CCNR
CENTRAL COMMISSION
FOR THE NAVIGATION OF THE RHINE

Reflection paper

"Act now!" on low water and effects on Rhine navigation

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Summary of the report

Nine presenters and eleven panelists at the workshop shared their views on low water and discussed the challenges facing Rhine navigation with the 150 participants present. The workshop's objective, which was to help inland navigation overcome challenges associated with the low water phenomenon and stimulate discussion on coping strategies, was supported through active participation of high-level participants from industry, administration, river commissions, universities and research institutes from six European countries as well as representatives from the European Commission. This diversity of participants favored a discussion of the challenges of low water from several perspectives and forged a unique opportunity to address the points of view from a wide spectrum of inland navigation's key players. As concluding remark, the fact was highlighted that there are no "one size fits all" solutions to address the low water challenges being faced by the inland navigation sector. A range of actions needs to be taken rapidly regarding adaptation of fleet, infrastructure, logistics and storage concepts, as well as implementation of digital tools, in order to ensure that inland navigation remains a reliable mode of transport and to avoid a permanent shift away from inland waterways to other transport modes. The measures required are already well-known and available, but it is now time to make a first step towards implementation. To support this, there is consensus among inland navigation key actors that funding and financing solutions must be made available.

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1. Introduction

The Reflection Paper that follows is a collection of statements and information shared at the CCNR workshop on low water and effects on Rhine navigation held on 26 November 2019 in Bonn.

The document has been prepared by the CCNR Secretariat. However, it reflects the views only of the workshop participants and the CCNR cannot be held responsible for any use which may be made of the information contained therein.

In 2020, the CCNR agreed to extend chapter 5 on "next steps" with an inventory of ongoing measures/projects to help inland navigation overcoming the challenges related to the low waters. The second edition of the reflection paper was validated by the competent committees beginning of 2021 for publication on the CCNR website.

1.1. General information

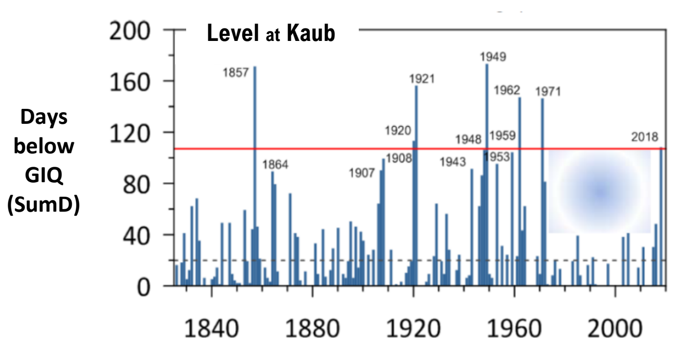
In the aftermath of the extreme low water period in 2018, the CCNR decided to organise a workshop on low water in coordination with the International Commission for the Protection of the Rhine (ICPR) and the Commission for the Hydrology of the Rhine (CHR). In addition to these two international organisations, 150 participants, including representatives of waterway administrations, ports and terminals, associations of the shipping industry and shippers, environmental associations, engineering offices and river commissions participated. Nine presentations were made and 11 panellists shared their views on low water and discussed the challenges facing Rhine navigation today. The aim of the workshop was to help inland navigation overcome challenges associated with the low water phenomenon and stimulate discussion on strategies of how to cope with these situations. This was supported by the active participation of high-level attendees from industry, administration, river commissions, universities and research institutes from six European countries as well as representatives from the European Commission. The diversity of participants favoured a discussion on the challenges of low water from several perspectives and forged a unique opportunity to address the points of view from a wide spectrum of inland navigation's key players.

1.2. Hydrology

The workshop heard that a low water period for the Rhine, with its dynamic water flow such as that in 2018 was not unprecedented and therefore could also be anticipated in the future. Over the past 200 years, there have been 15 years in which the Rhine has experienced an at least comparable number of days which, in terms of today's infrastructure requirements, would constitute an obstruction to navigation, and five of them were significantly more severe. Admittedly, 14 of these 15 years (2018 is the only exception) were before 1972. In terms of low water discharges, and according to the ICPR low water classification[1], the event on the southern Upper Rhine can be classified as a "rare" event (return period once in 15 years) and for the rest of the Rhine - downstream from Worms - as a "very rare" event (return period once in 40 years). With regard to the duration of low water, the event on the Upper and Middle Rhine can be classified as an "extremely rare" event with a return period of once in 50 years, and for the Rhine below the confluence with the Moselle, as an extremely rare event with a return period of once in 100 years.

Compared to other European rivers, however, the Rhine has a relatively balanced run-off regime.

[1] See also ICRP report on an "Inventory of the low water conditions on the Rhine": https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/Fachberichte/EN/rp_En_0248.pdf



- ➔ *Since 1900 11 similar or longer events*
- ➔ *No similar event since 1972 (with the exception of 2018)*

Figure 1: Days with a discharge lower than the equivalent discharge GlQ (Source: WSV)

1.3. Morphology

In the shallowest section of the Middle Rhine valley, particularly between Mainz and St. Goar, the low water period was an enormous challenge for inland water transport.

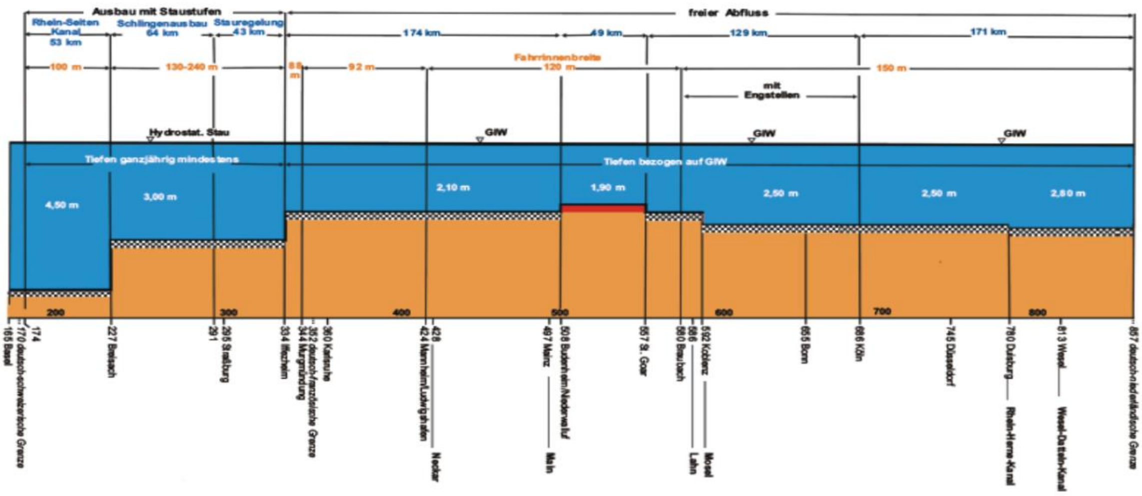


Figure 2: Longitudinal section of the Rhine (Source: WSV)

In this section, a navigable channel depth of 1.90 m is available 345 days per year, classified by the German waterways and shipping administration as a bottleneck. Nevertheless, the Rhine is the most important inland waterway in Europe and the gateway for Switzerland to the open sea.

1.4. Inland Waterway Transport (IWT)

Since 1945 cargo transported on the Rhine has been growing constantly and is expected to grow further. In 2017, a total of 151 million tonnes of cargo were transported through Emmerich, and some 200 million tonnes are expected for 2030.

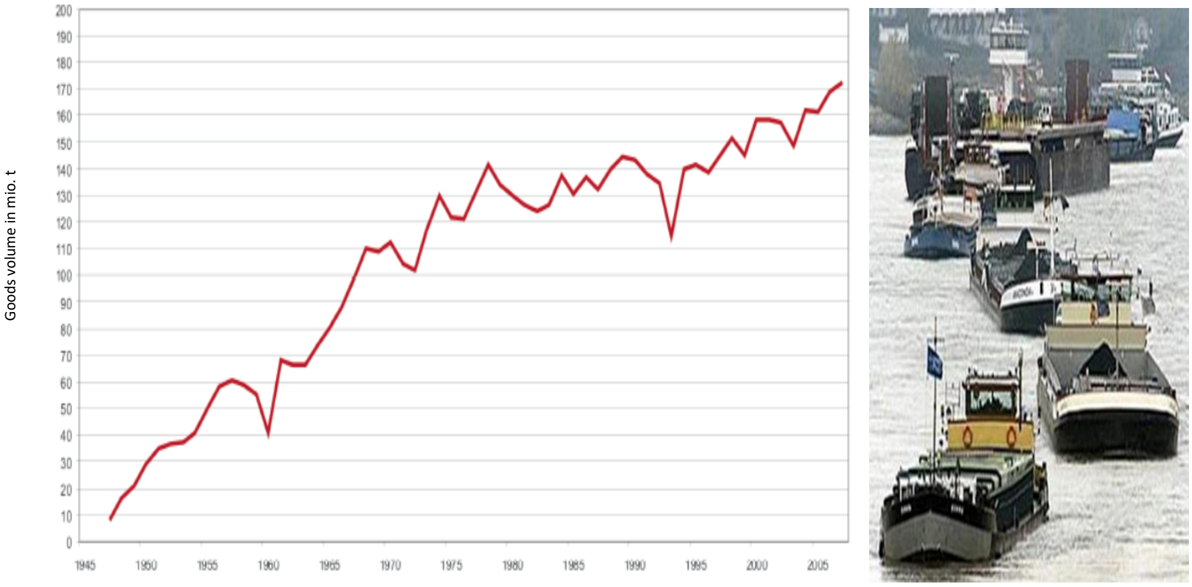


Figure 3: Development of cargo transport at Emmerich (1945 till 2007, source: WSV, DESTATIS)

In the past decades, the traffic increased by a factor of 5 to 10. At the same time, vessels on the Rhine became twice as large and the infrastructure was adapted to the increasing size of ships. However, storage capacity for riparian shippers and the industry decreased significantly. With the hydrology of the Rhine being almost constant, this has led to a significant increase of vulnerability of Rhine navigation.

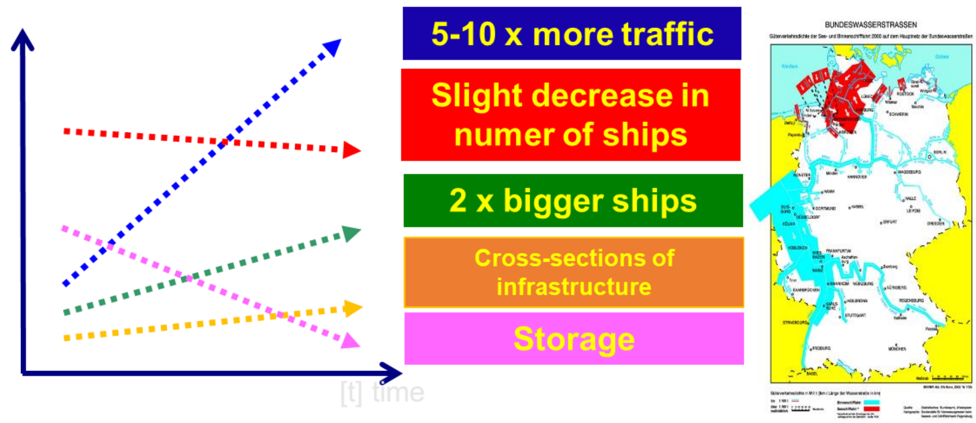


Figure 4: Developments in Rhine navigation (Source: WSV)

1.5. Transversal key takeaways

Knowing that the Rhine hydrology is a given factor, the solutions to strengthen the resilience of inland water transport must originate from other factors. However, there are **no one size fits all solutions**, therefore a combination of measures is needed. **Measures need to be taken** regarding adaptation of fleet, infrastructure, logistics and storage concepts, as well as implementation of digital tools, in order to ensure that inland navigation remains a reliable mode of transport and to avoid a permanent shift away from inland waterways to other transport modes. At the same time, the extreme low-water period in 2018 has also shown that such events, with regard to the industrial processes concerned, cannot be controlled by short-term modal shift.

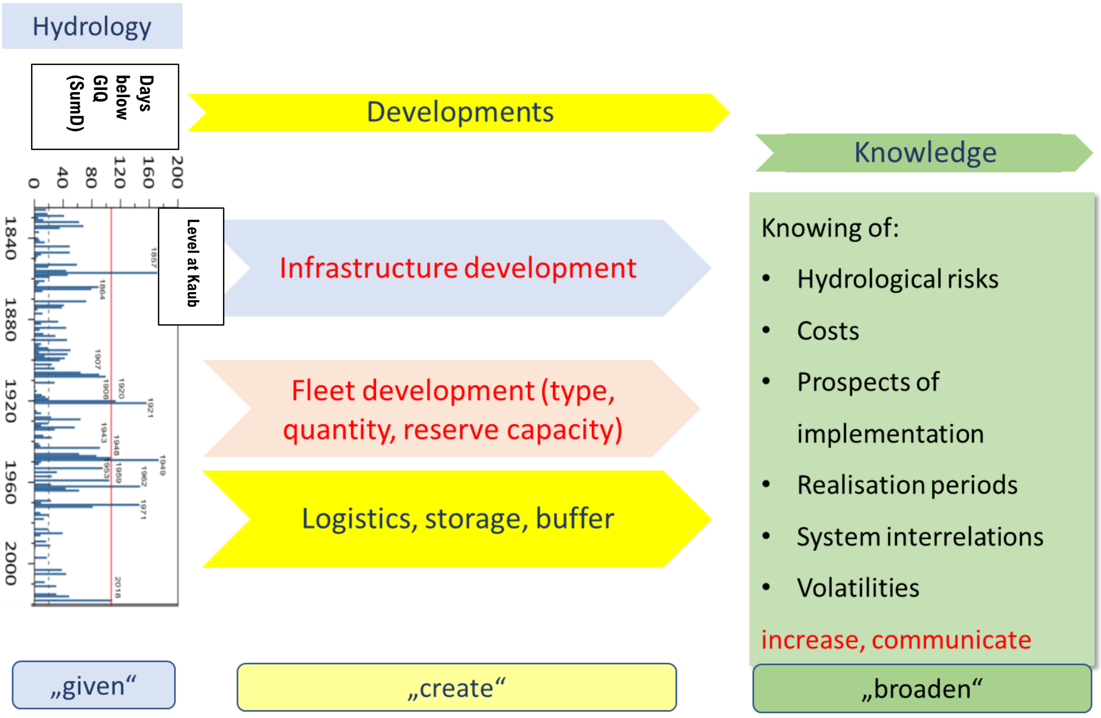


Figure 5: Fields of future activities (Source: WSV)

The workshop also identified the need for a **continuous intensive dialogue between the industrial, logistical, political and environmental stakeholders**. In particular, it is essential to allow these players to put their ideas and visions for the future at the forefront so as to find the right balance between infrastructure and fleet development on the one hand, and preservation of biodiversity and water protection on the other hand.

The low water in 2018 was a **wake-up call**. Despite their negative consequences, they also allowed the sector to take adaptation measures. The objective is to **act now** and prepare for the future.

2. Fleet

2.1. Impacts

If the water depth decreases, the ratio between water depth and draught (h/T) also decreases, leading to more resistance and thus a higher demand for power. Less keel clearance at the same speed leads to an increasing sinkage of the vessel and often a reduced speed. These effects can be taken into account when discussing design considerations. However, the broader the mission and the operational profile, the harder it will become to optimise a vessel design for specific conditions.

Low discharge on the Rhine leads to low navigable channel depths in the free-flowing sections of the Rhine. The decreasing navigable channel depth has impacts on transport safety with effects of insurance policies, energy consumption and voyage times. It limits the maximum cargo-carrying capacity of a fleet and thus reduces efficiency with further effects on stock and stock management.

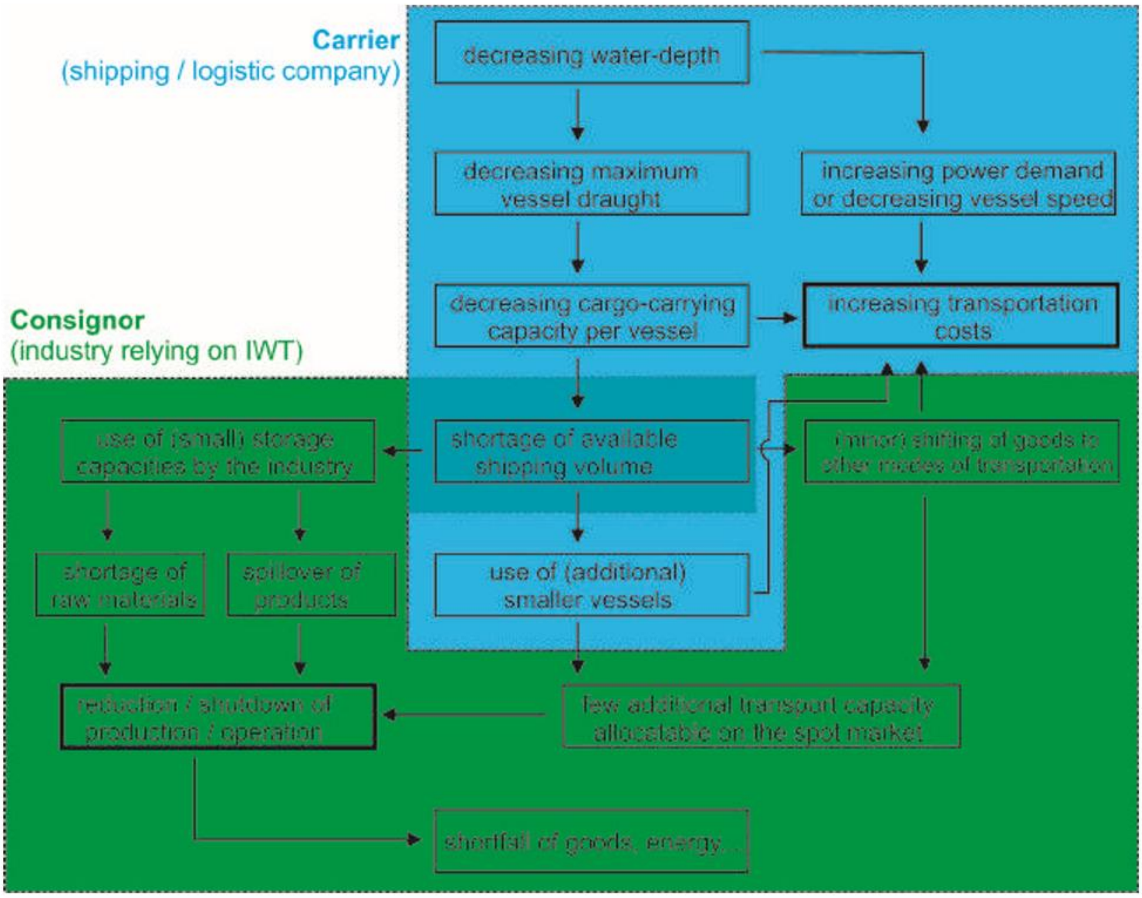


Figure 6: Schematic representation of the functional chain of the vulnerability of IWT due to low water (Source: RWS, IMPREX)

Low water also leads to nautical challenges for inland navigation as regards security clearance, narrow fairways, congestion and thus complex navigation.

Figure 7: Rhine navigation at low water (Source: ESO)

In addition, the loading degrees of vessels can be considerably reduced because of low waters, resulting in a lower volume of goods transported per voyage. This leads to an increase in transport costs of IWT in order to cover the fixed costs of transport and compensation for the lower volume of goods transported.

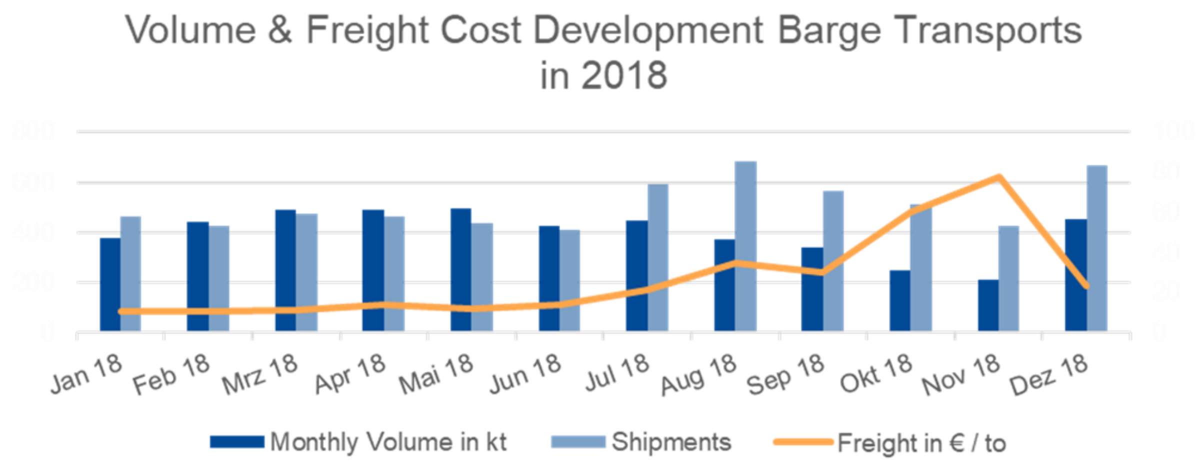


Figure 8: Volume and freight cost development in 2018 (Source: BASF)

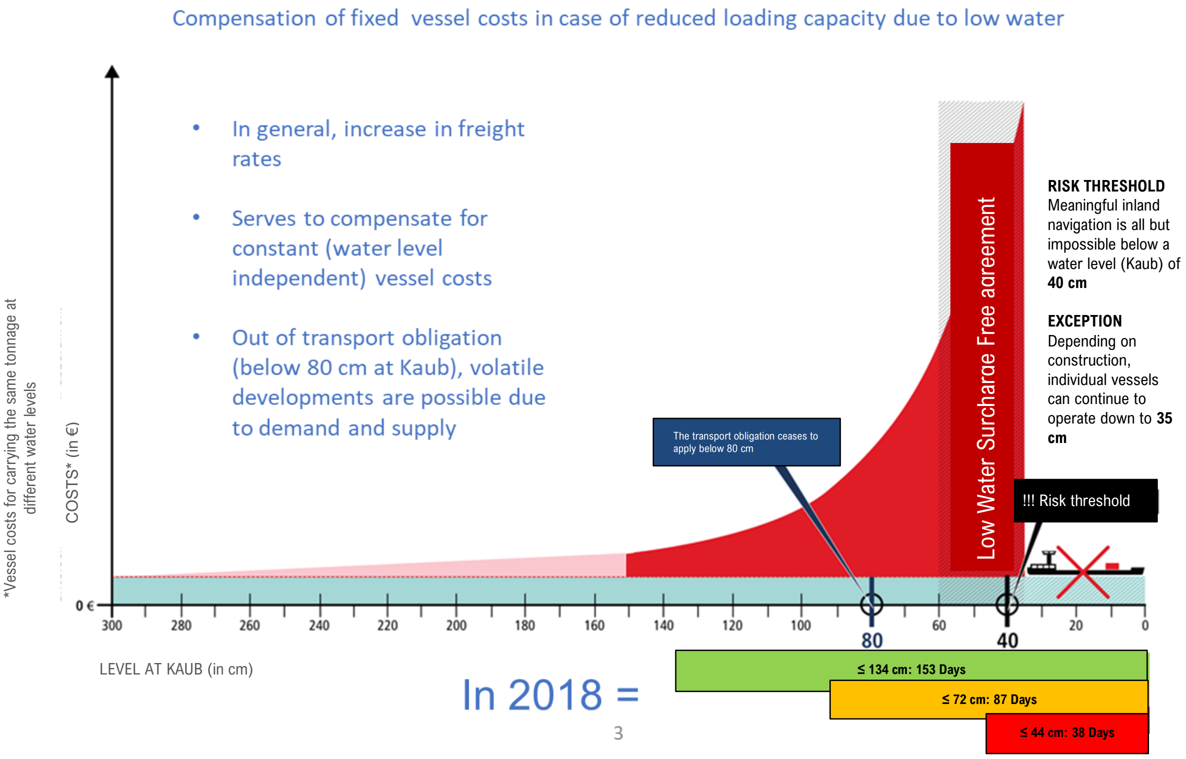


Figure 9: Compensation of fixed vessel costs in case of reduced loading capacity due to low water (Source: RHENUS Logistics)

This affects not only the transport of classic dry and liquid cargo but also container transport. The figure below shows that at an indicated gauge depth of 2.50 m at Kaub, a standard container ship with a load capacity of 208 TEU can carry 100% of its capacity. If the indicated gauge depth at Kaub drops to 75 cm, this leads to a decrease of loading capacity of 75%. Thus, four vessels or four voyages are needed to transport the same volumes of cargo. If the indicated gauge depth at Kaub drops further to 55 cm, six vessels or voyages are required to complete the transport.

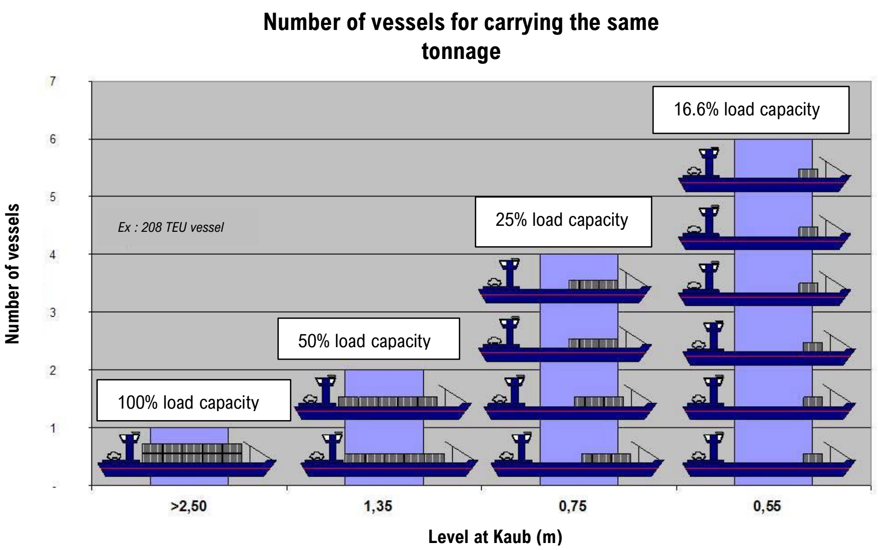


Figure 10: Amount of ships required to transport a fix amount of cargo (Source: CONTARGO)

A similar conclusion can be drawn for a dry/tanker fleet with average capacity. Below 134 cm, 72 cm and 44 cm, it can navigate respectively at 50%, 25% and 15% of their capacity (source: Rhenus Logistics, see also figure 11 below). At an indicated gauge depth of 40 cm at Kaub, inland waterways transport simply cannot take place, despite some vessels which are adapted to navigate up to an indicated gauge depth of 35 cm.

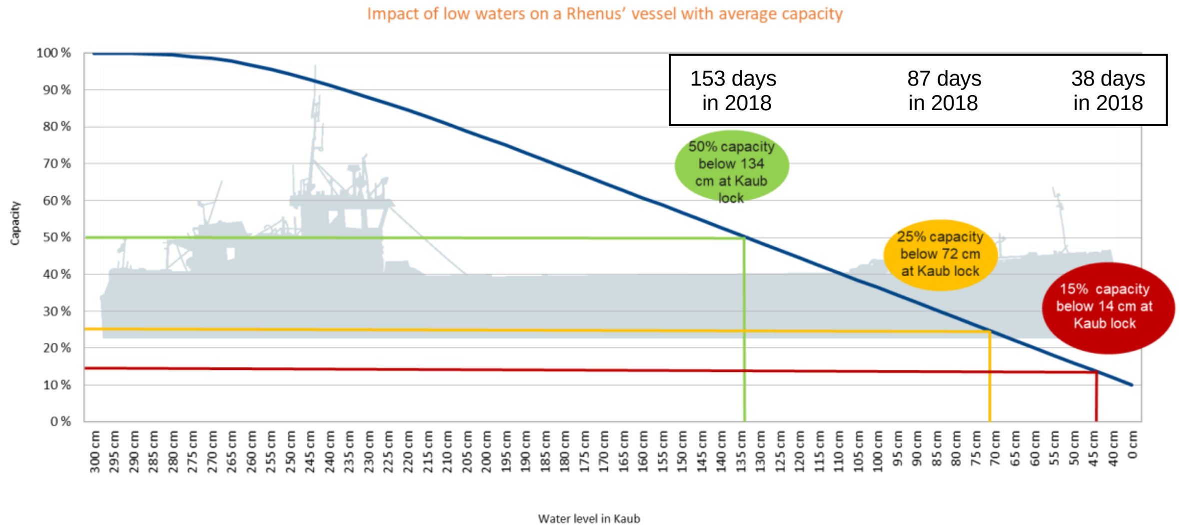


Figure 11: Fleet capacity vs water levels at Kaub (Source: Rhenus Logistics)

2.2. Solutions

<u>Vessel</u>

Whether a vessel can be used efficiently at low water or not depends on:

- Vessel construction (design for low weight construction)
- Vessels draught
- Construction of the vessels' aft ship
- Size of the propellers
- Pressure on the propellers.

Hence, the vessels' design, such as hull and propulsion system, is an essential aspect if transport at low water is envisaged at design phase. As already stated above, there are no one size fits all solutions. Newly designed vessels need to be optimized for defined operational profiles. Therefore, several options are already available, such as:

- Optimised bow design to minimise wave making for the different loading conditions (based on operational profile)
- Optimised propeller(s) with smaller diameter to reduce draught
- Application of modern propeller design and nozzle
- Installation of two or more propellers
- Prevention of air suction to the propeller by installation of tunnels, flex tunnels or cover plates

Figure 12: Optimisation of vessels’ aft and propellers (Source: CONTARGO)

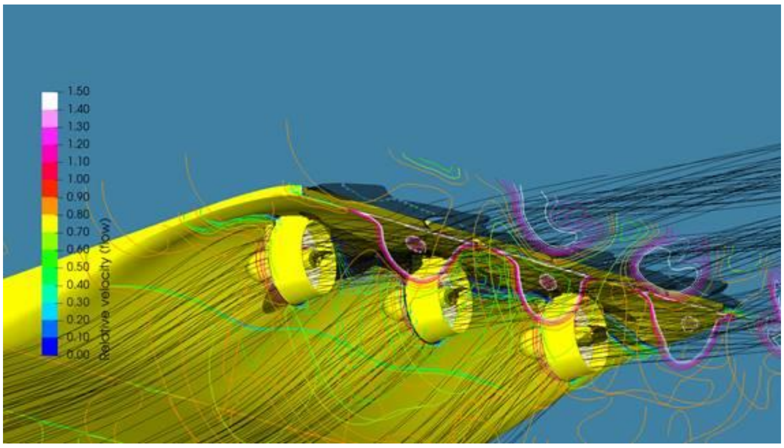


Figure 13: Analyses of aft ship design with Computational Fluid Dynamics (source MARIN)

Figure 14: Aft ship design with 3 thrusters, reducing propeller diameter for low water operation (Source: MARIN, Photo: S. Oudakker, Oudcomb)

The workshop concluded that today, all necessary means to better adapt to low water are already available. However, some demand for research remains in order to further improve model predictions, such as:

- Interaction of aft ship with propellers, nozzles, rudders, tunnels etc. in (extreme) shallow water
- Ship waterway interaction
- Ship ship interaction
- Shipping traffic in confined waterways.

However, it was also highlighted that there are limits to such adaptation measures. Indeed, inland navigation vessels should also be versatile and adapted to most economically significant situations (not only low water situations).

Fleet

To better adapt IWT to low water, a diversification of the fleet would be desirable which means that a dedicated part of the fleet would be optimized for use in times of high or low water. However, this would lead to additional costs in IWT since parts of the fleet would operate outside their design parameters. These costs have to be internalised into the transport price. It also leads to the question of whether these vessels would be operated outside their design parameters at all or kept at berth until needed.

The workshop identified further solutions to adapt the fleet to low water, such as:

- Optimisation of existing vessels, as described above
- Use of smaller vessels in coupled formations
- Optimised new builds.

Several fleet operators already have experience with optimization measures. CONTARGO reported that during the low water peak, three of their upgraded coupled formation were still able to navigate on the Middle Rhine section each with two additional barges to compensate for the lower loading degree.

In scenarios where sheer optimization of fleet and fleet management are not sufficient, further measures such as transfer of freight to rail have to be taken into account. Both transport modes can benefit from each other if interruptions or congestions on inland waterway or rail corridors occur.

3. Shippers and industry

3.1. Impacts

The impacts of the low water period in the second semester 2018 should not be underestimated. This phenomenon is not new but the vulnerability of inland waterway transport towards low water seems to have increased. Indeed, despite 2018 being the second to last longer-lasting low water period out of the seven most severe episodes of low waters in the last 100 years, 2018 was also the year when, from an economic point of view, inland waterway transport suffered the most.

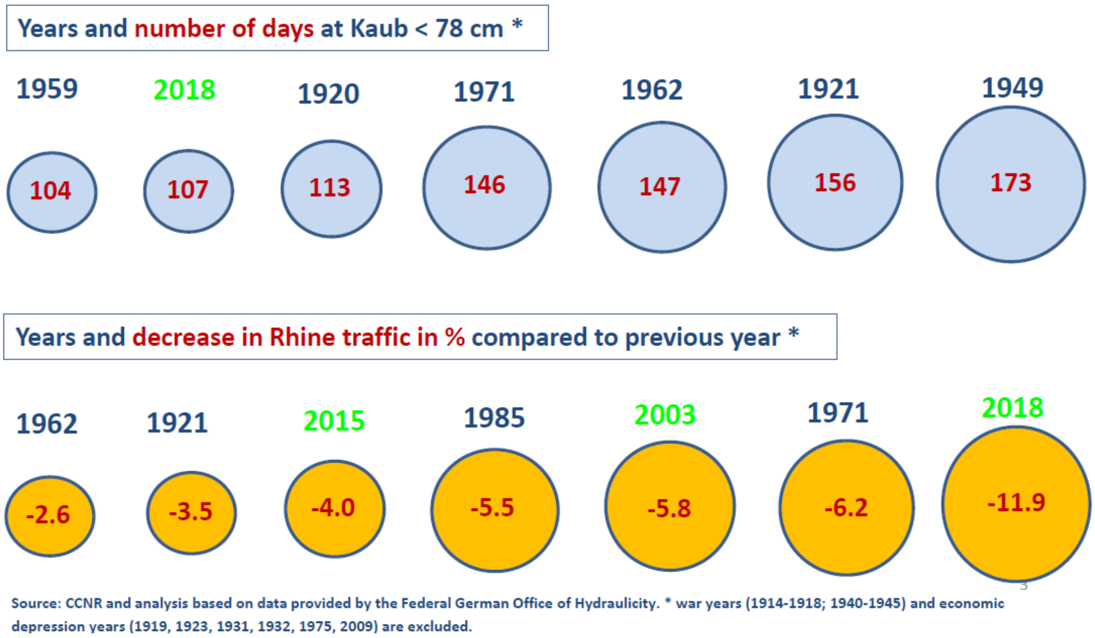


Figure 15: number of low-water days vs impact on Rhine traffic (Source: CCNR calculation based on German Federal Institute of Hydrology (Bundesanstalt für Gewässerkunde – BfG))

As explained in previous chapters, the reason for these more severe impacts can be linked to many aspects, such as fleet development, infrastructure but also logistics. Indeed, the principle of “Just-In-Time” logistics is preferred, which operates under the concept of receiving raw materials, products and parts as they are needed, rather than having them in stock. It allows businesses to cut storage costs by not having to store as much material. However, it plays against inland waterway transport in case of incidents such as low waters.

The interruption in the logistics chains caused by the low water period in 2018 caused considerable economic losses. For Germany, this heavily disturbed the delivery of raw materials (in particular iron ore Coal and basic chemicals) as well as final products of the chemical, metal and petrochemical industry, which resulted in a decrease of its industrial production by almost 5 billion Euros.

Low waters had a particular impact on the German companies BASF and thyssenkrupp [1] for which Rhine navigation plays an important role. Indeed, when final products cannot (or in only limited quantities) be shipped and raw materials cannot be supplied, ultimately, the reduction of production becomes unavoidable. In the long term, both see low waters as threats, respectively for the BASF major integrated chemical complex in Ludwigshafen and the thyssenkrupp blast furnace site in Duisburg.

Some industry representatives went as far as stating that the sites at the Upper Rhine are in question because of unclear future developments.

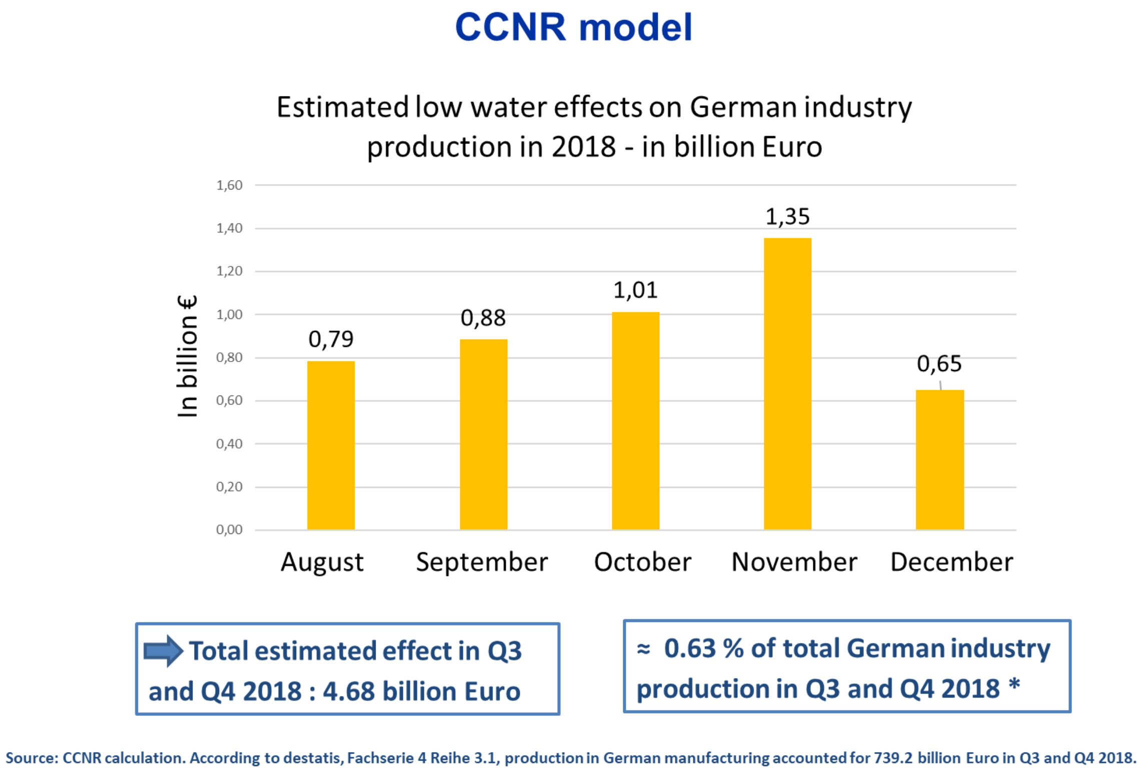


Figure 16: Estimated effect of low waters in German industrial production (Source: CCNR calculation based on Destatis)

The logistics chain also needs to adapt to other follow-up effects of low waters, such as the handling of unforeseen stock in maritime and inland ports, with goods being stored for longer time periods than expected, and delays in loading and unloading activities not only for inland waterways transport but also other modes.

In addition, in order to maximize transport volumes, the use of smaller freight vessels - which are more resilient to low waters - is necessary, implying modifications of the transport chain. Indeed, to carry the same volume of goods generally transported on one single vessel, three to four vessels may be necessary.

1 The chemical company COVESTRO was also impacted by the crisis.

In times of low waters, IWT therefore becomes a costly option:

- increase in freight rates (up to seven times higher than during normal water levels), directly linked to the shortage of barge capacity and limited availability of barges that can navigate at low water levels,
- major increase in the number of voyages needed to transport equivalent volumes of goods,
- increased risk of accidents (low water levels combined with additional vessels on the waterways), thereby increasing insurance costs,
- production losses, for which a significant amount of energy is needed for companies to decrease or increase the full continuous production at chemical companies, leading to additional financial losses,
- and bottlenecks in distribution / customer which all adds up to the balance sheet.

A modal shift to other modes, in particular rail and road, is also a direct consequence of low waters, especially for market segments where there is a strong multimodal competition, such as container transport. This is shown by the evolution of waterside container traffic in the Swiss Rhine ports. In the first half year 2018, a modal shift from rail to IWT took place due to the effects of the Rastatt accident (interruption of the railway line on the Rhine axis). However, the low water period in the second half of 2018 led again to a modal shift, but this time in the form of a loss of market shares for inland waterway transport and resulting in a 16% reduction of Rhine container traffic in the first half year of 2019 compared to 2018. An even more serious problem is the possible lasting effect of such incident-related modal shifts, given that shippers may become more reluctant to choose inland waterways as a mode of transport.

For industries, short-term responses in case of low waters must be found and result in internal business adaptation, mainly through prioritisation across different business units, monitoring and planning. An example is the decision-making chain that takes place in BASF in case of low waters, as illustrated below.

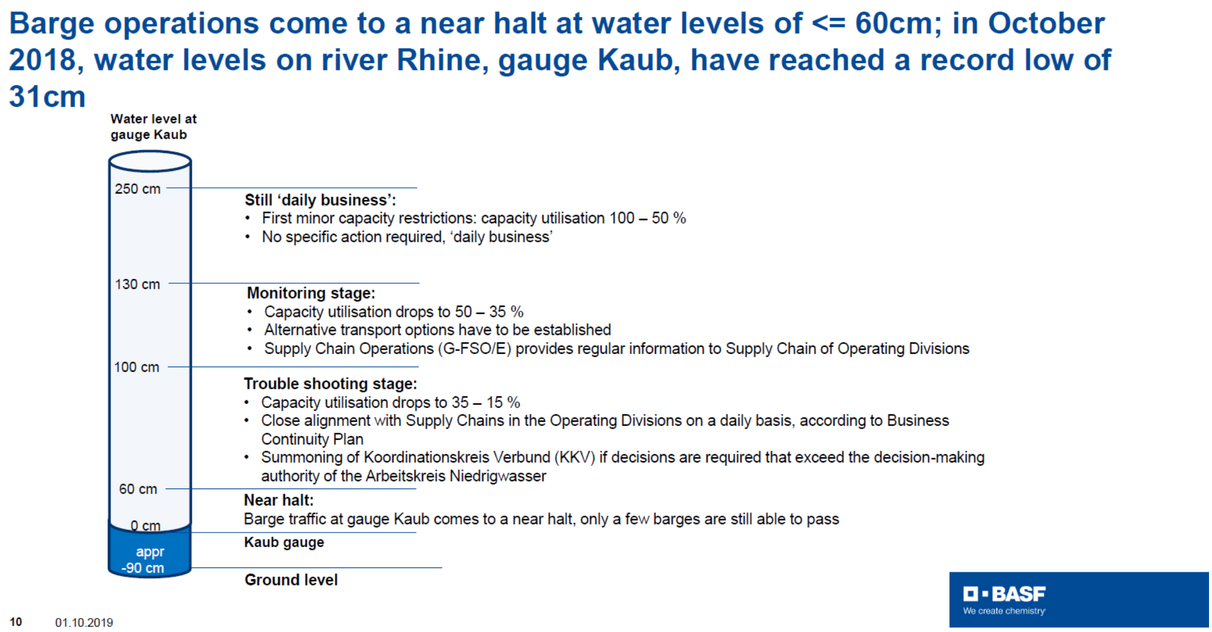


Figure 17: BASF decision-making chain in case of low waters (Source: BASF)

3.2. Solutions

The availability of alternative modal solutions and further cooperation with other modes - rail in particular - is in any case seen as one of the available solutions to cope with possible future lasting low water periods. It is important to bear in mind that organizing the supply of goods (being final products of raw material) by an alternative mode in case of a crisis is not an easy process, in particular for capacity reasons (rail capacities are limited and cannot compensate for all IWT volumes in case of low water levels) as well as technical/infrastructural restriction and technical facilities for loading and unloading at the production sites. Moreover, it comes with additional costs. This is why a modal shift to other modes in case of low water is particularly relevant to secure the supply of critical raw materials/final products and somewhat compensate for the volume of shortfalls of barges (not all volumes). To foster multimodality in case of incidents of this kind, a swift shift to other modes at terminals must be possible, which may require the construction of new and/or modification/optimisation of loading points.

In addition to the above-mentioned measures, adaptation of the logistics and storage concepts are part of the pool of measures available to foster resilience of inland waterway transport to low waters.

A measure which has been tested and proved efficient during the 2018 low water period was the recourse to barges with improved tonnage capacity that can still operate even at lower water levels, under time charter[1] contract. For a key industry player such as BASF, this enabled securing the capacity to transport critical raw materials, even during longer-lasting low water levels.

For key industry players, one solution could be the expansion of handling capacities in the ports located next to the industrial sites and an increase of storage capacities close to the production sites. However, this needs a strong hinterland connection to an alternative transport mode – such as rail – which at present does not exist for the needed capacity from / towards the north west ports. Also, the possibilities to increase tank storage capacities at the chemical parks should be positively appraised by the responsible states.

From a mid- to long-term perspective, optimization of supply chain control (e.g. use of dynamic tracking and tracing) also appeared to be a solution. This aspect will be looked at in more detail in the next chapter, which deals in part with digital solutions. The operational redesign of logistics sites (e.g. longer opening hours and usage of the weekend) could also be an option.

Last, but not least, an intensified dialogue within the logistics community may be necessary to anticipate such incidents and to be able to provide a quick response in the event that a new crisis may occur. As an example, handbooks for international Contingency Management for railway undertakings[2] and for Infrastructure managers[3] were published respectively in December 2019 and May 2018, in an effort to avoid major disruption to the European railway network, such as the Rastatt incident in 2017 when a tunnel under construction collapsed, closing the Rhine Valley railway for six weeks. It is worth contemplating whether, in the short to medium term, such a tool could be useful for inland waterway transport to cope better with low water levels and more generally whether a multimodal handbook could be developed in case of incidents affecting all modes of transport.

1 Transport vessel or vehicle charter for a fixed period instead of a certain number of voyages or trips.

2 https://uic.org/IMG/pdf/railway_undertaking_s_handbook_for_international_contingency_management_1.0.pdf

3 https://www.corridor-rhine-alpine.eu/files/downloads/european_context/InternationalContingencyManagementHandbook_RFCs.pdf

There is a strong need for an emergency plan which must be developed in advance and which can be used when a low water level period occurs. It should involve all process partners within all transport modes.

4. Physical and digital infrastructure

4.1. Impacts

Impacts on infrastructure are more likely to occur in case of high water rather than low water. However, low water can have a significant indirect impact through higher traffic density and less keel clearance, resulting in increased shear stress on the river bottom, causing possible obstacles for navigation.

For inland navigation, a stable and resistant river bottom is preferable. This sets the objective for waterway administrations maintenance works. However, natural rivers do not have river bottoms with these static characteristics. From the perspective of nature restauration and preservation, a dynamic river bottom would be more favourable. The implementation of the EU Water Framework Directive (Directive 2000/60/EC) led to an increase in communication and understanding between the different users of rivers. As a next step, common objectives have to be identified, planning of measures have to follow an integrated approach and coordinated within the different uses and users.

There may also be other low water impacts, for example on the operation of ship locks. At the Upper Rhine however, sufficient discharge is available all year round to guarantee the passage through and the operation of the ship locks.

Although the impact of low water is quite limited on inland waterway infrastructure, such infrastructure is an integral part of the solutions to cope with low water effects.

4.2. Solutions

<u>Waterway upgrades</u>

Measures for the optimization of laden draughts in the German section of the Rhine are identified in the so-called “Bundesverkehrswegeplan 2030”, which is the central planning instrument for the German transport system, covering all transport modes. The project “Optimization of laden draughts on the Middle Rhine” leads to an increase of navigable channel depth from 1.90 m to 2.10 m and the “Optimization of laden draughts on the Lower Rhine” to an increase of navigable channel depth from 2.50 m to 2.70 m/ 2.80 m. Although the transport benefits of optimizations of laden draughts are greatest in the range of normal low-to-medium water levels, they can also nevertheless help to reduce downtimes in the event of extreme low-water events. These measures should be realised as soon as possible.

Concern was raised with regard to **environmental protection**. For all scenarios, the multi-uses and the different users of the Rhine need to be taken into account. The Rhine is not only an inland waterway, but also a drinking water resource, a habitat for animals and plants and an important resource for recreation. Hence, all possible infrastructure measures need to be democratically discussed, balanced and possible negative impacts from these measures need to be compensated, possibly leading to lengthier project authorisation procedures. It was stated that communication and cooperation between the different users had already increased and identification of common objectives is ongoing. An alliance for the users and neighbours of the Rhine is in discussion under the umbrella of the so-called "8 Punkteplan" developed by the German Ministry BMVI together with industry and associations. Thus, win-win solutions seem to be possible if, from the beginning of project planning, an integrated approach is implemented, uses are prioritised and natural resources are protected. Further balancing of TEN-T regulation[1] demands and WFD requirements will be essential for the further development of waterways and restauration of rivers.

At the same time, these project **authorisation procedures,** which are already extreme lengthy, were criticised by IWT stakeholders, who asked for a significant speeding-up of planning and authorisation processes. These lengthy procedures were recognised as a significant risk for the development of waterway infrastructure and thus as a risk for industries to settle along the Rhine.

Water management

There was also an identified need to improve water management on the Rhine. Focus should be placed on keeping the water in the system, especially in times of high and low water, by buffering it or extending the water use cycle.

It was also suggested to keep more water in upstream lakes such as lake Constance or lakes in the Swiss Alps. Together with other affected stakeholders and organisations, possible solutions to safeguard sufficient discharge in drought periods by planning of new and extending existing water reservoirs need to be studied further as mid-/ long-term solutions.

However, the construction of new reservoirs / dams is also highly controversial and criticised by ecologists and the ICPR due to their negative impact on landscape and ecology (e.g. fish migration, disrupted sediment transport) and must also be discussed in the context of the water framework directive and the principle of non-deterioration.

[1] Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network: https://eur-lex.europa.eu/legal-content/FR/TXT/?uri=celex%3A32013R1315

4.3. Digital solutions

Digital solutions offer a unique possibility to support inland navigation with real-time information on available navigable channel depth, short-term and long-term water level forecasts, traffic intensity and estimated time of arrival (ETA). The further development of these solutions is partly up to the inland navigation sector and partly to the competent waterway administrations.

Information of navigable channel depth is available in general through the competent waterway administrations. However, this information is often not up to date when published, because post-production of surveys requires adequate time. Therefore, a significant safety margin is added to the published measurement to compensate the delay. To make better use of actual available navigable channel depth, the COVADEM project developed a system to distribute measured depth data on-board inland vessels in real-time. By making use of this system, the boatmaster has a better understanding of the actual situation and can thus optimise vessel loading, see https://www.covadem.org/over. As a next step, waterway administrations could integrate their data as reference for the data measured to further increase the usability of the system.

In addition, a possibility which needs to be developed further is the ability of barges to exchange dynamic real time measurements between themselves. This would allow a preceding vessel to inform the others following behind. To enable this, there is a need for a totally covered network condition alongside the river Rhine. Today, certain tracks are without an internet connection.

Figure 18: COVADEM data acquisition (Source: RWS)

In addition, data on available navigable channel depth should be added and regularly updated in the official electronic charts (ENC) provided by the competent waterway administrations.

For the relevant Rhine gauging stations, water level predictions and forecasts are available for a period of up to four days.

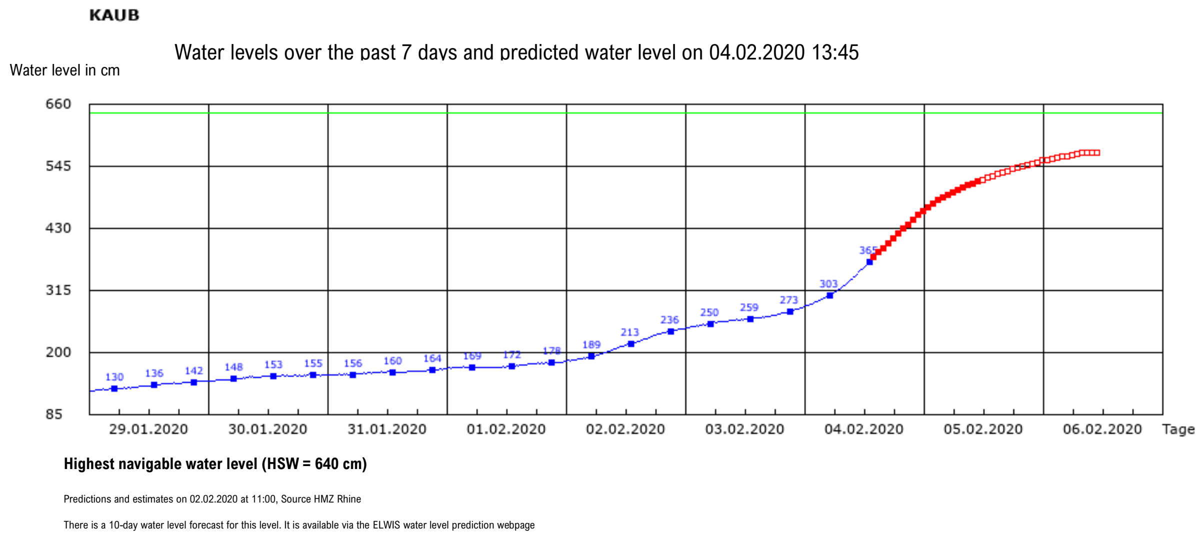


Figure 19: Water level and forecast (Source: Elwis.de)

A 10-day probabilistic forecast for selected Rhine stations is a new service provided. This improved forecast was developed in the context of the IMPREX[1] project.

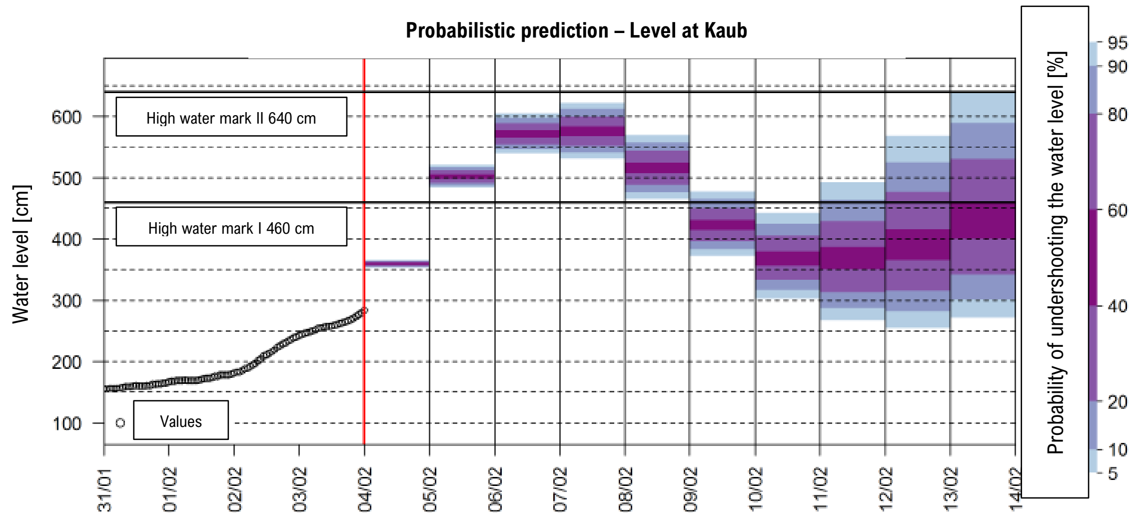


Figure 20: Improved water level forecast (10-day forecast, Source: Elwis.de)

This improved forecast aims to support the boatmasters and the shippers in planning and optimising their loading and transport operations and to avoid critical voyage situations such as inappropriate vessel draught for available navigable channel depth. This usually happens when hydrological conditions are misjudged upon loading of cargo and appropriate water level information is not available for the entire length of the voyage. The new forecast aims to help prevent this from happening.

1 https://www.imprex.eu/central-european-rivers

All this information could be integrated in a corridor approach following the example of RIS COMEX[1]. Corridor Management as a concept aims at improving and linking existing RIS on a route or network in order to supply RIS not just locally, but on regional, national and international levels. Therefore, Corridor Management will realise support for route planning, voyage planning, transport and traffic management. In that respect “Corridor Management” is defined as information services shared among waterway authorities mutually and with waterway users and related logistic partners in order to optimise the use of inland navigation corridors within the network of European waterways.

Figure 21 : RIS COMEX corridor management (Source : riscomex.eu)

Current limitations for the implementation of the above-mentioned approaches are:

- Availability of real time data
- Lead time of predictions
- Different service providers
- Integration of information.

1 https://www.riscomex.eu/

5. Next steps

Many participants in the workshop called for **EU coordinated actions**. Indeed, despite low water phenomena generally being regional problems, the impact of low waters on inland navigation transport is European wide. Therefore, some reflections about how to cope with such events in the future could also be discussed at EU level, possibly **at the level of corridors**. It could also be integrated into future work on the **Good Navigation Status**. Thus, these aspects were also integrated into the recommendations by the Naiades II Implementation Expert Group for an **inland waterway transport agenda** for Europe.

A further coordination and **harmonisation of the Water Framework Directive (WFD) and TEN-T regulation objectives** is needed. A first initiative to start the coordination was already initiated through PIANC's WFD Navigation Task Group. This process needs to be further developed and intensified and stakeholders need to be integrated into the harmonisation.

Intensification of the dialogue between industry, logistics, politics and environmental associations was identified as a necessary measure during the workshop. To foster and encourage such a dialogue, and to ensure sufficient monitoring of the topic, a concrete action for the CCNR could be to organise regular "low water talks" with relevant actors (for instance every two years).

The **measures required are already well-known and available**. However, the low water period that impacted inland waterway transport in the second semester of 2018 shows the urgent need for action. In order to make a first step towards implementation of available measures, there was a clear consensus among inland navigation key actors that adequate financial and planning resources should be made available.

Regarding the fleet, **major investments** would be necessary both for commissioning new building better suited to cope with future low water situations as well adapting the existing fleet.

In particular, **EU co-funding** could be made available for the purpose of research and development in that domain as well as for vessels and infrastructure development. In addition, EU support for projects such as the IMPREX project should continue to be available.

Action plans are already being developed at national level, such as the Action Plan "Niedrigwasser Rhein". Indeed, the Federal Transportation Minister Andreas Scheuer presented an eight-point plan in July 2019 to prevent dramatic consequences for the economy and Rhine shipping caused by heat and drought. The extreme low water period had severe consequences for companies such as thyssenkrupp, whose steel plant was running out of coal. The plan includes measures which were all discussed during the workshop such as better water level forecasts, better and more up-to-date information, the creation of new storage capacities, support for the construction of new types of shallow-water vessels and loading optimization in the Middle and Lower Rhine.

Source: bmvi.de[1]

The workshop has therefore enabled light to be shed on the type of measures and actions that should be taken to foster the resilience of inland navigation transport towards low water. Implementation of short, medium and long-term measures is now required in the fields of infrastructure, fleet as well as shippers, logistics and industry.

In light of the above, in table 1, an inventory of measures with ongoing projects (national and european) has been created by the CCNR. This allows to have a better overview on how different issues are being addressed by projects. As not all issues could be addressed due to lack of projects, such information could be gathered in future workshops and integrated in a revised version of the reflection paper “Act now!”.

The CCNR also plans for future activities, such as workshops and round table discussions to further support identification and implementation of projects and measures and to stimulate research activities.

[1] Action plan “Low water Rhine”
Provision of information: 1. Improving water level forecasting; 2. Establishment of a Climate & Water service in the context of the German Strategy for Adaptation to Climate Change (DAS); 3. Making up-to-date information about navigable channel depth available
Transport and Logistics: 4. Adaptation of transport concepts/optimization of transport and cargo containers
Infrastructure: 5. Accelerated implementation of the "Optimization of navigable channel depth in the Middle Rhine valley and Lower Rhine"; 6. Cutting administrative red tape (in particular approval procedures for infrastructure projects)
Long-term solutions: 7. Investigation of hydraulic engineering and water management options to ensure reliably calculable transport conditions on the Rhine; 8. Social dialogue

	Short-term	Medium-term	Long-term
A-Infrastructure	1-Improving water level forecasting 2-Up-to-date information about navigable channel depth, in particular by further developing digital solutions and the ability of barges to exchange dynamic real time measurements between themselves	3- integrated project planning approach 4-Accelerated implementation of the "Optimization of navigable channel depth in the Middle Rhine valley and Lower Rhine" 5-Cut administrative red tape (e.g. authorization procedures for infra projects) 6-Dialogue between industry, logistics, politics and environmental associations	7-Investigate hydraulic engineering and water management options to ensure reliable transport conditions on the Rhine 8-Improve water management on the Rhine 9-Study on possibility to have new /extension of existing water planning of reservoirs
B-Fleet	1-Research in optimisation of existing vessels 2-Research in optimisation of new builds	3-Dialogue between industry, logistics, politics and environmental associations 4-Use of smaller vessels in coupled formations	
C-Shippers, logistics, industry	1-Secure time charter contract for barges adapted to low water levels 2-Optimisation of supply chain control 3-Operational redesign of logistics site (e.g. longer opening hours)	4-Optimization of container transport 5-Construction/optimization of terminals to facilitate modal shift 6-Adaptation of transport/ storage concepts 7-Dialogue between industry, logistics, politics and environmental associations	8-Expansion of handling and storage capacities in the ports next to the industrial sites

Table 1: Inventory of ongoing measures/projects to help inland navigation to overcome the challenges related to the low waters

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
1	IMPREX (Improving PRedictions and management of hydrological EXtremes)	A1	Project to improve the prediction and impact of extreme meteorological and hydraulic events (link : https://www.imprex.eu/)	Related to inland waterways / inland waterway transport: Improve water level forecasting to medium-range and monthly time-scales	Past (finished in 2019)	No	Participation of the CCNR to the user group (CCNR was involved in IMPREX as stakeholder)	Project coordinator: Royal Netherlands Meteorological Institute (KNMI) / NL (https://www.imprex.eu/about/at-a-glance) Consortium: 23 partners from 9 countries (https://www.imprex.eu/about/meet-the-team)

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
2	COVADEM (Cooperative Depth Measurement of the Fairway)	A2	Project aiming at enhancing performance of inland shipping by providing smart hands-on insights on available loading water depths and both performance and sustainability metrics, related to a vessels' operational conditions. (link: https://www.covadem.org/)	Precise planning and management of loading capacity of vessels Collection of up-to-the-minute data	Ongoing (short-term)	No		

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
3	Action plan for low water on the Rhine «Aktionsplan Niedrigwasser Rhein »	A1-9, B1-4 and C1-8	Eight-point plan to ensure reliably calculable transport conditions on the Rhine even in the event of an accumulation of extreme low water periods caused by climate change and to meet the climate change-related challenges for the industrial sites on the Rhine and its tributaries.	1. Improve water level forecasts 2. Set up DAS (German Strategy for Adaptation to Climate Change) basic service "Klima & Wasser" 3. Provide up-to-date depth information to boatmasters 4. Adapt transport strategies/optimize transport and load receptacles 5. Speed-up implementation of "Optimization of laden draughts on the Middle and Lower Rhine" 6. Acceleration by acts to adopt measures 7. Investigate options of hydraulic engineering and water management to ensure reliable and predictable transport conditions on the Rhine 8. Social dialogue	Ongoing (short-, mid- and long term)	National (Germany) Coordination with the Rhine riparian states should take place within the framework of cooperation in the CCNR	CCNR as a platform to spread knowledge among other member states	Germany

N°	Name	Contributing to measure identified in chapter 5 “Act now” number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
4	Blue Deal (Flanders Region,)	A3, A6, A8 and A9	Blue Deal is a program started by the Flemish Government to make Flanders more resilient to droughts and water scarcity. A part of the program also contributes to the navigability of the Flemish waterways during low water periods by investing in pump capacity at sluices and prevent leakages at sluices. (link: https://www.integraalwaterbeleid.be/nl/nieuws/blue-deal-bindt-strijd-aan-tegen-droogte)		Ongoing	No	CCNR as a platform to spread knowledge among other member states	Belgium
5	RIS COMEX	A2, C2. C4, C5 and C6	Project to implement Services for inland navigation on the entire connected EU waterways network on one pprtal supplying information about the infrastructure, actual and predicted traffic and information for intra and intermodal logistics	Easier planning of voyages, improved planning of voyages with accurate ETA’s at locks and ports, improved transport coordination berween shippers, skippers, ports and other logistics partners	Ongoing. Project will end at 31-12-2021. Operation will continue	No		Netherlands

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
	Fenix Network	C2, C3 and C4	A European FEderated Network of Information eXchange in LogistiX https://fenix-network.eu/ https://egtc-rhine-alpine.eu/wp-content/uploads/2020/12/4-Huschebeck-FENIX_EGTC_PTV.pdf	Establish a federated network of transport and logistics actors across Europe, enabling sharing of information and services needed to optimise TEN-T - demonstrate the operational feasibility and benefits through the organised national pilots – focus on testing the achieved interoperability capabilities - set up the EU corridor community building programme and to promote the benefits to the participants in terms of reduced costs and GHG emissions				EU

N°	Name	Contributing to measure identified in chapter 5 “Act now” number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
	Call "HORIZON-CL5-2021-D6-01-09: Climate resilient and environmentally sustainable transport infrastructure, with a focus on inland waterways"			Clean, resilient, safe and smart mobility Energy as in all modes, incl. waterborne - Zero Emission Waterborne Transport (ZEWT) Partnership	1 Call April 2021-October 2021 2 Call October 2021-January 2022			EU

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
	NOVIMOVE	C2, C3, C4	https://novimove.eu/	Enhancing the logistics system density 1. Improved load factor of containers by means of cargo reconstruction; 2. Improved port logistics by reducing waiting times at terminals and sailing time between terminals; 3 Improved river navigation by satellite, sensor and data fusion; 4. Reduced waiting time at bridges and locks by dynamic scheduling system; 5. Innovative vessel solutions to cope with variable water levels; 6. New business models in current stakeholders' networks.	Kick Off June 2020			EU Lead TU DELFT

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
	PROMINENT	B1, B2, B3, B4	Project to adress key needs for technological development in the light of greening the fleet and respecting the EU set objectives to zero emission. It further strengthens the competitiveness of the IWT sector by addressing air pollutant emissions. Coordinated by STC Group https://www.prominent-iwt.eu/	Massive transition towards efficient and clean vessels; – Certification and monitoring of emission performance and development of innovative regimes; – Harmonisation and modernisation of professional qualifications and the stimulation of the further integration of IWT into sustainable transport chains.				EU
6	IRM (Integral River Management	A3, A4, A7, A8 and A9	Project to integrate demands of all functions of river into an overall planning and decision making. More specific:flood protection, water supply, nature development, river bed stabilisation, navigation	Balanced river development to accommodate all river functions	Ongoing (mid- and longterm)	National, but seeking coordination with Germany and Belgium	Finding and using opportunities to improve cooperation with other river functions	Netherlands

N°	Name	Contributing to measure identified in chapter 5 "Act now" number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
7	RPIS 4.0	A2, A3, A6, C2, C3, C4, C5, C6 and C7	The RPIS project "4.0 – smart community system for Upper Rhine Ports" aims to improve the performance and competitiveness of multimodal transport through the integration of digital solutions in the global supply chain and thus be able to promote modal reporting on clean transport modes such as inland navigation. https://www.interreg-rhin-sup.eu/projet/rpis-4-0-smart-community-system-for-upper-rhine-ports/	Strengthening multimodal freight transport (= through the RPIS traffic management platform) Improving the offer of cross-border services for Rhine navigation operators (through the integration of real-time data managed by other river information services (E-RIS, AIS), as well as data from the Cargo Community Systems of major seaports) Strengthening sustainable mobility in freight transport (= through the development of new digital services for the port community)	Ongoing. Project will end at 30-04-2022. Operation will continue	No		Switzerland EU

N°	Name	Contributing to measure identified in chapter 5 “Act now” number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?	Country where program originated
			(What)		(When)	(Who)	(How)	Country
8	Clim-ability	A1, B1-3 and C2-8	Consulting services for companies, which brings together experts and researchers with several objectives: - collecting meteorological, climatic, hydrological, economic and social information to identify risks - diagnoses the vulnerabilities of companies in the Upper Rhine and identifies scenarios for adapting to climate change. - develops specific information for companies and support for decision-making. It also helps to build innovation perspectives. https://www.clim-ability.eu/en/welcome/	Encourage the adaptation of companies	Ongoing project between 2019 and 2022	No	Making the project better known	France / EU

Table 2: Inventory of future measures/projects to help inland navigation to overcome the challenges related to the low waters

N°	Name	Contributing to measure identified in chapter 5 “Act now” number ….	Description	Main effects/ outcome	Status and timing	CCNR coordination possible (Yes/No)	What could be the CCNR role?
			(What)		(When)	(Who)	(How)
1	Roundtables/Colloquia	A6; B4 and C7	Activity to intensify the dialogue between industry, logistics, administration and environmental associations on the topic of low water	Keeping the momentum as to the need to address the low water issue	Second quarter 2021 (short-term then on a regular basis)	Yes	CCNR and its Secretariat responsible for the organisation of these roundtables and colloquia to bring together all relevant actors

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