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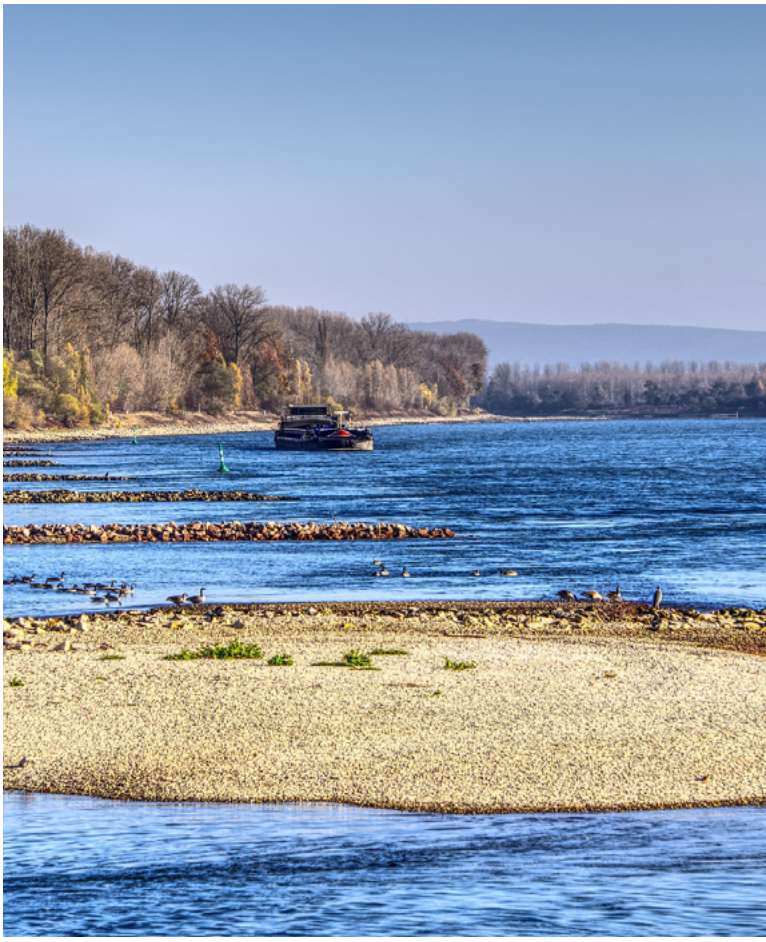
IMPROVED FORECASTING AND RISK MANAGEMENT FOR THE WATER TRANSPORT SECTOR

New hydro-meteorological forecast products by IMPREX boost the operational efficiency of the European water transportation sector and help mitigate the vulnerability of waterway transport to hydro-meteorological extremes, in particular low flows.

Inland waterway transport along free-flowing rivers such as the river Rhine is susceptible to hydrological phenomena such as droughts or high discharge events, affecting safety and efficiency. Low stream flows and low water levels limit the maximum cargo carrying capacity of vessels and increase their energy consumption and their travel time.

Inland waterway transport is highly vulnerable to hydro-meteorological extremes

The 2018 low flow situation in many European Rivers, including the Rhine and Danube, has demonstrated the wide-ranging impacts of floods on the sector, from pressure and reduced vessel loading to a week-long gridlock. Showing the severity of this drought, a record-low water level was registered at Kaub gauge, a water transport bottleneck in the Middle Rhine. The extreme low-flow situation had a particularly severe impact on waterway managers, but also hit shipping and logistics companies and economic sectors that rely on waterway transport, such as industrial enterprises or power plants. As a result, waterway users and managers faced many a challenge in adapting their operational management procedures accordingly.



Hydro-meteorological extremes can be managed with accurate forecasts over a range of time scales

In the waterway transport sector, safety and efficiency are at risk due to hydrological impacts from short-term to climate time scale, illustrating the urgent need for new products for short to climate time scale forecasts to ensure efficient, strategic management within the waterway transport sector.

Climate change projections will be all the more important in future to ensure optimal fleet planning for shipping companies as well as for sustainable infrastructural waterway management. In light of this, stronger focus on climate change analyses and projections for the transportation sector should be considered in future research.

PRESENTATION OF IMPREX PRODUCTS

The IMPREX project developed two innovative approaches to help the transportation sector deal with hydrological extremes:

- **A pre-operational probabilistic water level forecasting system for traffic and transportation covering up to a 10-day forecasting period**
- **A pre-operational probabilistic forecasting system to improve waterway management (e.g. sediment management) and to aid logistics decision-making within river systems covering up to a 6-week period**

PRE-OPERATIONAL PROBABILISTIC FORECASTING SYSTEMS

IMPREX developed and implemented new forecasting systems for German waterways to give stakeholders improved navigation-related forecasts for better decision-making.

Longer lead times enhance decision-making processes

IMPREX delivers forecasts for discharges and water levels with lead times of more than four days. This was achieved by improving the hydrological modelling and output post-processing of existing forecasting systems. Forecasts with a longer lead time give companies a basis for better logistics planning, enabling them to take advantage of the maximum possible vessel load capacity for guaranteed economic efficiency. Possible savings are within the range of around EUR 5 million per year, with medium- to large-sized vessels benefitting more than small vessels owing to their larger transport volume.

The forecasts further allow decision makers to factor in any necessary transportation restrictions caused by floods. To achieve the longer lead times, extended-range meteorological forecasts were combined with an improved chain of hydrological, hydrodynamic and statistical models.

Economic benefits from rational decision-making facilitated by probabilistic forecasts

Deterministic forecasts are limited to relatively short-term lead-times as knowing related uncertainties becomes more relevant with longer lead-times. IMPREX developed probabilistic approaches that consider uncertainties, improving the basis for efficient and risk-based decision-making. Probabilistic forecasts include accurate uncertainty information, providing a more reliable basis for decision-making. IMPREX provides probabilistic forecasts on future water levels that exceed lead times of four days for the first time ever.

The 10-day and 6-week forecasting approaches that were implemented within IMPREX are based on recent hydro-meteorological ensemble forecasting systems. These comprehensive inputs are driving hydrological models for Central European Rivers, hydrodynamic models for the waterways as well as statistical models for the relevant gauges.

Various stakeholders already enjoy the benefits of using the new forecasting products. Besides waterway and harbour managers, the target user group also includes companies that rely on waterway transport, such as industrial enterprises, transmission network operators and river basin authorities. To fully understand and use these free-of-charge probabilistic forecasting models efficiently, knowledge and capacity development is helpful, although the products can be employed even with basic background knowledge. In-depth knowledge of the capabilities of the forecasts has been transferred to potential users in interactive stakeholder workshops.

COMPETITIVE EDGE

- **IMPREX's approach enables long-term planning, risk-based decision-making and the optimisation of management procedures on the longer term, thus increasing economic benefits.**
- **Very little training is needed, with experts in the field grasping the information in the 10-day forecast, in particular, with relative ease.**
- **The methodologies developed for waterway transport can be transferred to other rivers and other parts of Europe.**

CASE STUDY RIVER RHINE

EnBW, one of the largest energy supply companies in Germany, is pushing the expansion of its renewable energy business – primarily wind and hydropower – at the same time running state-of-the-art conventional power stations to secure energy supply. Waterway transport accounts for the biggest share in fuel logistics even though it is susceptible to hydrological extremes.

> *I am impressed by the model performances. The model ensures a responsible approach to dealing with inevitable uncertainties in forecasting*
>
> *Dr. Christoph Elsässer, analyst for energy meteorology at EnBW*

During extreme low-flow periods in past years, shipping companies reported up to 85 percent less cargo to avoid running aground, requiring more ships to transport the same quantities. During the second half of 2018, the low water situation resulted in transport restrictions, a sharp increase in logistics costs and reduced power plant availability. These disturbances in the company's waterway transport resulted in significant higher transportation costs. For both economic and ecological reasons, there is no viable alternative to water transport for the company.

The IMPREX pre-operational probabilistic forecasting system, which has a lead time of 10 days, creates an important added value for EnBW in the form of improved logistics planning security. The company worked closely with IMPREX for a period of two years, testing and implementing the system successfully.

The forecasting product has now been integrated into EnBW's management processes and is being used on a daily basis. Especially in summer and autumn, when low flow periods are likely to occur, the 10-day forecasts are instrumental in optimising management processes. Although there will be a comprehensive structural change within the German energy sector in future years, reducing fossil energy sources by 2038, waterway transport will remain an important mode of transportation for EnBW. For this reason, the company needs tools that can deal with hydrological extremes that are likely to occur with increasing frequency in future as a result of climate change.

> *Models such as these are an absolute must. There is a huge demand for these kinds of forecasts and this will become even more so the case in light of climate change*
>
> *Dr. Christoph Elsässer, EnBW*

POLICY RELEVANCE

EU-supported River Information Services (RIS) are a set of services designed to support inland waterway transport by improving safety and efficiency with the help of optimised traffic and transport processes. RIS include geographical, hydrological and administrative data on waterways as well as other data relevant to navigation in the short, medium and long term.

IMPREX has shown that the probabilistic forecasting products developed help make waterway transport more reliable and more efficient. More efficient decision-making processes will ultimately improve safety on European waterways. The possibility of integrating the results of the probabilistic forecasting systems presented into the RIS should be considered in order to have a positive impact on inland navigation traffic and transport management within the EU.

For further information please visit www.imprex.eu and check out our interactive product demonstrator!

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This factsheet was compiled by adelphi based on the work done within the context of the research project IMPREX and interviews of involved users. Special contributions were made by Bastian Klein (BfG) and Bart van den Hurk (Deltares). Graphic design by Arctik.

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IMPREX is designed to help reduce Europe's vulnerability to hydrological extremes by achieving a better understanding of the intensity and frequency of potential disrupting events. Enhancing our forecasting capability will increase the resilience of European society as a whole, while reducing costs for strategic sectors and regions at the same time. The research project brings together 23 partners from 9 countries and has received funding from the European Union's Horizon 2020 Research and Innovation Programme.