IMPACTS OF LOW AND HIGH WATER LEVELS ON RELIABILITY AND TRANSPORT COSTS IN INLAND WATERWAY TRANSPORT

AN INTERVIEW BASED REPORT

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Contents

1 Introduction

The aim of this study is to obtain insight into (1) the effect of low and high water levels on reliability and costs of inland waterway transport, and (2) the responsive behavior of inland waterway carriers and shippers. Consequently, we get an impression if this responsive behavior could be disadvantageous for the competitive position of the Port of Rotterdam. This "research line" is presented in Figure 1 below. We define reliability as the percentage of shipments which arrives on time (within a margin) at its destination within a determined period (week/ month/ year).

Data are collected by means of face-to-face interviews and interviews by phone. In total 8 interviews have been carried out. In six of those interviews the respondent was a shipper. The remaining two interviews were aimed at carriers.[1]

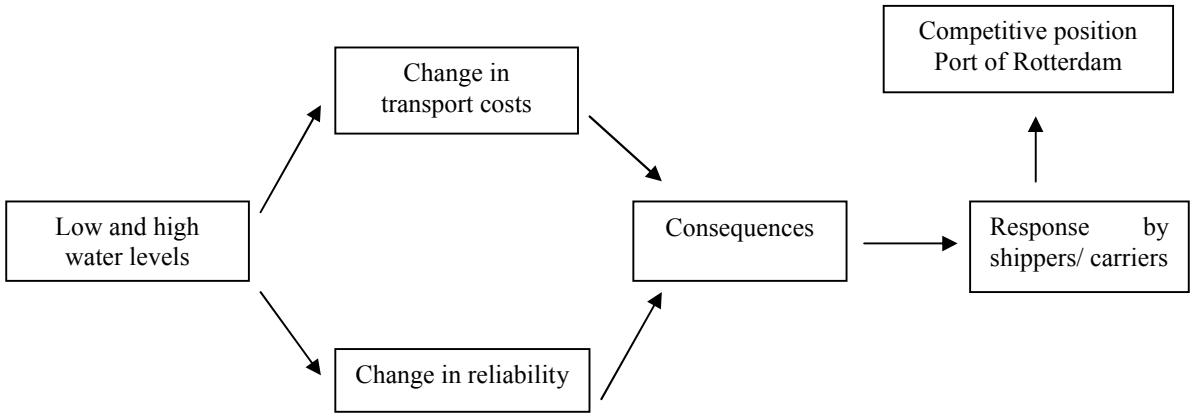

Figure 1: Research line

The insights we obtain in the current report are relevant since costs and reliability play an important role in determining the competitive position of inland waterway transport. Climate change is likely to affect these determinants of mode choice negatively, possibly resulting in a loss of freight by inland waterways to competing modes. Consequently, the competitive position

[1] The respondents are obtained via the consortium partners and Rink Jan Slotema from EVO, an organization which looks after the logistical interests of shippers. We contacted all the potential respondents (15) and finally 8 were willing to participate.

of sea-ports that (heavily) rely on inland waterway transport (the Port of Rotterdam for example) may worsen. An overview of the existing literature on the topic of climate change, transport costs and transport reliability can be found in (Jonkeren and Rietveld 2009).

The remainder of this report is organized as follows. In Section 2 we will discuss the interviews with the shippers and in Section 3 the interviews with the carriers are presented. Finally, Section 4 concludes.

This interview based research is carried out in the framework of the Dutch National Research Programme "Knowledge for Climate, Hotspot Rotterdam". Its aim is to contribute to the knowledge of the impact of climate change on the Rotterdam region and to examine how the impact can be reduced in order to make the Rotterdam area 'climate proof'.

2 Interviews with shippers

As a result of future climate change, inland waterway dependent shippers might be confronted with disturbances in their logistical processes. A considerable number of days with extremely high water levels, such that inland waterway transport is blocked during these days, may have significant consequences for transport and production. In periods with low water levels, inland ships are usually able to navigate. However, due to detours, congestion in front of bridges and locks and restrictions with respect to the load factor of ships[2], inland waterway transport becomes more expensive and less reliable. As a result, production processes of inland waterway transport dependent firms may be disturbed. To gain some insight into this issue we interviewed six shippers who make use of inland waterway transport. Table 1 shows some characteristics of the interviewed firms.

[2] Because the capacity of the fleet is limited in periods with low water levels a new equilibrium between demand and supply for cargo hold is established. As a result, the transport price per tonne increases. In addition, shippers pay a so called low water surcharge to the carriers in order to compensate them for the higher costs per tonne.

Table 1: Characteristics of the interviewed shippers

Firm	Annual amount of cargo transported by barge (in tonnes)	Route	Cargo
A	100.000	Hengelo – Utrecht[a]	Salt
B	750.000	Obrichheim – Maastricht[b]	Bricks, gypsum, nitrate, iron oxide
C	250.000 – 350.000	Rotterdam – Enschede[c]	Gravel, sand, animal fodder
D	24.000.000	Rotterdam – Duisburg[d]	Ore, coal
E	1.000.000	Liekse (B) – Rotterdam[e]	Gypsum, fly ash, bottom ash
F	2.500.000	IJmuiden - Basel[f]	Coils

[a] Twente canal, IJssel, Neder-Rijn, Amsterdam-Rhine canal
[b] Neckar, Rhine, Meuse
[c] Twente canal, IJssel, Neder-Rijn, Lek
[d] Waal, Rhine
[e] Meuse or Meuse, Waal
[f] North-sea canal, Amsterdam-Rhine canal, Waal, Rhine
Note: Shipper D makes use of pushed barges with a large draught.

Our goal to create some heterogeneity in the respondents is fulfilled. They differ considerably concerning their annual demand for transport by barge, the origin-destination combination and cargo type. This allows us to identify differences in the vulnerability to climate change across shippers. For example, a shipper that hires transport on a route which includes an origin or destination that is located in the upstream part of a river is likely to be more vulnerable to low water levels than a shipper whose demand for inland waterway transport concerns a route in a downstream part of a river.

We will now discuss the answers of the respondents on each question. The questionnaire can be found in Appendix A.

Question 1:

In the first question we asked the respondent what the margin for a reliable inland waterway transport service is considered to be.

Three out of six respondents mention a time span of between 0 and 4 hours from the agreed arrival time (shippers A, C and D). The remaining three respondents all gave different answers: within 1 hour, within 1 day and within 3 days. The answers imply there is a considerable level of heterogeneity with respect to what is an acceptable level of reliability.

Question 2:

In the second question, we asked if the shippers have experienced periods with low and high water levels in the past (question 2A) and if they have been confronted with (1) a decrease of the reliability of inland waterway transport and (2) an increase in inland waterway transport costs (question 2B) in these periods.

In appears that all shippers have experienced an increase in transport costs and five out of six shippers observed a decrease of the reliability of inland waterway transport as a result of low and/or high water levels in the past. The answers to this question show that all respondents are suitable for inclusion in this research.

Question 3:

In question three the respondents were confronted with two low water level situations and two high water level situations, as how they may occur in the KNMI'06 climate scenarios "W" and "W+":

High water, W: a blockage of the waterway of 2 days once a year.

High water, W+: a blockage of the waterway of 5 days once a year.[3]

Low water, W: during an uninterrupted period of 20 days a year the water depth in the river Rhine is less than 250 cm.

Low water, W+: during an uninterrupted period of 31 days a year the water depth in the river Rhine is less than 180 cm.

The respondents were asked about their expectations on the impact of the low and high water level situations on reliability and transport costs. First, we focus on the high water level situations.

[3] Some shippers transport their cargo on routes which do not make use of the Rhine. In this case the shippers' shipments are not influenced by a blockage. However, it is interesting to know how these shippers would react in case a blockage occurs because their answers may be representative for other, not-interviewed shippers who do make use of the Rhine.

In general, a blockage of inland waterway transport of 2 or even 5 days does not imply serious cost increases. The extent to which shippers are confronted with cost increases is partly dependent on what is agreed in the contract with the carrier. In some cases (shippers B, C, E and F) the risk of not being able to navigate is (partly) taken by the carrier. Apparently, the carrier is willing to bear this risk because the frequency with which a blockage due to high water levels occurs is very low (about once a year on average). Two shippers (A and D) mention that they are confronted with an increase of transport costs because the cargo on the inland ships that are not able to navigate is transshipped to other transport modes and further transported to its end destination by those modes. In the case of shipper A the cost increase for a particular transport due to a blockage is estimated to be 5% in scenario W and 10% in scenario W+.

The interpretation of reliability is for some shippers different than the definition given above. In their minds reliability is considered to be the probability to which their production processes are interrupted due to disturbances in the delivery of cargo. A blockage of transport of 2 days is considered to lead to a deterioration of reliability for none of the shippers. Stocks are high enough to bridge such an interruption in deliveries.[4] For three (C, E, F) out of the six shippers an interruption of 5 days may have a negative impact. Shipper C mentions that its stock is sufficiently large to bridge a non-delivery period of 5 working days. However, in case that a peak in demand (in spring and autumn for shipper C) coincides with a blockage of the waterway of 5 days or more (so that ships are not able to reach their destination during this period), it is likely that the shipper's production process will be interrupted. Shipper E suffers from the same problems in case a blockage lasts for 3 days or more. This shipper has to stop production because the stock facilities at the production location are filled up to maximum capacity then. Shipper F mentions that reliability of inland waterway transport will also worsen from a blockage of 3 days or more. However, by informing the client and by updating the arrival time the consequences for its clients will be limited.

If we focus on low water levels and its effect on transport costs, we observe that all shippers are confronted with increasing transport costs both, in scenario W and W+. However, the extent to which this occurs differs significantly over the shippers. Shippers A and C for

[4] Note that a shipper's location can be the destination of an inland waterway trip, but also an origin. In the latter case, the deterioration of reliability applies to the client.

example, who make use of an inland waterway route which is relatively insensitive to low water levels (canals and a downstream part of the river Rhine), mention that in scenario W, transport costs rise by about 10%. However, in periods with economic upswing it can be somewhat more.[5] For shipper D, who has a relatively high annual demand for transport by inland waterways and makes use of large barges, the situation is much worse as it is confronted with an increase of the transport price per tonne of 500% in the low water level period in the W scenario. Shipper B, who transports on a route which covers the middle Rhine mentions price increases of about 100%. Shipper F takes into account an annual low water level period when annual inland waterway transport contracts are being set up. So the costs of low water surcharges are already included into the contracts and annual budget. In case of scenario W+, shippers B, D, E and F agree that transport prices explode. Shipper A mentions an increase of about 20% and in periods with economic upswing about 50%.

All shippers agree that in case of scenario W, the reliability of inland waterway transport will hardly be affected. In the W+ scenario however, the consequences for reliability are worse although there are differences. Shipper A thinks this situation will lead to a 10% decrease in reliability (10% of the shipments do not arrive within the time frame). Shippers B, D and E fear that reliability (and frequency) of delivery will deteriorate to such an extent that the use of materials is higher than its delivery. As a result, production processes will be interrupted or come to a standstill. Shipper D says: ‘our fleet cannot be used during one month of the year in case of the W+ scenario because without being loaded the draught is already 200 cm, so we focus on the spot market’.

Question 4:

In this question we asked the respondents to tell something about the consequences of the situations that were outlined in the previous question.

[5] Shippers who are not confronted with low water levels when hiring inland waterway transport do pay higher transport prices in periods with low water levels because of the scarcity effect: supply of cargo hold in the market is reduced in periods with low water levels. In periods of economic boom this scarcity effect is combined with a relatively high demand leading to even higher transport prices.

The consequences are shipper-specific. Therefore, each shipper will be dealt with separately.
Shipper A: the consequences are dependent on the season. In winter, demand is high, in summer low. The main consequence is a potential limitation of production.
Shipper B: the continuity of production will be in danger when there is a blockage of 14 days or more (high water levels) or in case of the low water level situation in the W+ scenario.
Shipper C: a blockage of 5 days or more and low water levels in case of scenario W+ will harm production.
Shipper D: low water levels in the W+ scenario will lead to a *standstill* of production.
Shipper E: in order to make optimal use of the stock facilities we have to downgrade the product (in wet conditions the product will decrease in volume, but also in value (40-50%)).
Shipper F: the consequences will apply to the client, not to us.[6]

Question 5:

This question is posed to get some insight into the short term adaptive behavior of the shippers. Knowledge on this issue is relevant for the Rotterdam region as this behavior might have positive or negative consequences for the Port of Rotterdam.

All shippers mention the use of alternative transport modes (rail and truck) as a short term reaction to interruptions in inland waterway transport, although for some shippers railways is not an option. In addition, the capacity that is offered by those alternative modes is usually less than the capacity offered by inland waterways. As a result, every day that barges cannot be used, stocks at production locations decrease. Shipper A mentions that the impact of low water levels on the use of alternative modes is much larger than the impact of high water levels. Shipper B is able to shift all the cargo originally transported by barge to trucks. This is possible because if cargo is delivered by truck, it is sourced from a more nearby location. Trucks drive in colons in this case. In addition to alternative modes, shipper B mentions other short run measurements, for example, postponement of inland waterway transport. In case a low water or high water situation does not last long it is able to postpone transportation by inland waterways. This shipper is also able to change the composition of the product they make: the proportion in which the different

[6] This shipper is not the receiver of the cargo but the sender.

inputs are being used can be changed. Shipper D mentions that shifting to railways is seen as a bad alternative because it considers the reliability of this mode to be bad and in addition there is not enough capacity because other shippers also move to railways.

Question 6:

This question is posed to get some insight into the long run adaptive behavior of the shippers. Knowledge on this issue is relevant for the Rotterdam region as this behavior might have positive or negative consequences for the Port of Rotterdam.

As the answers to this question were quite respondent-specific each shipper will be dealt with individually.

Shipper A mentions that investing in extra stock facilities at the production location could be an option in the case that the extra transport costs by inland waterways outweight the investment costs.

Shipper B uses push barges as temporal stock facility. This shipper plans to put empty push barges close to the production location. The advantage is that the extra stock capacity is hired temporarily. For a warehouse rent has to be paid during the whole year.

Shipper C has explored the possibility to insure the extra costs as a result of transportation by truck instead of by barge in periods with low water levels. However, the fee turned out to be very high so that insuring the risk of low water levels is not an issue of consideration.

Shipper D increased its inland ship fleet capacity by means of ordering more and larger barges so that during periods with low water levels more capacity remains available.

Shipper E applies a higher safety stock level during the year. In addition, this shipper contractually transferred the risk of non-delivery to the client. So, it is not responsible anymore for the consequences for the client of non-delivery. Next, it contracts more ships. In periods in which a part of the hired capacity is not being used it tries to rent the excess capacity to other shippers.

Shipper F: explored the possibility of an alternative logistical chain. The idea was to transport the cargo from Ijmuiden to Duisburg by inland waterways and for the remaining part to Basle by

train. In the W+ scenario this alternative could be interesting from a cost perspective. Under current climate circumstances it is not.

Question 7:

Shippers were asked if, from their point of view, the high- and low water situations as described in question 3 harm the image/ reputation of the Port of Rotterdam.

Shippers B and C indeed do think that the image will deteriorate as a result of a worse functioning of inland waterway transport (due to climate change). The answer of shipper D is somewhat more subtle. The image of the Port of Rotterdam does not change for this shipper, however, it argues that the port should take its responsibility with respect to supporting the inland waterway transport sector. For example, during the low water level period in 2003 sandbanks originated in the Waal. Because the budget for dredging was already gone, at first the Dutch government could not gain financial means for extra dredging. The Port of Rotterdam eventually helped the inland waterway transport sector by means of lobbying for extra money. From the point of view of shipper D the Port of Rotterdam could have acted quicker.

3 Interviews with carriers

Like in the previous section, we start by showing some characteristics of the interviewed respondents. The questionnaire which was used to interview the carriers is very similar to the one to interview the shippers. It can be found in Appendix B.

Table 2: characteristics of the interviewed carriers

Firm	Annual amount of cargo transported by barge (in TEU)	Route	Cargo
G	90.000	Rotterdam/ Antwerp – Cologne[a]	Containers
H	800.000	Rotterdam – Basle[b]	Containers

[a] (Scheldt) Waal, Rhine
[b] Waal, Rhine

Question 1:

Also the carriers were asked about their opinion on a reliable service and the arrangements concerning this issue with their clients.

The reliability target of carrier G is to deliver within one hour from the agreed arrival time. His client has the disposal over tracking & tracing facilities. Carrier H has agreed with its client to deliver the container within a time window of one day. This carrier also works with a performance indicator concerning reliability: on an annual basis 95% of all deliveries to clients must arrive within the time window.

Question 2:

In the second question, we asked if the carriers had experienced periods with low and high water levels in the past (question 2A) and (1) if their reliability decreased and (2) if their transport costs increased (question 2B) in these periods.

Both carriers answered positively to the first part of the question. Carrier G mentioned that in case of low water levels, reliability and transport costs are the same for his enterprise as in a situation of normal water levels. For his client, reliability is equal as well in both situations but transport costs increase during periods with low water levels because it has to hire additional capacity from the spot market. In case of high water levels leadings to a blockage the carriers' reliability will deteriorate if nothing is undertaken.

Carrier H says that its reliability worsened several times due to periods with low/high water levels in the past. During a period with low water levels, transport costs rise for its client due to low water surcharges. In case of short-period blockages due to high water levels (up to maximally 24 hours) the extra costs are limited and those costs are not or only partly passed on to the client.

Question 3:

Also the carriers were confronted with the two low water level situations and two high water level situations, as how they may occur in the KNMI'06 climate scenarios "W" and "W+". For the sake of convenience we repeat them:

High water, W: a blockage of the waterway of 2 days.

High water, W+: a blockage of the waterway of 5 days.

Low water, W: during an uninterrupted period of 20 days the water depth in the river Rhine is less than 250 cm.

Low water, W+: during an uninterrupted period of 31 days the water depth in the river Rhine is less than 180 cm.

So, the carriers were asked about their expectations on the impact of the above mentioned situations on reliability and transport costs. First, let's focus on the high water level situations.

If water levels are so high that a blockage is nearly the case, carrier G is only able to navigate with 4 layers with containers instead of 5. So, he is restricted in its load factor but still able to deliver the same level of reliability. In case of a blockage of 2 or 5 days, the costs of lying still are borne by the carrier for 50% and by the client for the other 50%. Reliability will decrease because the carrier is not able to reach its destination. However, a blockage can be foreseen a few days in advance. So, the carrier tries to reach a terminal before the high water level situation occurs. In the terminal the containers can be transshipped to other modes. The containers will arrive too late but are not stuck on the carrier's ship for a few days.

The opinion of carrier H is that a blockage of 2 or 5 days, once a year, does not harm the reliability so much because reliability is measured over a period of one entire year. Like carrier G, it mentions that much can be arranged in case of a blockage of 2 or 5 days (alternative navigation schemes and alternative transport modes for example) because a blockage is forecasted. So, it never comes as a surprise. The deterioration of reliability for the client will therefore be limited. The costs of a blockage of 2 or 5 days will (partly) be charged to the client.

At extreme low, but navigable water levels (W+) carrier G can still offer a reliable transport service. He receives his daily rent, but the load factor is about 50%. So, reliability and costs for the carrier in this low water situation are equal to a situation with normal water levels.

As reliability does not change for this carrier, it neither changes for its client. However, because carrier G can transport only half the amount of the original shipment size, in a W+ low water situation costs rise for the client. After all, the client has to rent extra inland shipping capacity. In the case that water levels are so low that navigation is not possible anymore, carrier G will not receive his daily rent anymore.

For carrier H low water levels in the W scenario do not affect reliability. Transport costs increase but they are recovered by means of low water surcharges. Low water levels in scenario W+ have a major impact on reliability and costs. Costs will increase because the low water surcharges are not high enough to compensate for the extra costs of hiring extra capacity.[7] Reliability will be around 50% in the W+ scenario. Depending on the duration of this extreme low water situation the performance objective of 95% on an annual basis will be harder to meet. Carrier H thinks that if low water situations like in 2003 (which is representative for a year in the W+ scenario) occur more often, clients will get more familiar with these situations and act more rational. As a result the reliability percentage will probably be higher.

Question 4:

In this question we asked the carriers to tell something about the consequences of the situations that were outlined in the previous question.

Shipper G mentioned that the described consequences on costs and reliability above do not have further impacts for his company. According to carrier H, some large shippers have structurally divided their cargo over inland waterways and railways where possible, while especially before the year 2003 those shippers fully focused on inland waterways. However, clients did not leave carrier H.

Question 5:

This question was posed to get some insight into the short term adaptive behavior of the carriers and to observe if this behavior might have positive or negative consequences for the Port of Rotterdam.

[7] Carrier H will search for extra capacity at the spot market to increase the capacity of its own fleet in periods with extreme low water levels.

As carrier G is not confronted with further negative impacts of a worse reliability and an increase in transport costs he does not have to take any short term measurements. The short term adaptive behavior of carrier H is to:

- Increase navigation speed.
- Optimize the utilization of the fleet: re-distribute the cargo over the available capacity.

Question 6:

This question was posed to get some insight into the long term adaptive behavior of the carriers and to observe if this behavior might have positive or negative consequences for the Port of Rotterdam.

As carrier G is not confronted with further negative impacts of a worse reliability and an increase in transport costs he does not have to take any long term measurements. The long run adaptive behavior of carrier H is to convert its organization from a barge-operator to a container operator. It wants to offer its client a high-quality product: a reliable transport service against a competitive price. By which transport mode the container is moved from location A to location B is not of primary importance. In addition it is participating in research on the propulsion of the ship in order to (1) decrease the ship weight (which is interesting in the light of low water levels) and (2) increase the ship's fuel efficiency.

Question 7:

Carriers were asked if, from their point of view, the high- and low water situations as described in question 3 harm the image/ reputation of the Port of Rotterdam.

According to carrier G, the reputation does not change due to climate change. Carrier H has an advice for the port: if, as a sea-port, the Port of Rotterdam wants to be reliable, it has to promote/ develop all transport modes and use them optimally under different circumstances.

4 Conclusion

In this section we will briefly summarize the main findings from the interviews and examine how the behavior of shippers and carriers, as a response to low and high water level situations, may affect the competitive position of the Port of Rotterdam.

Because knowledge on the frequency and duration of future high water level situations - leading to a blockage of inland waterway transport - is lacking, we confronted the respondents with hypothetical W and W+ high water levels situations based on high water level situations from the recent past. Between 2002 and 2008 those situations happened infrequently and lasted for a relatively (compared to the duration of low water situations) short period of time (2 – 4 days) (Jonkeren and Rietveld, 2009). According to the respondents, the reliability of inland waterway transport will then decrease, however, because high water level situations can be forecasted quite precisely, carriers are able to arrange alternative forms of transport. So, consequences for shippers are limited. Nevertheless, two shippers mention that they fear that a blockage of inland waterway transport in the W+ scenario will lead to disturbances in their production processes. On an annual basis, the increase in costs due to high water levels (as a result of transshipment of cargo in terminals and transport by alternative modes) is limited.

In case of low water levels, in both climate scenarios, W and W+, it is expected that transport costs will increase for all interviewed shippers. Depending on the route, cargo type and size of the used barges[8] this increase varies between 10% and 500% and more. Reliability is not affected in case of climate scenario W but in the W+ scenario interruptions and even a standstill of production processes are expected.

[8] Jos Helmer, senior business manager Containers, Breakbulk & Logistics at the Port of Rotterdam, emphasized that especially the increase in ship size in recent years has contributed to the increase in load factor restrictions of barges.

The short and long term actions that are undertaken by shippers and carriers (only last two bullets) to reduce the impact of high and low water levels on transport costs and reliability are:

- Using alternative transport modes (for the whole inland waterway transport route)[9]
- Examining new logistical chains (partly inland waterways, partly rail e.g.)
- Postponement of inland waterway transport (in case of a short high/ low water level period)
- Hiring extra capacity on the inland waterway transport spot market
- Investing in stock facility capacity/ higher stocks
- Increase of the own fleet of inland ships
- An increase of navigation speed
- Transformation from barge-operator to container operator

For the Port of Rotterdam it is interesting to determine whether the above mentioned actions may have an impact on the functioning of the port.[10] As shippers mention that using alternative transport modes is a solution and a carrier is planning to convert its organization from barge-operator to container operator, a more frequent occurrence of periods with (more intense) low and high water levels (climate scenario W+) may increase the frequency and intensity of demand for alternative transport modes. As the railway system is relatively inflexible, those situations are likely to lead to a lack of rail transport capacity.[11] As a result, less cargo will be transported from and to the port in periods with low and high water levels. In addition, more transport by truck is contrary to the policy of the Port of Rotterdam to encourage the shift towards intermodal transport.

Postponement of inland waterway transport may lead to peaks in demand for barge handling capacity as it is likely that just before and after a (short term) high or low water level

[9] In recent years, a few large shippers in the Ruhr area invested in a railway (un)loading site at their industrial area in order to secure transport.

[10] Although not all the examined routes have Rotterdam as an origin or destination point, the behavior of the shippers concerned is relevant as there may exist non-interviewed shippers which do make use of the Port of Rotterdam and show similar behavior.

[11] Jos Helmer mentions the passenger – freight conflict and the number of available locomotives.

period these demand peaks will arise. Container handling and transport capacity will be able to cope with these demand peaks, but for the bulk cargo segment the danger of congestion is present here.

The existence of peaks in demand for barge handling capacity implies that there will also be peaks in demand for storage capacity. After all, if there are low and high water level periods in which barge transport is postponed or limited, the containers and bulk cargo which is supplied by sea vessels must be temporarily stored. Again, a problem is likely to arise here for bulk cargo. Container storage capacity is sufficiently available, certainly in the near future when the second Maasvlakte is constructed.

Strikingly, adaptive behavior like relocation is not mentioned as a (potential) long term action by the shippers, even in scenario W+ where the effects are expected to be severe for some of them. Apparently, the costs and efforts associated with relocating are expected to outweigh the extra costs as a result of low and high water levels. Next, the fact that a shipper decided to use large vessels (in order to have a larger remaining capacity in periods with low water levels) is paradoxical: one would expect the use of smaller ships with a lower draught so that the load factor of the ship can better be utilized in periods with low water levels. Apparently, the savings from economies of scale with large ships during the whole year are larger than the benefits from having a higher load factor with small ships in periods with low water levels.

Concluding, the identified potential impacts for the Port of Rotterdam are (1) a loss of cargo in periods with low/ high water levels and (2) a need for more storage capacity for bulk cargo in the port. Therefore, we may conclude that high and low water levels under the W and W+ scenarios are unlikely to have severe negative impacts on the competitive position of the Port of Rotterdam (via costs and reliability of inland waterway transport).

Acknowledgements

We would like to express our thanks to the interviewed parties for their willingness to participate, the consortium partners for their comments and Rink Jan Slotema from the EVO for the contact data of the respondents.

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Appendices

Appendix A: Questionnaire for shippers

Kenmerken bedrijf:

- Naam.
- Locatie (plaats lossen/ laden).
- Omvang (# personeelsleden).
- Vervoersbehoefte per jaar (in tonnen).
- Product/ grondstof welke u laat vervoeren?
- Modal split aanvoer.
- Modal split afvoer.
- Via welke route worden goederen per binnenvaart aangevoerd?
- Via welke route worden goederen per binnenvaart afgevoerd?

Vraag 1:

Wat is de marge voor een betrouwbare binnenvaartdienst voor uw bedrijf?

- Binnen 1 uur van de afgesproken tijd.
- Binnen 0 – 4 uur van de afgesproken tijd.
- Binnen 1 dag (0 – 24 uur) van de afgesproken tijd.
- Binnen 0 – 7 dagen van de afgesproken tijd.
- Anders namelijk …..

Vraag 2:

Een aantal studies meldt dat klimaatverandering de betrouwbaarheid en transportkosten van de binnenvaart gaat beïnvloeden.

Hoge waterstanden: geen scheepvaart mogelijk gedurende een aantal dagen (in geval van stremming).

Lage waterstanden: mogelijke vertragingen door omleidingen, 1-richtingsverkeer, congestie bij sluizen/ bruggen door extra scheepsbewegingen, laagwatertoeslagen.

A Heeft uw bedrijf in het verleden te maken gehad met perioden met lage en hoge waterstanden? (ja/ nee).
B Heeft u last gehad van hoge en/of lage waterstanden in termen van:

- Een verslechtering van betrouwbaarheid van de binnenvaartdienst voor uw bedrijf? (ja/ nee).
- Een stijging van de transportkosten? (ja/ nee).

Vraag 3:
Kunt u aangeven in welke mate u denkt dat de betrouwbaarheid en de transportkosten veranderen bij verschillende laag-en-hoog water situaties (schatting)? (Voor betrouwbaarheid: dus verandering in % zendingen, dat te laat komt en verandering in hoeveel te laat. Voor transportkosten: in welke mate (%) u denkt dat de transportkosten stijgen (of dalen)).

Hoog water:

- Stremming van 2 dagen (W)? Gemiddelde (over de tijd) stijging afvoer in dec/jan/feb 8% t.o.v. huidig.
- Stremming van 5 dagen (W+)? Gemiddelde stijging afvoer in dec/jan/feb 16% t.o.v. huidig.

Laag water:

- 20 dagen per jaar vaardiepte Rijn < 2,5 meter (W)
- 31 dagen per jaar vaardiepte Rijn < 1,8 meter (W+). Gemiddelde daling afvoer in jun/jun/aug 40% t.o.v. huidig. Situatie 2003.

% verandering gelijk voor Lobith, Kaub, Rheinfelden.
Bronnen: KIM, 2008 en te Linde, 2007.

Vraag 4:
Wat zijn gevolgen van deze mate van veranderingen in hoog en laag water voor de betrouwbaarheid van de binnenvaartdienst en de transportkosten voor uw bedrijf? (Onderbrekingen productie?)

Vraag 5:
Wat doet uw bedrijf/ kan uw bedrijf op de *korte termijn* doen om de gevolgen van een slechtere betrouwbaarheid en hogere transportkosten door hoge en lage waterstanden op te lossen?

Vraag 6:
Bij welke mate van een verslechtering van de betrouwbaarheid en verhoging van de transportkosten zou uw bedrijf gaan overwegen iets te ondernemen (qua logistiek/voorraden, andere modaliteit, relocatie) om de (negatieve) gevolgen tegen te gaan op de *lange termijn*?

Vraag 7:
Indien uw bedrijf regelmatig met een verandering in de betrouwbaarheid en transportkosten wordt geconfronteerd als beschreven onder 4, verandert in uw ogen dan het imago van de haven van Rotterdam?
Zou deze verandering van het imago dan invloed hebben op de manier (binnenvaart, spoor, weg) waarop/ de mate waarin u gebruikt maakt van (de diensten in) de haven van Rotterdam?

Appendix B: Questionnaire for carriers

Kenmerken vervoerder:

- Naam.
- Omvang (# personeelsleden).
- Vervoerd gewicht/volume per jaar (in tonnen/TEU).
- Via welke route vervoert u hoofdzakelijk?

Vraag 1:

Wat is de marge voor een betrouwbare binnenvaartdienst voor uw klanten? (Of: wat vindt u een betrouwbare binnenvaartdienst voor uw klanten?).

- Binnen 1 uur van de afgesproken tijd.
- Binnen 0 – 4 uur van de afgesproken tijd.
- Binnen 1 dag (0 – 24 uur) van de afgesproken tijd.
- Binnen 0 – 7 dagen van de afgesproken tijd.
- Anders namelijk …..

Vraag 2:

Een aantal studies meldt dat klimaatverandering de betrouwbaarheid en transportkosten van de binnenvaart gaat beïnvloeden.

Hoge waterstanden: geen scheepvaart mogelijk gedurende een aantal dagen (in geval van stremming).

Lage waterstanden: mogelijke vertragingen door omleidingen, 1-richtingsverkeer, congestie bij sluizen/ bruggen door extra scheepsbewegingen, laagwatertoeslagen.

A Heeft uw bedrijf in het verleden te maken gehad met perioden met lage en hoge waterstanden? (ja/ nee).

B Heeft u last gehad van hoge en/of lage waterstanden in termen van:

- Een verslechtering van betrouwbaarheid van uw binnenvaartdienst? (ja/ nee).
- Een stijging van de transportkosten voor uw klanten? (ja/ nee).

Vraag 3:

Kunt u aangeven in welke mate u denkt dat de betrouwbaarheid en de transportkosten veranderen bij verschillende laag-en-hoog water situaties (schatting)? (Voor betrouwbaarheid: dus verandering in % zendingen dat te laat komt en verandering in hoeveel te laat. Voor transportkosten: in welke mate (%) u denkt dat de transportkosten stijgen (of dalen)).

Hoog water:

- Stremming van 2 dagen (W)? Gemiddelde (over de tijd) stijging afvoer in dec/jan/feb 8% t.o.v. huidig.
- Stremming van 5 dagen (W+)? Gemiddelde stijging afvoer in dec/jan/feb 16% t.o.v. huidig.

Laag water:

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% verandering gelijk voor Lobith, Kaub, Rheinfelden.
Bronnen: KIM, 2008 en te Linde, 2007.

Vraag 4:
Wat zijn gevolgen van deze mate van veranderingen in hoog en laag water voor de betrouwbaarheid van uw binnenvaartdienst en de transportkosten voor uw klant? (Klanten weg?).

Vraag 5:
Wat doet uw bedrijf/ kan uw bedrijf op de *korte termijn* doen om de gevolgen van een slechtere betrouwbaarheid en hogere transportkosten door hoge en lage waterstanden op te lossen?

Vraag 6:
Bij welke mate van een verslechtering van de betrouwbaarheid en verhoging van de transportkosten zou uw bedrijf gaan overwegen iets te ondernemen om de (negatieve) gevolgen tegen te gaan op de *lange termijn*? (Ander type schepen? Gebruik andere zeehaven?).

Vraag 7:

Indien uw bedrijf regelmatig met een verandering in de betrouwbaarheid en transportkosten wordt geconfronteerd als beschreven onder 4, verandert in uw ogen dan het imago van de haven van Rotterdam?

Zou deze verandering van het imago dan invloed hebben op de manier waarop/ de mate waarin u gebruikt maakt van (de diensten in) de haven van Rotterdam?

Referenties:

KIM, 2008, *Effect van klimaatverandering op verkeer en vervoer*, Kennisinstituut voor mobiliteit, Den Haag.

Linde te, 2007, *Effect of climate change on rivers Rhine and Meuse*, WL, Delft Hydraulics, prepared for Rijkswaterstaat.