



Moving Sediment Management Forward

River basin case studies

The Meuse

The Meuse International River Basin District (IRBD) covers, from up- to downstream, parts of the territories of France, Luxemburg, Belgium (Wallonia, Flanders), Germany and The Netherlands (1). The IRBD covers a total land area of 34,548 km², with close to nine million inhabitants. The source of the main river - the Meuse - is situated at an altitude of 384m in Pouilly-en-Bassigny in France and its length from its source to its mouth in the North Sea is 905 km. Urbanisation, industrialization, agriculture and navigation are the main driving forces that determine the status of the waters of the IRBD Meuse. There are different types of pressures (emissions, losses and discharges of pollutants; sluices, weirs and dams; canalisation, artificial banks and dikes; and water abstractions) which result in potential or observed impacts and consequences - sometimes individually, sometimes in combination.



Fig. 1: The Meuse river basin ([http://en.wikipedia.org/wiki/Meuse_\(river\)](http://en.wikipedia.org/wiki/Meuse_(river)))

The WFD requires an assessment of the likelihood that water bodies will fail to meet their environmental objectives in 2015. This analysis highlights that over the whole basin district, about 50% of the natural surface water bodies are considered to be at risk and that nearly all the artificial and heavily modified water bodies subject to a risk analysis are at risk. The following causes of qualifying water bodies being “at risk” are considered to be the main determinants for surface waters in the basin as a whole: chemical oxygen demand, nitrogen, and phosphorus; pesticides (in particular dichlorvos and pyrazone); specific pollutants (in particular copper, zinc and PCBs); hydro-morphological modifications and discontinuities in the main river course and some of its tributaries.

Challenges related to sediment remobilisation (2)

Currently available global climate projections anticipate crucial changes in extreme weather conditions, oceanographic conditions and the water regime of rivers. These changes are expected, in turn, to severely modify basic fluvial processes like currents and erosion, thus inducing important physical, geochemical and biological reactions. Several recent research projects (AquaTerra; Modelkey) concluded that floods and storm flows will remobilize historically contaminated soil or sediment from riverbanks and floodplains. Furthermore, they concluded that the remobilized contaminated material will be eroded and transported further downstream, where it will affect chemical and ecological water quality.

Such scientific information might be perceived as too generic to inform any response action. A hypothetical – but realistic – flood event affecting the severely contaminated Flémalle site (a former coke plant site) near Liege was therefore simulated as a typical example of many such riverbank sites along the Meuse. The resulting ecological risks in the Meuse surface water downstream of the Flémalle site were estimated.

The assumed flood and associated erosion event comprised the erosion of a small proportion (1.4%) of the volume of the fill material at this site (7,000 m³) over a period of 24 hours. Based on soil quality data obtained at the Flémalle former industrial site, the hypothetical erosion event causes the release of 29.2 kg cadmium, 874 kg of benzene and 5023 kg of fluoranthene. Information for other substances is available, but these have not yet been analysed. The eroded mass of benzene is about equal to the annually averaged river load of this substance at the Walloon-Dutch border (1999-2008); the eroded mass of fluoranthene is 9 times higher than the annual river load.

The fate of the eroded amounts of cadmium, benzene and fluoranthene was simulated with the EXPOBASIN model (Figure 2), using data from the December 1993 flood event in the Meuse to generate time and space dependent fluxes of water and suspended particulate matter, which carry the substances downstream and determine their fate. The results show that the eroded substances are carried downstream. Cadmium and fluoranthene demonstrate significant sorption to particles, and these substances are therefore partly deposited in floodplains and riparian zones on their way towards the Rhine-Meuse-estuary.

The simulated concentrations of benzene and cadmium downstream of the Flémalle site do not exceed the WFD Maximum Allowable Concentration Environmental Quality Standard (MAC-EQS). However, the simulated concentration of fluoranthene (Fig. 3) significantly exceeds the MAC-EQS. At Eijsden (just past the Walloon/Dutch border), the ratio of the maximum concentration and the MAC-EQS amounts to 18.7. The concentrations in the suspended matter and in deposited sediment layers are expected to exceed relevant Environmental Quality Standards. In freshly deposited sediment, LC₅₀ values for sediment dwelling crustaceans are exceeded and the predicted toxicity by the PAF method (Potentially Affected Fraction of species) is significant. In more understandable language: the exercise indicated that sediment-dwelling crustaceans are likely to suffer acute toxicity effects in the downstream areas where the remobilized sediments are deposited.

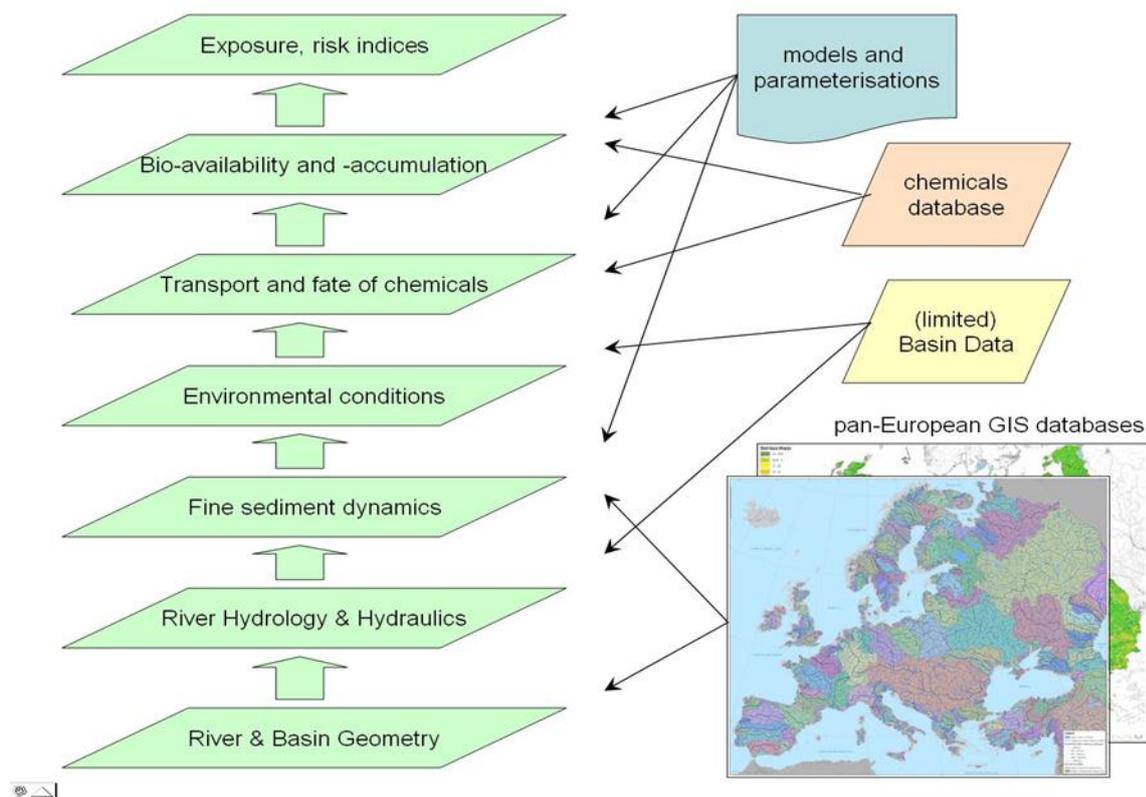


Fig. 2: EXPOBASIN model

Scientific perspectives to solve the challenges

The reported results are obtained for one site – that has now been remediated – and for a limited set of substances only. An outstanding challenge from a scientific point of view is to take a closer look at the issue of downstream risks resulting from mobilized contaminants originating upstream on the Meuse riverbanks and floodplains. This requires the following approach, which needs to be taken at the level of the entire Meuse river basin:

1. Gather all available information on contaminated sites and the concentrations of hazardous substances at these sites,
2. Screen and prioritise these sites and substances,
3. At the identified 'hot-spot' sites, assess in more detail the actual risk of remobilisation and the implications for downstream ecology.

Such an environmental risk analysis could eventually be extended to include the potential economic implications for downstream areas. With the results of this analysis, relevant stakeholders can be identified and the economic aspects of possible solutions can be explored. Comparison of the impacts of remobilized contaminated sediment with the impacts of other sources of potential contamination should also be addressed in these further studies.

By applying the above steps 1 to 3, the contaminated Meuse riverbank sites that pose an actual risk to downstream ecology could be prioritized for further analysis and – if perceived necessary – for taking measures, including measures aimed at reducing the risks of erosion or remobilization.

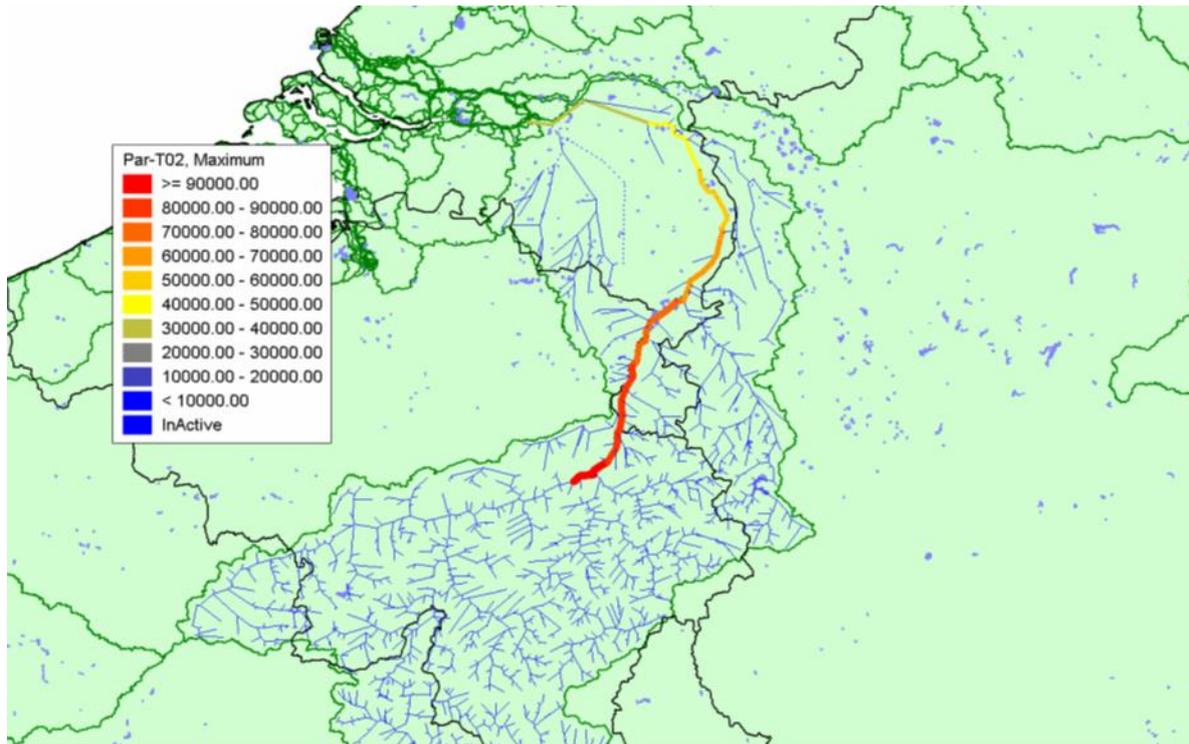


Fig. 3: Quality of deposited sediments ($\mu\text{g}/\text{kg}$ of fluoranthene).

The Meuse case study highlights how climate change is expected to exacerbate existing problems where sediment quality and remobilization are affecting ecology:

- more frequent extreme events associated with climate change could potentially remobilize contaminated sediments at a number of 'high risk' sites throughout the Meuse River Basin District
- simulated flood events have been used to confirm this risk and basin-wide investigations have been recommended to improve understanding of the likely consequences for downstream ecology

Literature

- (1) Information is extracted from: "International River Basin District Meuse – Analysis, Roof Report, International Meuse Commission, 2005"
- (2) Information extracted from; "Downstream ecological risks in the Meuse from historically contaminated upstream river banks, Deltares memo, 24 February 2011"

Links

International Meuse River Basin Commission

www.cipm-icbm.be

AquaTerra

www.eu-aquaterra.de

Modelkey

www.modelkey.org

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June 2014