adaptation and management of inland waterways and their waterfronnts for safety, navigability, economy, employment and liveability based on Aquapuncture®.

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Shared value in port-city development through Aquapuncture®

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Abstract
80% of the world’s largest populated centres are found in vulnerable, densely populated coastal and deltaic areas. 20% are situated inland but most of them, like the aforementioned 80%, have a relation with rivers, lakes, lagoons and canals. Within this context, this article focusses on worldwide port-city development via Aquapuncture©. This specific integral approach explains how to create shared value for all involved stakeholders. This article will shed light on this integral approach and how business and society can unlock shared value on the basis of port-city relationships. The authors stress the need to consider port-city development – both in terms of port, city and water infrastructure - from an integral perspective. The research question is how port-cities can unlock and create shared value from the unique relationship with their waterways and waterfronts.

Figure 1: Population development in coastal and deltaic cities (Waterman, 2008)
Port-City Interface Tensions and Opportunities

From ancient times, civilisations thrived at places where water and land met. At these junctions, port-cities emerged. It is interesting to also see the decline of civilisations when access to water became scarce, access to sea weakened or cities were flooded. Coastal cities generally owe their origin and development to their port functions. Historically the prosperity of these cities largely depended on the fortunes of the port: either they developed together or they declined together. (B. S. Hoyle, 1989, 2000). In today’s society, this interdependency is not necessarily the case as the port function has become disconnected from the city function. The lower interdependency created and still creates tensions on the boundaries of the port and the city. Many ports around the world struggle with the relation with their parent-city. As Waterman already stipulated (2008) too often a city and its port do not develop harmoniously in relation to each other. Autonomous development of the city on the one hand and of the port on the other hand leads to a back-to-back position. Especially in the last three decades of the 20th century ports and cities rapidly segregated, both spatially, socially and economically. On the one hand economies of scale of ship size, storage and handling equipment required ports to build infrastructure beyond human scale, necessitating port authorities to seek port areas further away from the city. Where port activities used to be given priority at the waterfront for loading and unloading activities, the obsolete port and waterfront areas in the city were rediscovered by city developers for revitalisation. Striking examples are London Docklands, Rotterdam’s Stadshavens, Hamburg’s HafenCity, Amsterdam’s IJ area and Antwerp’s The Islet.

Shared Value

Ports and cities often compete for space. Porter and Kramer (2011) bring the concept of shared value to front, which involves creating economic value in a way that also creates value for a sustainable society by addressing its needs and challenges. Businesses must reconnect company success with social progress. In the view of Porter and Kramer, shared value does not come only from ‘sharing’ the value through a redistribution of wealth, merely shared value has a positive sum outcome in which both economy, ecology as well as social value are expanded as a whole.

Although both practitioners, planners and researchers agree upon the strategic significance of the port-city interface, there is only too little common understanding what this strategic significance actually is, and how to realize shared value in terms of a truly sustainable development of the port-city interface.

Introduction to the concept of Aquapuncture

Aqpuncture is an instrument for the optimal use, adaptation and management of inland waterways and their waterfronts (Waterman and Brouwer, 2015). An analogy is found in the traditional Chinese method of acupuncture. Whereas acupuncture is defined as a treatment to adjust and alter the body’s energy flows into healthier patterns, Aquapuncture is defined as the optimal use, adaptation and management of inland waterways and their waterfronts for safety from flooding, navigability, economy, employment and spatial quality, while safeguarding environmental values, nature and landscape.
Urban & Rural Characteristics
For an optimal use, adaptation and management of the waterways and waterfronts, it is necessary to take into account the urban and rural characteristics along the waterfronts.

User Groups
Six actual and potential user groups should be considered: commercial shipping, touristic motor boating, water related sports (sailing, rowing, rafting, angling, canoeing, surfing, swimming), special nautical events (e.g. SAIL, floating flower shows, regatta of historical ships, dragon boat races, concerts on water), waterfront users and developers (residents, visitors and companies at the waterfront), and lastly flora and fauna in the waterbed, water column and waterside (Waterman & Brouwer, 2015).

Physical Adaptations / Interventions
In order to achieve the full value of Aquapuncture for the user groups, a number of physical adaptations c.q. interventions will have to be taken. Waterman & Brouwer (2015) distinguish 20 different adjustments to waterways and their waterfronts, waterfront development, civil works constructions (such as sluices, bridges, pumping stations, quay walls), environmental dredging, connecting waterways infrastructure, inland terminals, yachting harbours, improvement of spatial and environmental qualities, revitalising cultural heritage in and along waterways, measures with regard to climate change, introduction of more efficient and environment-friendly vessels.

Organisation
An integral approach also necessitates organisational measures, particularly an active participation of stakeholders, public private partnerships, a societal costs-benefits analysis, cooperation with different levels of government, a well-functioning institutional framework (Trias Politica), knowledge and education, information, awareness, promotion, and communication tools (e.g. internet, apps).
**Shared Value of Aquapuncture with regard to the Port-City interface**

Waterman and Brouwer (2015) identified five streams of shared value creation via Aquapuncture: 1) water quantity revenues, 2) water quality revenues, 3) waterway navigability revenues, 4) waterfront revenues, and 5) spatial quality revenues.

For unlocking the five streams of shared value creation, upfront investments will have to be taken for realizing the long term direct and indirect revenues (e.g. improved liveability, quality of life) as well as for avoiding costs (e.g. in the case of flood disasters). Apart from initial investments, maintenance and operational costs have also to be reckoned with. In return there are often in a later stage revenues of various types and from various sources, as well as from cost avoidance. In all cases the combined involvement of governments (central, regional, local), private enterprises, research institutes, educational institutes and environment-nature-landscape, and the sociosphere with inter-human relationships - is required.

Harmonious integration means on the one hand multiple functions, on the other hand zoning of functions, both with active involvement of all relevant actors. Aquapuncture is an important instrument for the improvement of port-city relations based on creating shared value all around. The importance of shared value of Aquapuncture with regard to the Port-City interface can be perfectly illustrated in the development of the port-city Rotterdam.

**Rotterdam – waterways and their waterfronts for city and port development**

Rotterdam is a typical example of a transition from separate Port-City development to Port-City development in conjunction. A port development in seaward direction away from the city is now followed by a seaward development of the city in harmony with the port, striving for a sustainable multifunctional climate proof Port-City.

Going from east to west, we observe a step-by-step expansion of the Rotterdam port in seaward direction, but also from west to east, for cruise port activities, but also for inland waterway connections for both cargo and commuting and leisure traffic. Parallel to the port developments we see the development of the city likewise in both directions, leading to a stronger fruitful harmonious interaction between city and port. All this follows perfectly the principles of Aquapuncture.

It is interesting to note that these multifunctional port-city developments along the parallel shores of the Rhine-Maas River were coupled by crosslinking the advanced northern city centre with the underdeveloped southern city parts through the iconic Erasmus bridge. This resulted in the creation of a lively urban district Kop van Zuid with a dynamic waterfront. In addition floating structures were successfully introduced in old harbour basins for various purposes, such as a congress centre, floating houses and a floating forest.

The Kop van Zuid district is part of a larger city renewal programme, called Stadshavens. This programme covers an area of 1,600 hectares, including 600 hectares of port basins. Over a period of 20 to 40 years, four port areas are being redeveloped into an area for accommodating business, not only for port and transport companies, but also for start-up companies and knowledge institutes. With Stadshavens the city of Rotterdam has three ambitions: connecting the city with the port, sustainable development and strengthening the international image. In the entire area, the city plans to develop 13,000 climate resilient houses of which 1,200 will be developed as a floating village on water, 1,000 students will find their education and 13,000 new jobs will be created within the area. The four ports Waalhaven/Eemhaven, Rijn/Maashaven, Rotterdam Drydock Company (RDM) and Merwehaven/Vierhavens are currently still being used for port and transport purposes although the areas are showing an increasingly wider variety in use. RDM is converted into a campus where students
from Rotterdam universities and vocational colleges are jointly learning and working on innovative industrial design projects, such as 3D printing, robotics and city architecture.

Further going westward, we see waterfront development of the adjacent cities of Schiedam, Vlaardingen, Maassluis ending with Hook of Holland. Hook of Holland has a unique position at the end of two confluent important European rivers Rhine and Maas and at the same time is bordering the North Sea. Therefore is foreseen in a further development of Hook of Holland with a tidal lagoon, marina, housing in an attractive dune landscape, a hotel conference centre with rotating top restaurant with a view to the double entrance of the Port of Rotterdam, and with intermodal connections by rail, road and waterway. In addition, an iconic Dutch Wind Wheel is planned to be realized providing hotels, houses with an internal wheel that generates energy for the entire complex. Rotterdam World Expo 2025 is also considered.

**Rotterdam – waterfront for port and inland waterway transport**

The importance of Aquapuncture© is shown by these waterfront developments and in the optimal use, adaptation and management of the waterways Rhine, Maas, New Waterway, Caland Canal, Hartel Canal and further inland waterways for transportation of cargo and passengers (commuters, tourists), urban waterfront development and for festivals.

Referring to the transportation of cargo, we must realise that we have to consider transportation by water, road, railroad and pipeline separately and in conjunction. We need simultaneously improvement of all these transportation modes with the emphasis on environment-friendly transportation.

<table>
<thead>
<tr>
<th>Year</th>
<th>Barge</th>
<th>Rail</th>
<th>Road</th>
<th>Pipeline</th>
<th>Int'l</th>
<th>Overall</th>
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<tr>
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<td>136</td>
<td>12</td>
<td>67</td>
<td>-</td>
<td>206</td>
<td>276</td>
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<tr>
<td>1985</td>
<td>122</td>
<td>57</td>
<td>25</td>
<td>35 15%</td>
<td>225</td>
<td>251</td>
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<tr>
<td>1990</td>
<td>141</td>
<td>68</td>
<td>26</td>
<td>41 16%</td>
<td>260</td>
<td>288</td>
</tr>
<tr>
<td>1995</td>
<td>157</td>
<td>69</td>
<td>25</td>
<td>45 16%</td>
<td>282</td>
<td>293</td>
</tr>
<tr>
<td>2000</td>
<td>143</td>
<td>76</td>
<td>26</td>
<td>52 18%</td>
<td>288</td>
<td>322</td>
</tr>
<tr>
<td>2005</td>
<td>146</td>
<td>94</td>
<td>30</td>
<td>53 17%</td>
<td>311</td>
<td>370</td>
</tr>
<tr>
<td>2010</td>
<td>147</td>
<td>87</td>
<td>29</td>
<td>52 17%</td>
<td>304</td>
<td>430</td>
</tr>
<tr>
<td>2013</td>
<td>152</td>
<td>96</td>
<td>30</td>
<td>48 15%</td>
<td>317</td>
<td>440</td>
</tr>
</tbody>
</table>

*Table 1: Modal split in Rotterdam (source: Port of Rotterdam)*

Inland waterways are becoming more and more important for the transport of cargo through the introduction of inland container terminals combined with physical adaptation of the inland waterways including higher and moveable bridges, adaptation of dredging depths, sluice adaptation, quay walls and mooring facilities, implementation of new logistics concepts based on data acquisition, data storage, data transmission, data processing and data sharing.

Inland ports are at the heart of the hinterland strategy of many seaports. They allow the seaports to reach far into the hinterland, thereby offering transport mode alternatives, which are often cheaper and ‘greener’ than moving goods by truck. Cities along the inland waterways are now (re-)discovering their economic potential by developing terminals for bulk and container handling. A striking example how such concept can work on a short distance as well is the Alpherium inland container terminal in Alphen aan den Rijn, a city only 70 kms away from the port of Rotterdam. Dutch beer brewery Heineken (export) and retailers Zeeman, Blokker, Intertoys and Marskramer (all import) bring sufficient volumes to run a daily shuttle service to the ports of Rotterdam and Antwerp. A positive effect for the densely populated region is the reduction of trucks over the motorways, which leads to a reduction of approximately 7.5 million road kilometres per year and 35% CO₂ reduction.
InlandLinks is the initiative started in 2011 by the Port of Rotterdam Authority, in collaboration of VITO, the association of inland container terminals. For the port of Rotterdam to maintain accessible, the port has to make better use of the waterways for hinterland transport. Sustainability, accessibility and transparency were the keywords for developing a platform which would help shippers and forwarders finding information on hinterland transport alternatives, i.e. locations of inland terminals, available facilities, services of barge and rail operators, and route planning. It is interesting to witness how additional dynamic services are now being developed on top of this platform.

Inland waterways for people transport

Inland waterways are not only of importance to freight transport, but increasingly also for transport of persons and for festivals / special events.
Public transport over water through the introduction of the waterbus between the Drechtsteden and Rotterdam has become an attractive alternative for commuters traveling between their home cities and Rotterdam. Already after one year 1.8 million passengers were transported in this way. This network is now further expanded with connections to other neighbouring cities of Rotterdam. The waterbus carries passengers of which 65% bring their bicycles on board.
Another example of passenger transport is offered by Watertaxi, which brings people on demand from A to B. In 2012, Watertaxi transported around 200,000 passengers over water, while in 2015, they forecast to take more than 350,000 people on board. 70 skippers generate revenues of around € 2 million per year.

Another category of passengers can be found in the tourist cruise sector, both in river and canals as well as in world sea cruises. The city and port of Rotterdam recently invested in the sea cruise terminal. The investment of EUR 7 million – especially the enlargement of the passenger terminal allows for a doubling of the present 30 ship calls per year. River and canal cruises are becoming increasingly popular, providing opportunities for tourists to explore the dense inland waterways network of Europe. In addition, there is the sector of private motor boating using this network.
Optimal use, adaptation and management of this international network through Aquapuncture plays a vital role in the further development of the connecting inland waterways and their waterfronts for economy, employment and liveability.

Rotterdam - festivals and events on and along the waterfront

Although ports have vast industrial areas full of factories, warehouses, ships and heavy equipment, ports can form an attractive environment for leisure activities and festivities at the water or on waterfront areas. With the 38th annual World Port Days, the port of Rotterdam is most consistent in its endeavour to link port to city, and with success. In good or bad weather, the non-profit organization manages to bring in between 300,000 to 450,000 people into the port in a 3-day event. Besides, the city is a frequent start or stop-over for sailing events, such as the Race of the Classics and the Tall Ships Race. The Maritime Museum Rotterdam connects past to present with future oriented activities, linking generations and thereby using their fleet of heritage ships in the museum harbour.

Rotterdam - water quality and water quantity

The Municipality of Rotterdam, Port of Rotterdam Authority, DCMR Environmental Protection Agency Rijnmond and employers’ association Deltalings work together in Rotterdam Climate Initiative (RCI) as partners to enhance the sustainability of the city, port and industrial complex. There are a range of projects to find solutions for hazardous emissions from industry and transport sector for practical use in the urban and rural environment. Examples are numerous, e.g. the warm water circuit from industrial clusters for heating of houses as well as greenhouses, the use of CO₂ from industrial complexes and power stations for use in greenhouses of Westland district, adequate sewer systems coupled with modern waste water purification installations and rain storage facilities in city parking lots.
Aquapuncture - Shared Value: Objectives and Measurements

The realisation of shared value in port-city development through Aquapuncture can be expressed in a measurement model. This model sets SMART objectives and gives an insight into qualitative and quantitative factors involved, leading to the desired shared value.

### Aquapuncture – Shared Value: Objectives and Measurements

<table>
<thead>
<tr>
<th>Values</th>
<th>Objectives</th>
<th>Measurement Model</th>
</tr>
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</table>
| 1. Water quantity | a) Ensure flood protection  
      b) Surface water & ground water regulation  
      c) Drainage, irrigation for agriculture & aquaculture  
      d) Drinking water supply  
      e) Cooling water  
      f) Process water  
      g) Water flow energy | The above radar diagram visualises performance and comparison between various port-cities with regard to Aquapuncture achievements. |
| 2. Water quality | a) Improvement of water quality for environment  
      b) Improvement of water quality for nature  
      c) Improvement of water quality for health | Translating each item within the five classes of main objectives into measures requires context-specific insights. It is important to realise that there is a large variety in complexity when measuring these objectives. It is important to understand the unit of measure, as well as the measurement scale. Furthermore, there is both an interdependency as well as an overlap between various items. Nevertheless, it provides an overall insight into the shared value drivers of the port-city interface. |
| 3. Navigability | a) Commercial transport of persons  
      b) Commercial transport of goods  
      c) Tourism and recreation  
      d) Special events on/at water  
      e) Water related sports  
      f) Waterway classification & connectivity | The chosen measurement model is based on a SMART approach: specific, measureable, achievable, result oriented, time bound. |
| 4. Water front  | a) Increased liveability  
      b) Economic activities  
      c) Increased value of property |                                    |
| 5. Spatial quality | a) Improved urban & rural environment  
      b) Preservation, restoration & usage of cultural heritage  
      c) Attractive residential & business areas  
      d) Leisure parks, sustainable industrial parks  
      e) Overall sustainability, also with regard to climate & climate change |                                    |

*Figure 3: Aquapuncture measurement model*
Conclusion

Sustainable harmonious Port-City development using the instrument of Aquapuncture© leading to Shared Value Creation offers great already proven opportunities for safety from flooding, navigability, economy, employment, and spatial quality while safeguarding environmental values, nature and landscape. The instrument of Aquapuncture© applies to port-city development in all five continents. Ongoing urbanisation combined with increasing international global trade and increasing transportation of persons and goods makes this specific integral approach all the more relevant. Overviewing the leading principle of shared value through Aquapuncture, illustrated by a series of examples in Rotterdam, we introduce an instrument for sustainable port-city development. This instrument is focussing on societal cost benefit analysis, taking into account five streams of shared value. This instrument provides an insight in the present (baseline) condition of port-city relations, while at the same time it forms a roadmap for improvement of this relationship. Furthermore it allows for a comparison between various port-cities with regard to Aquapuncture achievements.

Literature


