Closure of River Rhine at the Lorelei Rock:

Estimate of Impact and Allocation of Damage

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Summary

This report describes a concise study to estimate the impact of the damage that was caused by the lengthy blockage of the inland shipping sector that took place in the beginning of 2011.

This study aims at a better understanding of:

- The societal impact of the closure from a European perspective.
- The allocation of the damage over the different stakeholders.

The damage costs were allocated over the various IWT stakeholders. These are inland water transport operators but also shippers and other stakeholders. Due to the blockage, alternative means of transport had to be arranged, resulting in scarce capacity and higher fares.

Conclusions

1 The damage to society is considerable: based on the input data used, the total damage done is estimated between 50 and 55 million euro.

2 Although many different parties suffer damages, the major part of the damage costs are absorbed by operators: about 14 million euro due to involuntary waiting and shippers, forwarders and brokers: about 26 million euro, mainly due to having to arrange alternative transport via a shift to other modes or a by-pass.

3 The freight prices used are a very important parameter. In this study we used an average freight price. Freight prices can fluctuate strongly due to variations in the water level. In case of a situation with a low or high water level the damage done to shippers, forwarders and brokers may easily be cut in half or double.

4 Some parties at both ends of the transport chain indicated that they suffered losses, based on the sparse available data it is estimated that the damage varies between millions and tenths of millions of euro. Given the uncertainty, the effect is considered a *pro-memory* item (PM).

5 Concerning the direct damage that was done, stakeholder are not able and/or willing to release any information on the salvaging and repair costs. After an investigation, the German public prosecution department (Staatsanwaltschaft) has concluded that at the time of the accident, the Waldhof was overloaded. This caused a lack of stability that in turn resulted in the accident. Currently, the German Water and Shipping Directorate[1] is still investigating the event, also looking at the salvation and measures taken during salvation.

6 During the closure there was a lack of sufficient berthing places for the operators that had to wait. Operators reported that nautical safety was

[1] Wasser- und Schifffahrtsdirektion (WSD)

contravened. This effect has not been monetized in the study but is considered a PM item.

Recommendations

1 This concise study gives an indication the societal impact of the closure and the allocation of the damage over the various stakeholders. In order to monetize effects it was sometimes necessary to make assumptions. Not all effects contribute equally to the cost overview and in a number of cases the overall contribution is rather small, even when estimated conservatively. In that case it does not seem necessary to further detail those effects. However, also effects exist that contribute more to the cost overview. In such cases it is recommended to further investigate the sensitivities of these effects. In particular, the water levels have a strong influence on freight prices that in turn strongly affect the cost overview. A better view on the frequency of occurrence with regards to certain water levels, as well as predictions concerning the change of this regime in the future due to climate change could provide a better understanding of the possible effects.

2 A number of budget items have been coined as PM items. Again, in case contributions are expected to be small, a further monetization may not be necessary. However, in case of the very diverse group of dispatchers and the recipients each at the end of the transport chain, a more elaborate survey would be required in order to be able to estimate the damage more precisely. It is recommended to further investigate this path in order to see if total damage costs would be significantly influenced.

3 Knowing the scale and the allocation of the impact is necessary if safety measures are considered in order to minimise the reoccurrence of accidents as the one described in this report. This concerns two possible fields of application:
   - Before any accident has taken place, the damage costs, together with an estimation of the frequency of occurrence, may give an indication to what extent investment in safety measures could be justifiable.
   - When an accident has happened, the extra costs of a swift response with adequate salvaging measures can be weighed against the benefits that are related to a shorter duration of the blockage.

   In this way, further development of the approach used in this study could support a standard methodology to provide authorities with an instrument to support decision-making.

4 The interviews and the survey showed that for many operators, shippers, forwarders and brokers the need for a reliable transport system was apparent. Some stakeholders mentioned that they managing transport risks by working through more than one modality. Others were considering to do so. Also here, a further development of the approach as presented in this study may provide valuable input with regards to the efforts to create a more redundant transport network. An interesting development on a European level that matches this development may be the concept of Mobility Continuity Plans, as

put forward by the EC in the EC White Paper[1]. Here, the EC underlines the need to guarantee the transport of goods in a crisis situation. According to the EC, Mobility Continuity Plans should be drawn up to address prioritisation in the use of working facilities, the cooperation of infrastructure managers, operators, national authorities and neighbouring countries, and the temporary adoption or relaxation of specific rules. It is recommended to further explore how to link up with EC objectives and initiatives in creating a safer and more reliable IWT network.

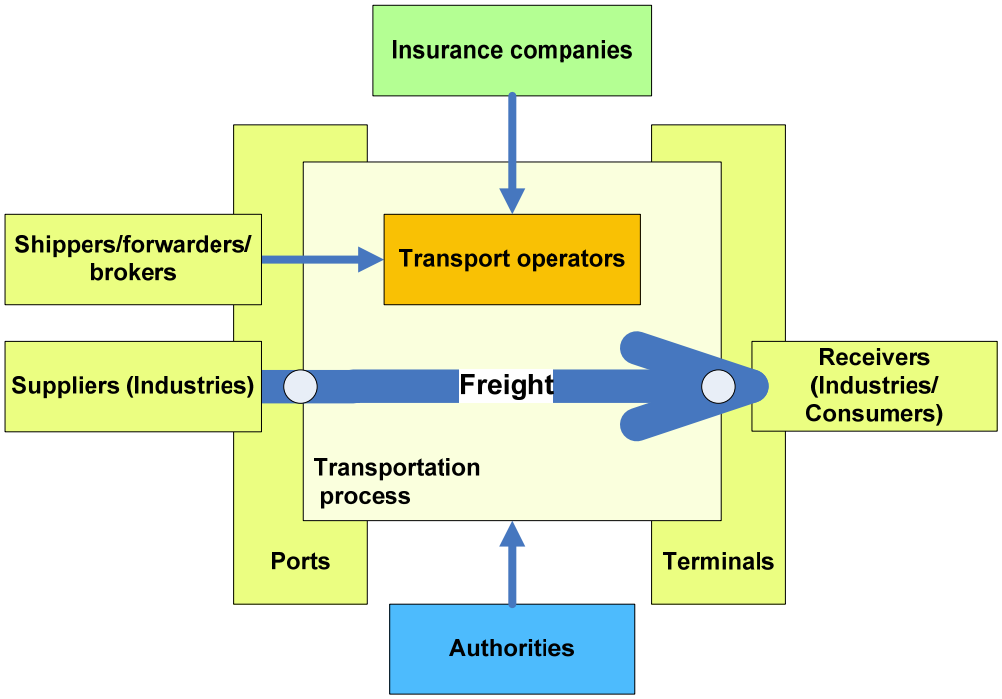
[1] ec.europa.eu/transport/strategies/2011_white_paper_en.htm

1 Introduction

On 13 January 2011, the German tanker “Waldhof” containing 2,426 tonnes of sulphuric acid capsized on the Rhine River. Two sailors were lost. The accident occurred near the Lorelei Rock, which sits on the eastern bank of the Rhine near the town of St. Goarshausen. The narrow bend in the river near the rock has strong currents and a rocky bottom and has been the site of various accidents.

On 14 February 2011, the river was fully reopened to both northbound and southbound shipping. The Rhine was obstructed to shipping for 33 days. The passage of hundreds of ships was blocked during this time. This was the most serious obstruction of the Rhine in post-war history.

Figure 1.1 Stakeholders in and among the transportation process



The damage to the inland water transport sector is considerable. However, the damage is not limited to inland water transport operators alone. There are many stakeholders involved in inland water transport. For a graphical overview of the most important stakeholders, see figure 1.1.

Shippers and other stakeholders also experienced damages. Due to the blockage, alternative means of transport had to be arranged, resulting in scarcity of capacity and higher fares. In some cases also alternative (more expensive) suppliers of goods had to be found resulting in a loss of turnover and/or of higher costs for affected production industries. Also stocks in certain areas (for example seaports) have risen, resulting in higher storage costs. In the longer

run, the inland water transport sector can also be badly affected due an image of being unreliable in the delivery of goods.

This study aims at a better understanding of:

- the societal impact of the obstruction from a European perspective;
- the allocation of the damage over the different stakeholders.

A better understanding of the impact and its allocation is necessary if measures are considered to minimise the reoccurrence of accidents as described above. But also when an accident has already taken place, knowledge about the scale of the impact will be of use. The extra costs of a swift response with adequate salvaging measures can be weighed against the benefits that are related to a shorter duration of the blockage. In this way, the approach used in this study could contribute to a standard methodology to provide authorities with an instrument to support decision-making.

2 Research Questions and Conditions

2.1 Conditions

This study gives an overview of the effects that the closure of the River Rhine had on European society as a whole and the allocation of effects over the different parties involved. The study focuses on the parties that are active in the transport chain, ranging from shippers, brokers, operators to receiving parties. Other parties involved are governments, insurance companies, ports, terminals and the industries on both ends of the transport chain.

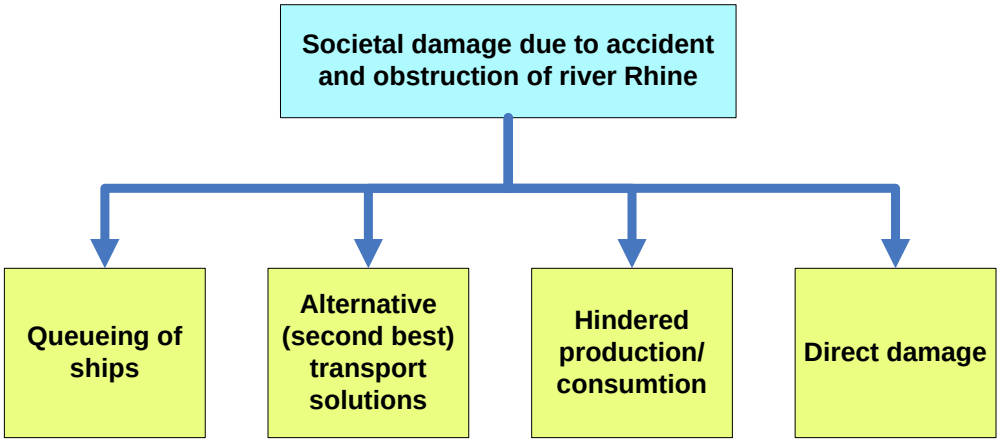
This study focuses on the transport of goods. Passenger transport or recreational boating is not a part of this study.

2.2 Research Questions

The main questions of this study are:

A. What is the societal impact caused by the obstruction of the river Rhine, seen from both an international and a European perspective, and
B. what is the breakdown of damages over different parties involved?

Figure 2.1 Components of societal damage



The main question A can be divided into various topics (see also figure 2.1 above):

1. What are the losses due to the queuing up of ships?
2. What is the effect of using alternatives for transport?
3. What are the effects of hindered production facilities and stockpiling?
4. What is the direct damage resulting from the accident?

In this study, the main question B concerns the following stakeholders:

- Transport operators;
- Shippers, forwarders and brokers;
- Insurers;
- Governments;
- (Sea)ports;
- Producers and receivers.

In the following chapters 3-6 the different types of damage are assessed Subsequently the damage allocation over the various parties involved is described in chapter 7. In chapter 8, an overview of the results is presented. In addition to the above mentioned questions, two more issues are highlighted that put the results of the study in a broader context: the influence of the water level and the availability of resting facilities along the Rhine. In chapter 9, conclusions are drawn and recommendations are given.

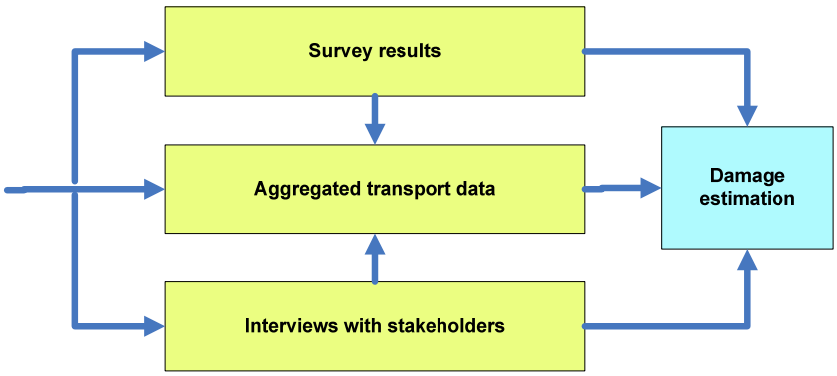
2.3 Input data

In this study, data is collected by means of the following instruments:

1 a survey among transport operators;
2 interviews with shippers, forwarders, brokers, insurers, industries that supply or receive goods;
3 aggregated data concerning IWT freight transport (DESTATIS, NEA).

The different data sources relate as indicated in figure 2.2 below.

Figure 2.2 Data input for this study



3 Losses as a Result of Queuing up of Ships

The damage to the inland waterway transport sector is based on the total amount of ships that queued up for the duration of the closure.

An online survey among Inland Water Transport (IWT) operators was held to estimate the losses due to involuntarily waiting as a result of the obstruction. In total 75 IWT operators responded to calls via SMS, Twitter and e-mail through the various IWT umbrella organisations. The results are mentioned in table 3.1 below:

Table 3.1 Survey Results

Averages	
Tonnage	2,800
Number of waiting days	16
Average damage inclusive of insurer benefits, unemployment benefits and share paid by shippers/forwarders (euro)	40,000

NEA survey data, 2011 (n=75)

The majority of the operators that responded to the questionnaire were carrying dry cargo. About 10% were tankers and another 10% carried containers. The average damage per ship reported by the 75 respondents in the survey was € 40,000. In reality, a total of 475 ships queued[1]. Assuming that the above data is representative, the total damage due to involuntary delay would amount approximately 19 million euro.

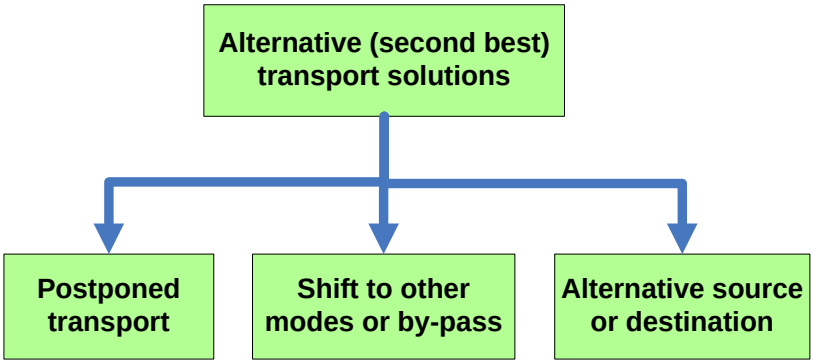
Operators indicated that insurers, shippers/brokers and government also absorbed part of this damage. About 40% of the operators work under a contract for a longer term[2], 60% work on a trip basis. In the survey operators working under a contract for a longer term mention that that losses due to involuntary waiting were shared with shippers/forwarders. This happens in about 50% of the cases and a 50% loss-sharing ratio was used most often. These values will be applied in this study for the part of the ships that were working under a contract for a longer term. This will be highlighted further in chapter 7 of this report.

[1] Database acquired from Schuttevaer, 2011
[2] Estimation NEA

4 Transport Alternatives

Due to the closure of the river Rhine, more expensive transport alternatives had to be used in case transport could not be postponed until after the closure. In order to estimate damage as a result of these transport alternatives, it is necessary to estimate the total transport volume that would have passed. The Lorelei Rock if the accident had not taken place. Further, an estimation will be made of the volume of different goods' categories as a part of the total amount of good transported.

Figure 4.1 Transport alternatives



There are three options for alternative means of transport (see also figure 4.1 above):

- Postponing transport until after the obstruction and then transporting the goods.
- Transporting the goods with other modes or via a by-pass, thus avoiding the closure.
- Abandoning the transport channel and transport with a different origin (alternative sourcing) or destination.

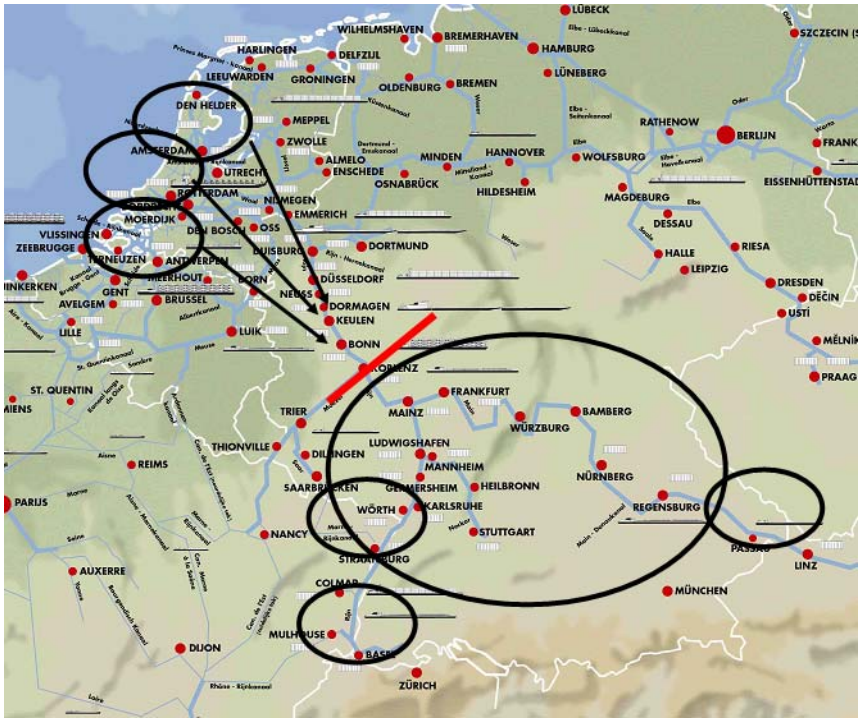
Each of these options require a different treatment. We used DESTATIS IWT data for January and February 2011[1] as the basis for the transport data. The relevant transport flows have been determined from this data based on the following assumptions:

- The influence of the obstruction relates to the transport between the Ports of Amsterdam, Rotterdam and Antwerp, on the one hand and the South German hinterland, France, Switzerland, Austria and other Central European countries on the other hand. This is illustrated in figure 4.2 below;
- The transport flows of 2011 can be meaningfully compared with the ones from 2010. This requires a correction for the degree of economic activity in the respective year;

[1] http://www.destatis.de

- An estimation for economic development between 2010 and 2011 can be derived from comparing the unaffected branches of the IWT network.

Figure 4.2 Area Affected by the Closure



The closure occurred from mid January to mid February 2011. After a “business as usual” first half of January with slightly high water, the closure took place in an instant due to the capsizing of the Waldhof. At first, the blockage was total. Later, during the closure period, a total of about 800 ships were allowed to pass (in turns, in upstream or downstream direction). The January 2011 DESTATIS data can be interpreted in such a way that any deviations from the normal transport pattern around that time of the year can be seen to have been caused by the closure. For the following month, February 2011, the situation is different. After the Rhine was reopened, postponed transport needed to catch up for reasons of restocking. In the February 2011 data, these two effects have been aggregated. This means that the data from February 2011 are perhaps somewhat less distinctive than the January data with respect to estimating the effects of the closure in that month.

In table 4.1, the decrease in transport over the affected area due to the closure is given:

Table 4.1 Decrease in transport over the affected area

	January 2011-2010		February 2011-2010	
	From hinterland	To hinterland	From hinterland	To hinterland
Decrease in IWT transport (tonnes)	387,610	830,036	346,116	660,081
Decrease in tonnekm (avg distance 740 km)	286,831,400	614,226,640	256,125,840	488,459,940

Transported goods' categories may vary:

- Agriculture
- Coal
- Ore/stone
- Consumption goods
- Oil products
- Chemical products
- Metal
- Machines
- Waste
- Other (mainly containers)

Based on DESTATIS data, the distribution over the various goods' categories is used as included in table 4.2:

Table 4.2 Distribution over the various goods categories

	From hinterland	Tonnes	To hinterland	Tonnes
Agriculture	5.0%	36,780	7.4%	109,974
Coal	22.9%	168,102	8.3%	123,559
Ore/stone	26.3%	193,203	13.5%	201,212
Consumption goods	6.8%	50,138	8.8%	131,570
Oil products	14.9%	109,123	16.7%	248,933
Chemical products	10.8%	79,252	20.9%	310,812
Metal	4.3%	31,615	5.4%	80,291
Machines	0.9%	6,578	1.6%	24,010
Waste	3.5%	25,930	7.2%	107,485
Other (containers)	4.5%	33,027	10.2%	152,396

With regards to the question whether to postpone transport or to look for alternative transport options, the goods' categories are treated differently. The treatment is based on characteristics such as:

- Value per tonne;
- Whether the goods are time-critical;
- The availability of a transport alternative;
- The availability of alternative sources or destinations.

In table 4.3 below the options are discussed for each type of goods, based on interview results with stakeholders and expert judgement.

Table 4.3 Characteristics of Different Goods Categories

Goods category	Characteristics
Agriculture	• Goods are transported over a greater distance. • Low value per tonne. • In few cases time-critical (for example due to tainting of products). • Alternative transport possible, but relatively costly compared to value. • Alternative sourcing was mentioned in a number of cases (animal feed). • It is assumed that transport was postponed.
Coal	• Goods are transported over greater distances. • Low value per tonne. • Not time-critical, receiving parties have coal in stock. • Transport alternatives are very limited, just as alternative routes. • It is assumed that transport was postponed until after the closure.
Ore/ stone	• Goods are transported over greater distances. • Low value per tonne. • Not time-critical. • Transport alternatives are very limited. • In interviews, some alternative sourcing was mentioned (Gravel from river Meuse, although of a lesser quality). • It is assumed that transport was postponed.
Consumption goods	• Goods are transported over greater distances. • High value per tonne. • Time-critical goods. • Alternative transport possible. • Alternative routes possible. • It is assumed that transport alternatives were utilised.
Oil products	• Goods are transported over greater distances. • Medium value per tonne. • Sometimes time-critical for the provision of fuel to airports, etc. • Alternative transport relatively costly (here pipeline is an extra modality). • It is assumed that for 50% of the transport volume alternatives were utilised.
Chemical products	• Goods are transported over greater distances. • Medium value per tonne. • Sometimes time-critical • Alternative transport is relatively costly. • Alternative sourcing has been mentioned in a number of cases (i.e. sulphuric acid). • It is assumed that for 50% of the transport volume alternatives were utilised

Metal	• Goods are transported over greater distances. • Medium value per tonne. • Sometimes time-critical (car industry). • Alternative transport relatively costly. • It is assumed that for 50% of the transport volume alternatives were utilised
Machines	• Goods are transported over greater distances. • High value per tonne. • Time-critical goods. • Alternative transport possible. • Alternative routes possible. • It is assumed that transport alternatives were utilised.
Waste	• Not transported over great distances. • As the value of waste flows is very low, no opportunity costs of capital will be accounted for. • Not time-critical. • It is assumed that transport was postponed until after the closure.
Other (mainly containers)	• Goods are transported over greater distances; • High value per tonne; • Time-critical goods; • Alternative transport possible; • Alternative routes possible; • It is assumed that in the majority of cases, transport alternatives were utilised. However, as also some stockpiling in ports was reported, it is assumed that 85% of the containers was transported alternatively.

4.1 Losses Due to Postponed Transport

The proportion of transport that did not take place will be estimated according to the different goods' categories. The damage will be estimated as the extra costs that will be incurred due to:

- The costs of extra storage;
- Capital costs due to the fact that goods are underway longer;
- Higher transport prices due to intensified transport after closure of the Rhine was over.

4.1.1 Costs of Extra Storage

In case of postponing transport, goods will start to accumulate in the ports and at the inland producers. Usually, in case storage facilities offer sufficient space to absorb the excess goods. For example, one dry bulk terminal specialised in coal remarks that they did no have any problems. However, problems were noticed by the steelworks and the oil companies. It is estimated that due to the period of the closure, the goods for which transport was postponed, were piling in the ports of origin. Storage costs are estimated as about 0.1 euro per tonne per day on average. In case the goods were shipped only after 20 days, the total extra costs would amount 3 million euro (round number).

4.1.2 Costs Due to Longer Transport Time

The costs caused by longer transport times of goods, will be based on the opportunity costs of the value of the goods. For this, an average value per tonne is assigned to the goods categories[1]. The values are included in table 4.4 below.

Table 4.4 Characteristics of Goods for which a Delay Strategy is Assumed

Goods	Assume % postponed transport	Postponed transport (tonnes)[2]	Value per tonne (euro)	Total value per category
Agriculture	100%	146,955	150	22,043,244
Coal	100%	291,661	225	65,623,725
Ore/stone	100%	394,415	10	3,944,150
Consumption goods	0%	0	8,000	0
Oil products	50%	179,028	600	107,452,414
Chemical products	50%	195,032	500	97,669,215
Metal	50%	55,953	600	33,604,961
Machines	0%	0	8,000	0
Waste	100%	132,968	0	0
Other (containers[3])	15%	27,751	8,000	222,011,525
Total				552,349,234

If delivery of these goods would be delayed for 20 days and the interest is assumed to be 6% on a yearly basis (short term financing rate), then the opportunity costs of capital would be 1.8 million euro. The outcome varies if a greater proportion of the transport of oil products, chemical products and metal is postponed (here assumed 50%). Capital costs would rise to 2,6 million euro in case of 100% postponed transport of these goods. In this study the total costs are assumed as 2 million euro (round number).

4.1.3 Higher Transport Prices Due to Intensified Transport After the Rhine was Reopened

In a number of cases, a catch up effect was observed after the closure. From the interviews it follows that for a short period this was the case for containers (less than a week),for fertilizer transport (increase 5%) and for steel products (increase 10-20%). In the survey, the operators also reported that spot prices tended to rise (12 out of 75 survey respondents conclude a range of between 5-35% (average 19%), 63 did not notice). These effects do not influence the transport under contracts for a longer term. About 40% of the operators in the survey were working under a contract for a longer term. If we assume average spot prices for bulk goods as 6-7 euro per tonne[4] (average transport distance is 740 km) then an increase of 10% would amount 0.70 euro. If it is further

[1] Reference NEA, 2011
[2] IWT transport in both directions added up
[3] Measured in terms of containers, also empty containers are included here
[4] NEA cost data, 2011

assumed that this increase pertains to the spot market only (60% of transported total volume) and that the price increase effect counts for the remainder of the month February (approximately two weeks), the consequence of the rise in prices is an increase in transport costs of 1.4 million euro.

4.2 Losses Due to Shift to Other Modes or Creating a By-pass

To estimate the amount of transport that was transported in an alternative way, the focus will be on the goods' categories that are more time-critical. There is a strong correlation between goods being time-critical and their value. Although transport was not postponed until after the closure, it may be expected that also these goods were underway longer. Further, alternative transport solutions may lead to extra costs.

The damage here will be estimated as the extra costs that will be incurred due to:

- Opportunity capital costs due to the fact that some delay occurs because other means of transport needs to be mobilised (assumed: 1 day).
- Higher transport prices due to more expensive transport via other modes.

4.2.1 Capital Costs Due to the Fact that Other Means of Transport Need to be Mobilised

For the capital costs of goods that are underway longer, an estimate of the value of the respective goods is necessary. An average value per tonne is assigned to these goods, for each category[1]. These values are included in table 4.5 below.

Table 4.5 Characteristics of goods for which a alternative transport strategy is assumed

	Assumed % diverted transport	Diverted transport (ton)[2]	Value per tonne (euro)	Total value per category
Agriculture	0%	0	150	0
Coal	0%	0	225	0
Ore/stone	0%	0	10	0
Consumption goods	100%	181,708	8,000	1,453,664,000
Oil products	50%	179,028	600	107,416,800
Chemical products	50%	195,032	500	97,516,000
Metal	50%	55,953	600	33,571,800
Machines	100%	30,588	8,000	244,704,000
Waste	100%	0	0	0
Other (containers)	85%	157,258	8,000	1,258,065,000
Total				3,188,544,600

[1] Reference NEA, 2011
[2] IWT transport in both directions added up

If the delivery of these goods were to be delayed for one day and the interest is assumed to be 6% on a yearly basis (short term loan), then capital costs would be 1 million euro (round number).

4.2.2 Higher Transport Prices due to More Expensive Transport Involving Other Modes and/or Destinations.

The total amount of tonnes that is estimated to be diverted to, for example, railway or road transport is assumed to be 799,161 tonnes. Although it may be expected that alternatives will be more costly than “business as usual” it also may be expected that the least costly alternative will be chosen from the different options. In order to estimate the extra transport costs, a number of transport options are identified that involve the use of other modes and destinations.

1. By rail from ports to inland destination (or vice versa);
2. By road from ports to inland destination (or vice versa);
3. From ports via barge to the Ruhr area, then by-passing the obstruction via road to inland destination (or vice versa);
4. From ports via barge to the Ruhr area, then by-passing the obstruction via rail to inland destination (or vice versa);
5. Coming from Hamburg/Bremen via the Ruhr area to an inland destination (or vice versa).

By rail from ports to inland destination (or vice versa)

More transport took place by rail via the Netherlands, but this was only a relatively small amount on the axis from the Ports of Amsterdam and Rotterdam in inland direction. There was insufficient capacity available. The Betuweroute, for example, needed a type of locomotive that was not available. Also, the extra capacity available on the track was limited[1]. There was rail transport, but via the Ruhr area directed to the North-German ports, in stead of Rotterdam, Amsterdam or Antwerp.

By road from ports to inland destination (or vice versa)

Ad 2) Compared to IWT, road transport is a relatively expensive solution over longer distances. Most of the transport alternatives were by truck (see also table 4.6). On average, the cost difference between IWT transport and road transport can be estimated as in the table below. The average transport distance for goods is 740 km. This result is based on a weighted average of distances between origins and destinations of goods, with the amount of tonnes shipped as weights. One TEU is estimated as 10 tonnes.

[1] Interview with Keyrail

Table 4.6 Estimation of transport costs

	IWT	Road transport
Bulk (per tonne x 740 km)	6-7	60-70
Containers (per tonne x 740 km)	35-40	80-90

NEA cost data, 2011

It is not to be expected that this option would be the first choice. Furthermore, in order to do the IWT transport of, for example containers, via trucks, a considerable number of trucks and drivers would be required. It is not very realistic to assume that most of the container transport was diverted to a solution in which road transport took care of door-to-door transport over 740 kilometres on average.

From ports via barge to the Ruhr area, then by-passing the obstruction via road to inland destination (or vice versa)

This option benefits from the relatively low transport costs by barge. In order to by-pass the obstruction, trucks are utilised. Cost differences compared with "business as usual" are related to more expensive road transport and to the additional transhipment that needs to take place. A benefit of this option is that road transport offers a door-to-door solution. The costs of additional transhipment operations, added to the higher costs of road transport are estimated as 30 euro per tonne in total.

From ports via barge to the Ruhr area, then by-passing the obstruction via rail to inland destination (or vice versa)

This option also benefits from the relatively low transport costs by barge. Subsequently, also rail transport costs will be in the same order of magnitude. Cost differences with "business as usual" are related to the additional transhipment that needs to take place. The rail transport costs are estimated as being comparable to IWT transport[1]. The additional transhipment is estimated as 25 euro per tonne in total.

Coming from Hamburg/Bremen via the Ruhr area to an inland destination (or vice versa)

This option is very similar to option (4), but the goods are transported by rail via the Ruhr area to the Ports of Hamburg and Bremen instead of Amsterdam, Rotterdam and Antwerp. It is assumed that the extra costs for the longer travel time outweigh the cost-reducing fact that no additional transhipment is needed.

From the above options it can be concluded that the extra costs probably range between 25 and 30 euro per tonne. In case of a cost difference of 25 euro per tonne, the extra transport costs would amount to 20 million euro. In case of a

[1] This may be a conservative assumption, given the scarcity of transport alternatives at that time.

cost difference of 30 euro, the extra transport costs would amount to 24 million euro. In this analysis we will use the average of these two amounts: 22 million euro.

4.3 Permanent Transport Shift to Other Transport Modes

The interviews with stakeholders and the survey also highlighted possible damage to the reputation of IWT as a reliable mode of transport. If shippers consider a modal shift, it would be an overestimation to attribute the costs solely to this particular accident.

Alternatively, some competitors advertise the fact that their rail shuttle connection will not suffer from river closures as a selling point with respect to reliability. A monetization of damage is not possible here. Some damage to the image of IWT has been done, but it does not seem to have a lasting effect. From the survey responses and the interview results it can generally be concluded that the Waldhof accident did not directly lead to shippers or brokers leaving the IWT market, in exchange for rail or road. However, the responses indicate that stakeholders are aware of the risks and try to diversify their activities over different modes. This effect will be included in the cost-benefit overview as a PM item.

5 Hindered Production and Consumption

In order to determine effects on both ends of the transport chain, questionnaires were sent to dispatchers and receivers of good. A limited amount of questionnaires was received back from these parties. From these responses the following picture can be described.

Oil Majors

For some of the oil companies the blockage caused stockpiling. In some cases, the transport was cancelled. Transport costs were higher. For some routes, rail transport was an alternative. Also pipelines were used. For transport of oil products, IWT transport costs 50% less than rail transport. Also, in order to not let the supply of oil products deplete too quickly, sales were reduced. Total damage cost of oil majors that reacted to the survey is estimated at 1 million euro.

Steelworks

This company ships 20,000 tonnes of steel products a month to the area that was affected by the closure. The division of contracts is 85% future and 15% spot market contracts. Transport were carried out either via rail or road, although this was much more costly. Stockpiling occurred along with interest losses. Total damage cost of the steelworks that reacted to the survey is estimated at 0,5-1 million euro. Transport prices remained some 10-20% higher for some time after the closure. Despite the supply problems, production processes were not disturbed.

Fertiliser Producer

The producer of fertiliser products that was interviewed, ships 20,000 tonnes per month to the area that was affected by the closure. No contracts for a longer term are used. Alternative transport via road caused extra costs of 60 thousand euro, while alternative loading point costs were 75 thousand euro. The shortage of raw materials led to a disturbed production process at the receiver end. The obligation to deliver product also resulted in extra transport costs and the purchase of products. After the Rhine opened again, a 5% increase in transport prices was observed.

Port companies, stevedores

The occurrence of stockpiling was mentioned in a number of cases. In case of the Port of Rotterdam, ocean-going ships in some cases missed cargo due to the blockage. Also, some containers remained in the port for a longer time before they could be transported. For a part, cargo shifted to road and rail transport, but especially rail could offer only limited extra capacity. Also after the Rhine opened again, processing ships at terminals took place in an orderly manner, without major problems.

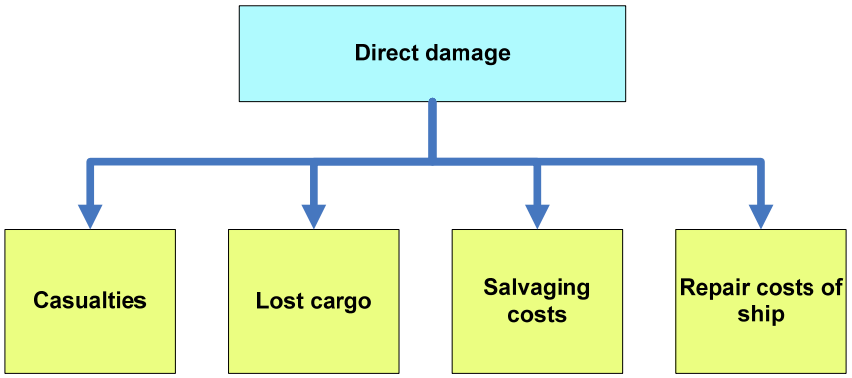
Conclusion

From the above data, it can be concluded that also dispatchers and recipients on both ends of the transport chain damage was suffered due to the closure of the River Rhine. The estimated damage that is mentioned mainly concerns higher transport costs and opportunity costs of capital. As such, these costs have already been integrated in the previous chapters. Oil companies also mention a reduction of sales, while the fertiliser producer mentions a disturbed production processes. Based on the sparse input data it is estimated that the order of magnitude of the damage varies between millions and tenths of millions of euro. Due to this uncertainty, a more precise monetization cannot be done within the limited context of this study. Therefore, the costs are included in the overview as *pro memory* (PM).

6 Direct Damage

The direct damage is the damage resulting from the accident: casualties, lost cargo, salvaging costs and the damage costs to the ship (see figure 6.1).

Figure 6.1 Direct damage components



6.1 Casualties

In the accident with the Waldhof, two of the crew members were lost. The loss of human life and the grief this has caused cannot be expressed in monetary terms.

However, this study only looks from an economic perspective and notwithstanding the above, from a purely economic perspective it is possible to determine the economic consequences of a casualty. In 2004, the European HEATCO research project[1] provided data for different EU countries. Numbers range from 1,5-2 million Euro per casualty. The economic consequences of the fatalities in this accident may be reflected by a damage of 3-4 million euro.

6.2 Lost Cargo

The cargo of the Waldhof consisted of 2,426 tonnes of concentrated (98%) Sulphuric Acid[2]. The costs per kg are estimated[3] as 10 ct/kg. Thus, the value of the load has an order of magnitude of about 0.3 million euro (round number).

[1] http://heatco.ier.uni-stuttgart.de/
[2] The tanker may have been overloaded by 631 tonne, as can be read in an expert report commissioned by the German public prosecution department
[3] Source: Brenntag

6.3 Salvaging Costs

A number of salvaging vessels and assisting vessels had to be mobilised. They were needed for a considerable period of time. Organisations involved were contacted (salvaging company, damage expert, ship-owner) with regard to the salvaging costs. However, the salvaging company, damage expert and ship-owner were not willing to release any information on the salvaging costs. Currently, the German Water and Shipping Directorate[1] is investigating the event, also looking at the salvation and measures taken during salvation.

6.4 Repair Costs of Ship

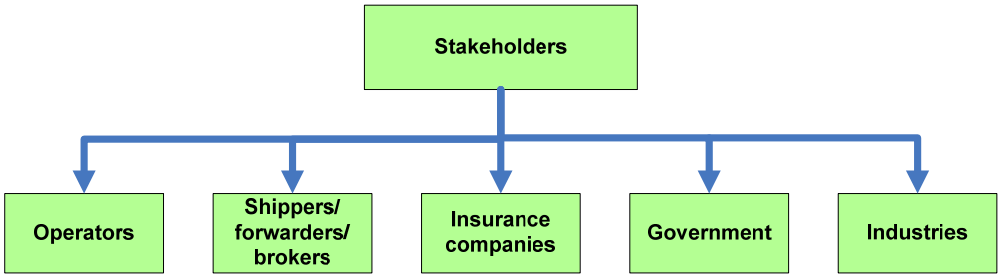
The Waldhof is a double-hull tanker that was built in 1994. The age of the ship can be considered as average. The ship has seven stainless steel tanks and is classified as a type C acid tanker (length 110 m, width 10.5 m, height 3.15 m). The ship-owner is not able to release any information on the damage of the Waldhof with regard to the costs for repairing the damage to the ship either. The damage expert who was consulted, indicated that the damage to the ship did not necessarily mean a total-loss. Therefore, the damage costs cannot be higher than the purchase price of a tanker similar to the Waldhof. The purchase price can be estimated as 4.5-5.5 million euro[2]. Obviously, the repair costs of the ship should be lower than this amount.

[1] Wasser- und Schifffahrtsdirektion (WSD)
[2] OPTO Cost model, NEA 2011

7 Allocation of Losses over Different Parties Involved

The effects discussed in the previous chapters are allocated over the different stakeholders as depicted in figure 7.1:

Figure 7.1 Stakeholders in the transport process



Regarding the allocation of the damage over different parties involved, the following remarks apply:

- Concerning the direct damage it is not yet clear which stakeholder is going to pay what, as the German public prosecution department (Staatsanwaltschaft) is currently (at the time of publishing this report) investigating this case. Following from that investigation, claims may be filed.
- An aspect between operators, shippers/forwarders/brokers and industries is “conveyance obligation”. The allocation of possible losses then depends on what has been agreed in the contracts between these parties. This particularly applies to contracts for a longer term, assuming that in the case of spot market contracts the conveyance obligation lies with the transport operator. Concerning the allocation of the damage that relates to transport under forward contracts it is necessary to have an idea about the provisions in these contracts. Especially important is to determine which party is contractually obliged to convey the goods.

7.1 Losses for Operators

As calculated in Chapter 4, the total loss as a result of queuing up of ships amount can be estimated at about 19 million euro. Operators report that part of these losses were taken by insurers and the government (Dutch so-called “part-time unemployment benefits”). It is not known whether a similar arrangement exists in Germany of any of the other countries that are involved in IWT on the river Rhine.

When working under a contract for a longer term, in a number of cases losses due to involuntary waiting were shared with shippers/forwarders. Based on the available data, it is estimated that shippers/forwarders contributed 3 million euro

(round number). The amount of the losses that were covered by the insurers is about 2 million euro (for a calculation of this amount see section 7.3).

Regarding the benefits provided by the Dutch government, from the survey it appears that 7.2% of the operators made use of this arrangement. On average, 2,682 euro was received. As the scheme described above is only for Dutch operators, it cannot be applied to all 475 ships that waited. Assuming a Dutch flag share of 50-60%[1], the benefits for the IWT operators would amount to 45-55 thousand euro. Looking at the scale of the other cost components, this amount is negligible. If similar arrangements exist in other countries too, it is to be expected also for operators under a different flag these effects – if any- will be small.

Based on the above, the net losses for the operators amount to about 14 million euro (round number).

7.2 Losses for Shippers, Brokers and Forwarders

The losses that have been absorbed by shippers, brokers and forwarders were caused by the need to use more expensive transport alternatives. Roughly two strategies can be followed here: postpone the transport or look for transport alternatives.

If the transport is postponed for a longer period, interest costs will be incurred. This strategy will be the best one to follow for goods with a low value and not time-critical. It is estimated that interest costs will be 3 million euro (round number).

In case alternative transport is utilised, the costs amount to 24 million euro (round number). This strategy will be the best one to follow in case of high value and time-critical goods.

As calculated in table 7.1, shippers and forwarders also contribute to the fact that ships were involuntarily delayed. This results from contract arrangements with operators. The amount involved is about 3 million euro (round number).

After the blockage was over, some interviewees mentioned that a catch-up effect caused a price increase on the spot market. The price increase would affect the spot market proportion of the transport volume that is transported along that stretch of the Rhine. In 4.1.3, the magnitude of this effect was calculated as 1,4 million euro. It us assumed that half of these costs will be borne by shippers, brokers and forwarders. The other half will be for the account of the industries that supply or receive goods.

[1] Estimated from DESTATIS data, January 2011. German flag share was 33%, Belgium 7% and other nationalities 7%.

7.3 Losses for Insurance Companies

Interviews with insurance companies were held to be able to estimate the proportion of the operators that were insured
The cover provided is included in the standard package of the mutual insurance companies (about 80% of cases in dry cargo). For the exchange insurers (about 20% in dry cargo) this may vary case by case. For tankers, the percentages are reversed. How this is with respect to the German fleet is not known. The clause is a typical Dutch insurance product.

In order to be able to claim insurance payments for prolonged suspension, four waiting days are applied before the insurance starts to work. Then follows a payment of 0,25 euro per tonne load capacity per day (with a maximum of 20 days, it was indicated that the majority of ship-owners failed to reach the 20 days). Example: for 1,000 tonnes per day 250 euro was paid by the insurer.

Table 7.1 Losses of Two Dutch Ship Insurers

Insurer	No of vessels insured	No of vessels in queue	% of vessels in queue	Total damage
Insurer 1	1,000	108	10.8	€ 676,058
Insurer 2	1,500	80	5.3	€ 700,000

In the Netherlands, there are four ship insurers. Two of the largest Dutch insurers were interviewed. The remaining two insurers insure about 1,100 ships (44% of total). Under the assumption that the losses for the remaining insurers are proportional to the ones made by the interviewed parties, the total loss for the insurers can be estimated at 2,0 million euro (see also table 7.1).

In the online survey the operators were also asked to specify if they could claim successfully from their insurance. On average, the average benefits can be estimated as 6,826 euro. As the above described insurance is a typical Dutch product, it cannot be applied to all 475 ships that were waiting. Assuming a Dutch flag share of 50-60%[1], the benefits for the IWT operators would amount to 1,6-2,0 million euro. This is broadly in line with the previous finding.

7.4 Losses for Governments

As mentioned earlier, the losses due to payment of unemployment benefits are negligible. Other losses may exist, such as damage costs that may have arisen from the accident itself. It remains to be seen if these costs can be successfully claimed (and therefore transferred to the operators or an insurer).

7.5 Losses for Industries that Supply or Receive Goods

The industries' main source of damage is that during the period of closure sales were not possible or at least lowered. Questionnaires have been received from

[1] Estimated from DESTATIS data

companies that indicate that this was the case. However, within the context of this study it is difficult to generalise this data and to estimate the losses that have been suffered as a consequence. Based on the responses received it is estimated that the losses amount to between millions of euro and tens of millions of euro.

Losses that can be better monetized are the losses due to the fact that goods are underway longer and the costs of extra storage. The interest costs as a result from goods that are underway longer are estimated at 3 million euro, the costs of extra storage is estimated as 3 million euro (both round numbers).

The costs that are caused by the price increase, after the blockage was over, are for 50% on the account of the industries that supply or receive goods. The amount involved is 0.7 million euro.

8 Analysis Results and Context

An overview of the results is presented in this chapter. In addition to the above mentioned questions, two other issues are highlighted that that put the results in a broader context: the influence of the water level and the availability of resting facilities along the Rhine.

8.1 Different Circumstances, Different Outcome?

Different circumstances may lead to different loss estimations. The accident with the Waldhof took place during winter, with a relatively high water level in the river at the start of the closure. Over time, the water level dropped. In a number of cases, this caused waiting operators to discharge part of their cargo in order to be able to maintain sufficient draught. If the closure had not happened, this would not have been necessary. It is difficult to monetize this effect, but it will included in the cost overview as *pro memory* (PM)

Water level variation may lead either to price increases on the spot market or an additional fee that has been laid down in a contract between operator and shipper. Low water levels lead to higher prices per tonne km, as ships can transport less freight because a certain minimum draught has to be maintained.

Transport prices may vary between about 3 and 15 euro per tonne. Changes in price have a very big influence on any losses incurred, as there is a linear relationship between the freight prices and the damage. The relation between price and societal damage may work a bit counterintuitive: in case the accident would have happened in a situation with lower prices, the damage is more severe as the transport alternatives would have been even more expensive compared to IWT.

The influence of other seasonal effects, should also not be neglected. As the accident took place in winter, transport volumes were lower than in other months. Further, there was no impact on the passenger transport on the River Rhine. A similar accident during the summer would have seriously affected the tourist industry on the River Rhine, as many cruises take place.

8.2 Wider Perspective: Nautical Aspects

Lack of a sufficient amount of berthing places for waiting ships along the Rhine may become apparent after an accident like this. Based on a comparison of peak demand and supply, we will deal with this issue in the report. In the survey, more than 50% of the operators state that these facilities were insufficient. All facilities were occupied over a stretch of 300 km. Furthermore, in a lot of cases berthing was simply not possible. Anchoring was the alternative. This made it difficult to leave the ship.

Under these circumstances, slightly less than 50% of the operators indicate that the lack of resting facilities contravened safety. First of all, due to congestion

and anchoring/mooring at unusual places, navigation became increasingly difficult with resulting higher nautical risks as a consequence. Second, if emergency services would be needed, the accessibility of the ships would be greatly impaired. Lastly, respondents also remarked that in some cases ships that were carrying dangerous good were allowed to berth close to living quarters.

The available data is not sufficient to determine whether during the closure, accidents with ships occurred at berthing places. However, accidents can have far reaching consequences, as the accident with the Waldhof has learned.

8.3 Overview of Effects and Allocation

The total damage and allocation over parties involved are summarized in table 8.1 below.

Table 8.1 Summary of effects and allocation over stakeholders

Damage (amounts in M€)	Costs involved for stakeholders					
	Total	Operators	Shippers/ forwarders/ brokers	Insurers (Dutch)	Governments	Dispatchers and receivers
Queuing of ships	19	14	3	2		
Alternative transport						
Delayed transport	3					3
Shift to other modes or by-pass	22		22			
Higher transport prices after reopening	1.4		0.7			0.7
Permanent shift to other modes	PM 1	PM 1				PM 1
Hindered production and consumption						
Lesser production and consumption	PM 2					PM 2
Stock piling due to delay	3					3
Direct damage						
Casualties	3-4	**Cost allocation to be determined and may depend on outcome of legal procedures**				
Lost cargo	0.3					
Salvaging costs	PM 3					
Repair costs of ship (estimate maximum)	<4.5					
Lower safety and comfort due to lack of berthing places	PM 4	PM 4				
Total (round number)	50-55 million euro + PM					

In the cost overview, four PM items are included:

PM 1: Permanent modal shift: cost due to loss of image as a reliable mode of transport In the interviews and the surveys this did not appear to be a major item, although nowadays backup options are considered.

PM 2: Negatively affected production and consumption
This item could have a bigger influence on the total damage: varying from millions to tenths of millions damage. Within the context of this study this could not be further detailed. Further research is recommended here.

PM 3: Salvaging costs
Currently, the cost data is not available.

PM 4: Lower comfort and safety due to lack of berthing places.
This item is difficult to monetize. Although it will probably not play a major role in the cost overview, the lack of safety may not be acceptable. In case of accidents to happen, consequences regarding costs can be considerable.

9 Conclusions and Recommendations

The data that was necessary to perform this study was obtained via statistical research, interviews and a number of surveys among stakeholders. The total damage and allocation over parties involved are summarized in the bar charts in figure 9.1 and figure 9.2.

Figure 9.1 Damage costs calculated (excluding PM items)

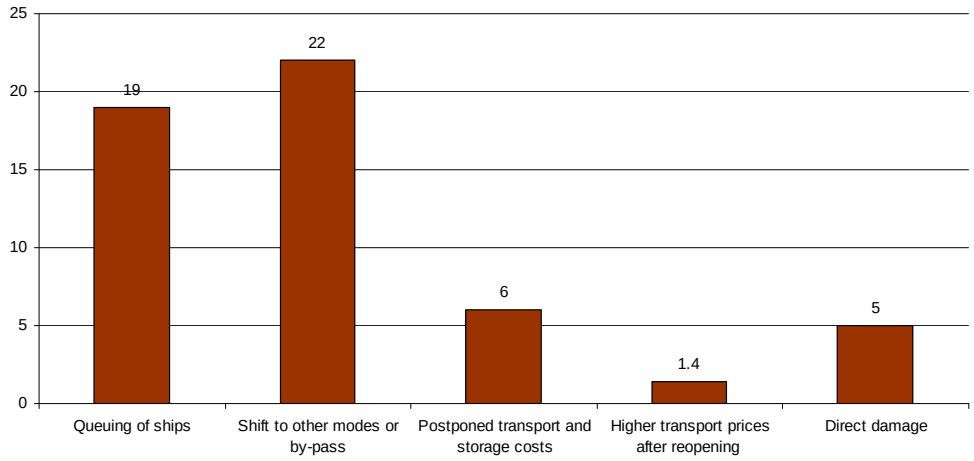
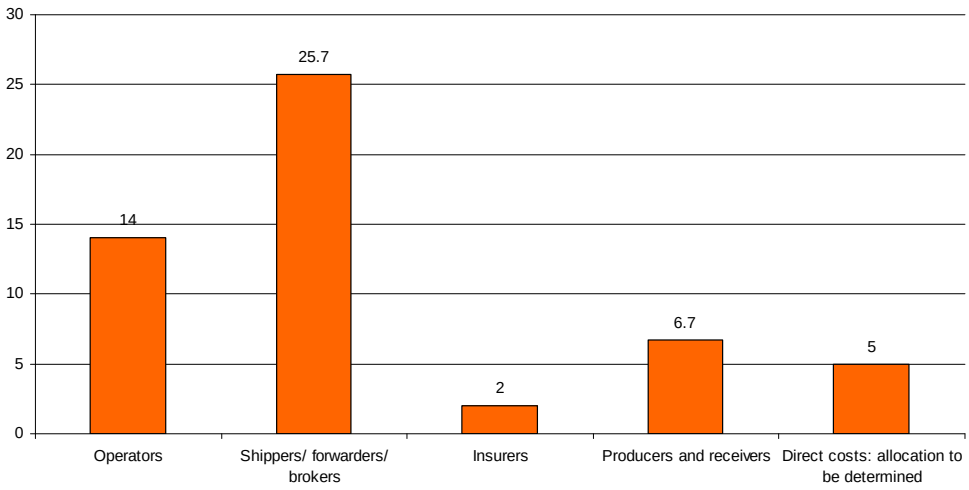


Figure 9.2 Allocation of damage costs (excluding PM)



Conclusions

1 The damage to society is considerable: based on the input data used, the total damage done is estimated between 50 and 55 million euro.

2 Although many different parties suffer damages, the major part of the damage costs are absorbed by operators: about 14 million euro due to involuntary waiting and shippers, forwarders and brokers: about 26 million euro, mainly due to having to arrange alternative transport via a shift to other modes or a by-pass.

3 The freight prices used are a very important parameter. In this study we used an average freight price. Freight prices can fluctuate strongly due to variations in the water level. In case of a situation with a low or high water level the damage done to shippers, forwarders and brokers may easily be cut in half or double.

4 Some parties at both ends of the transport chain indicated that they suffered losses, based on the sparse available data it is estimated that the damage varies between millions and tenths of millions of euro. Given the uncertainty, the effect is considered a *pro-memory* item (PM).

5 Concerning the direct damage that was done, stakeholder are not able and/or willing to release any information on the salvaging and repair costs. At the time of publication of this report, the German public prosecution department (Staatsanwaltschaft) is investigating the accident. Until the proceedings are closed (presumably end of 2011) the ship-owner is not allowed to comment on the accident.

6 During the closure there was a lack of sufficient berthing places for the operators that had to wait. Operators reported that nautical safety was contravened. This effect has not been monetized in the study but is considered a PM item.

Recommendations

1 This concise study gives an indication the societal impact of the closure and the allocation of the damage over the various stakeholders. In order to monetize effects it was sometimes necessary to make assumptions. Not all effects contribute equally to the cost overview and in a number of cases the overall contribution is rather small, even when estimated conservatively. In that case it does not seem necessary to further detail those effects. However, also effects exist that contribute more to the cost overview. In such cases it is recommended to further investigate the sensitivities of these effects. In particular, the water levels have a strong influence on freight prices that in turn strongly affect the cost overview. A better view on the frequency of occurrence with regards to certain water levels, as well as predictions concerning the change of this regime in the future due to climate change could provide a better understanding of the possible effects.

2 A number of budget items have been coined as PM items. Again, in case contributions are expected to be small, a further monetization may not be necessary. However, in case of the very diverse group of dispatchers and the recipients each at the end of the transport chain, a more elaborate survey would be required in order to be able to estimate the damage more precisely. It is recommended to further investigate this path in order to see if total damage costs would be significantly influenced.

3 Knowing the scale and the allocation of the impact is necessary if safety measures are considered in order to minimise the reoccurrence of accidents as the one described in this report. This concerns two possible fields of application:
   - Before any accident has taken place, the damage costs, together with an estimation of the frequency of occurrence, may give an indication to what extent investment in safety measures could be justifiable.
   - When an accident has happened, the extra costs of a swift response with adequate salvaging measures can be weighed against the benefits that are related to a shorter duration of the blockage.

   In this way, further development of the approach used in this study could contribute to a standard methodology to provide authorities with an instrument to support decision-making.

4 The interviews and the survey showed that for many operators, shippers, forwarders and brokers the need for a reliable transport system was apparent. Some stakeholders mentioned that they managing transport risks by working through more than one modality. Others were considering to do so. Also here, a further development of the approach as presented in this study may provide valuable input with regards to the efforts to create a more redundant transport network. An interesting development on a European level that matches this development may be the concept of Mobility Continuity Plans, as put forward by the EC in the EC White Paper[1]. Here, the EC underlines the need to guarantee the transport of goods in a crisis situation. According to the EC, Mobility Continuity Plans should be drawn up to address prioritisation in the use of working facilities, the cooperation of infrastructure managers, operators, national authorities and neighbouring countries, and the temporary adoption or relaxation of specific rules. It is recommended to further explore how to link up with EC objectives and initiatives in creating a safer and more reliable IWT network.

[1] ec.europa.eu/transport/strategies/2011_white_paper_en.htm