Interreg
Danube Transnational Programme

Programme co-funded by European Union funds (ERDF, IPA, ENI)

Newsletter

Danube Hazard m³c

FINAL PROJECT NEWSLETTER

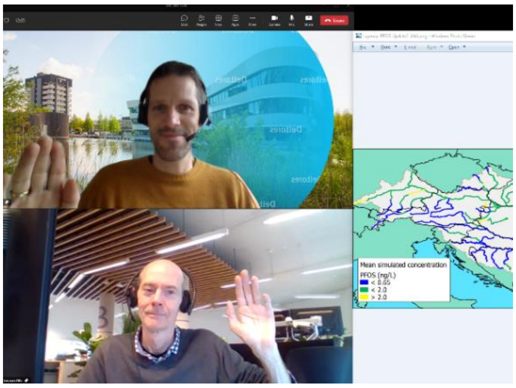
Contents

❖ Preface

Dear readers,
With this fifth and final newsletter, we take the opportunity to bring you a little closer to the feeling that permeates us because the project is nearing its end.
Namely, our joint Danube Hazard m3c journey, which started in July 2020, has almost come to an end. It is an extraordinary feeling when you travel with many people, over one hundred specialists, from 13 different countries, and different cultures, through the world of science, profession, and policy. You travel and realize that in reality there are no borders on our way. "Science without Borders" came to the fore this time too. We all started from different positions in terms of knowledge, expertise, and opinions, with partners coming from the EU member countries and from countries that are in the EU accession phase.
At the beginning, we had to face many challenges, but gradually we managed to overcome them making way for new ideas and solutions. Strong partnership (in terms of program development, knowledge and skills) helped the members with less experience to develop and to become strong parts of the national teams. And we thank them immensely for that.
All partners tried to make the best use of the opportunity to master new knowledge and expertise both through developing jointly efficient monitoring and inventory approaches and acquainting modelling skills to effectively manage water pollution in the future. Whether to monitor priority substances during the transfer of pollution or to take care of the source first and deal with it. Which approach to take? Is it necessary to research all priority substances or to choose certain specific markers? What about the finances for monitoring realization? What about inventories? Legislation? Many questions that were nurturing us and we needed answers to. Have we found them?
The most important finding was that we cannot tackle those challenges in isolation, without transnational teamwork. And we were a team from the beginning to the end of the project. We became friends with the need and desire to continue our professional, scientific and human fellowship in the service of environmental protection, especially of that element which means life for nature and for humans, which is "water". Water protection and human protection.
How far have we come? Have we achieved our goals? What are the remaining challenges? You can find all that in this latest newsletter.
Thank you for your trust and for following us.

on behalf of the Danube Hazard m^{3}c project team
colleagues from the Center for Ecotoxicological Research Podgorica (CETI)

MEET OUR DANUBE HAZARD m³c TEAM




12TH MICROPOL & ECOHAZARD
CONFERENCE 2022
MICROPOL
2022
IWA
gestagua
Infraestructuras
a su servicio

❖ Project achievements in data acquisition and evaluation

DH m³c inventory database

The project team collected, merged and harmonized the fragmented and dispersed available information on the concentration of hazardous substances (HS) in rivers, soils, wastewater treatment effluents and groundwater from different countries of the Danube Basin into one comprehensive database (Figure 1). This database also includes all DH m³c project measurement results.

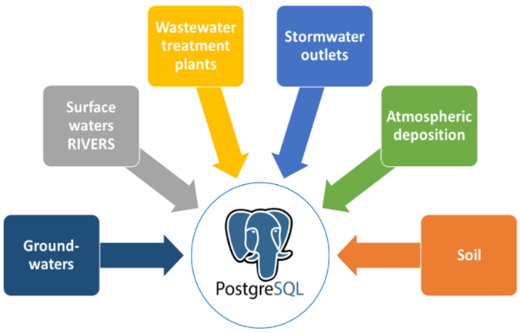


Figure 1. Structure of the DH m³c inventory

The DH m³c database establishes a valuable basis for assessing pollution levels in different compartments, deriving emission factors, identifying trends and generating consistent datasets for basin-wide modelling.

Data collection provided an overview of the data availability and coverage of the measurements, which highlighted some important monitoring gaps and critical differences between partner countries (missing monitored pathways, lack of harmonization of analytical methods, different analytical accuracy, different documentation and availability of metadata).

Targeted monitoring programme

To fill critical information gaps and to demonstrate alternative and cost-efficient monitoring approaches, targeted monitoring campaigns were carried out in seven pre-selected Danube pilot regions located in Austria, Bulgaria, Hungary and Romania (Figure 2). The regions have been selected to reflect distinctive traits with respect to climate, hydrology, land-use and pollution pressure.

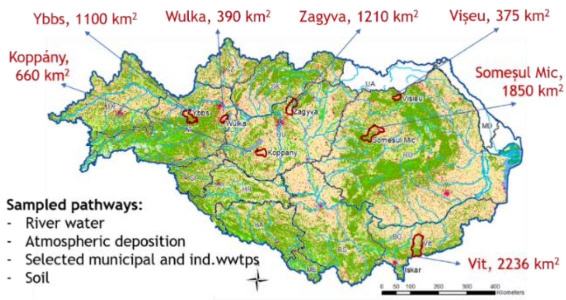


Figure 2. Pilot regions in the project

Bearing in mind the large number of HS present in the surface waters, the project focused on 46 indicator substances from 5 different substance groups of high relevance in the Danube River Basin, which are representative for different major sources and emission pathways. These include pharmaceuticals, industrial chemicals, pesticides, combustion products and potentially toxic elements.

In surface waters, composite samples were generated during one year by differentiating between baseflow and high-flow conditions. Coupled with continuous measurements of discharge and turbidity, this data allowed the calculation of reliable average HS in rivers.

The monitoring concept also covered measurements in different pathways (as shown in Figure 3). In this way, significant transport routes could be identified the relevance of point and diffuse pathways or the role of high-flow events in the contaminant transport in rivers could be understood better. The data collected during monitoring is a vital source of information for substance balances and input for modelling activities.

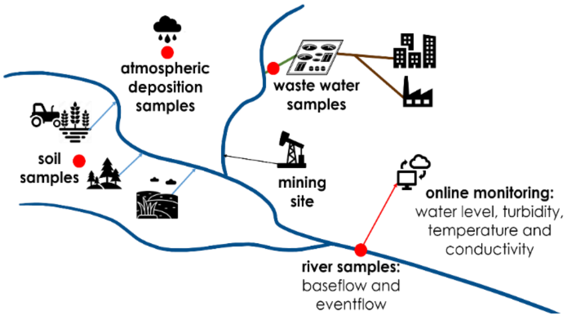


Figure 3. Monitoring concept in the project

Evaluation and risk assessment

From the results of this high-frequency monitoring, a mean annual concentration was calculated and compared to currently valid and newly proposed Environmental Quality Standards (EQS) for risk assessment under the Water Framework Directive (Directive 2008/105/EU amended by Directive 2013/39/EU and National Substance Lists). The risk assessment covered the following inorganic and organic substances and substance groups:

Pharmaceuticals: Diclofenac and Carbamazepine.

Industrial chemicals: Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA), 4-tert-Octylphenol, Nonylphenol, and Bisphenol A.

Pesticides: S-Metolachlor (herbicide) including Metolachlor-ESA and Metolachlor-OA (metabolites), and Tebuconazole (fungicide).

Industrial chemicals and combustion by-products: 16 EPA Polycyclic aromatic hydrocarbons (PAHs).

Potentially toxic elements (PTE): Mercury (Hg), Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), Zinc (Zn), Chrome (Cr) and Arsenic (As).

The number of sites and pilot regions, where exceedance of the EQS was determined for specific compounds is shown below.

Substance > EQS	No of monitoring sites	No of pilot regions	Countries
PFOS*	9	5	All
Cu**	2	1	RO
Cd*	2	1	RO
Zn**	2	1	RO
s-Metolachlor**	2	1	HU
Diclofenac***	11	4	AT, HU, RO
Bisphenol-A***	20	7	All

* Directive 2013/39/EU
** National Substance List
*** New proposal of the revised Priority Substance List

In a second step, for each of these “risk” substances, dominant pathways were evaluated for each catchment with the aid of emission modelling. Considering the dominant pathways, scenarios are formulated, which enable assessing the potential effectiveness of a specific measure to mitigate pollution.

Note: *The new proposal of the revised Priority Substance List was also assessed, but does not form a legal basis for the designation of measures at the present time. No assessment was performed for Benzo(a)pyrene (PAH), since all measured values were below the limit of quantification, which, however, is clearly above the EQS.*

For more details see the following **OUTPUTS** available at the project website:
https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs

- **Inventory of concentrations of hazardous substances in the Danube River Basin**

The harmonized database is available at https://doi.org/10.48436/xwve4-h7v43. It contains all data and metadata on HS concentration levels in surface water bodies and in major emission pathways, which was collected during the project and for which publication (partially in aggregated or anonymized form) was permitted by the respective data providers and owners.

- **Demonstration of a harmonized and cost-effective measurement concept for the monitoring of HS river pollution and of HS emission pathways in 7 pilot regions**

This report describes in detail the monitoring carried out in the project, which adjustments were necessary to the original concept based on the specific local needs and constraints, how data were managed and evaluated. A particular focus is dedicated to which lessons were learned in the implementation process and which can support the future optimization and harmonization of monitoring in the Danube River Basin and beyond.

- **Technical guidance manual on HS management for stakeholders**

This document provides practical support to water quality management experts dealing with different aspects of HS management in designing, setting up and implementing inventory databases and monitoring programmes similar to the ones developed and tested in the project. The guidance summarises experiences gained in the project in monitoring and development of emission databases and recommends best practices.

❖ Project achievements in modelling of HS pollution

Two complementary modelling approaches

The Modelling of Regionalized Emissions model[1] (MoRE) was applied to the seven pilot regions to quantify emission loads into surface waters via point and diffuse emission pathways.

Building on the increased system understanding thanks to this detailed analysis, the Danube Hazardous Substances Model (DHSM) was used to identify and estimate sources and emissions of HS for the whole Danube River Basin. Monitoring results based on stratified sampling were used to calculate annual substance loads and concentrations to validate model results. Uncertainties of input data and model approaches are considered by modelling base, minimum and maximum variants (Figure 4).

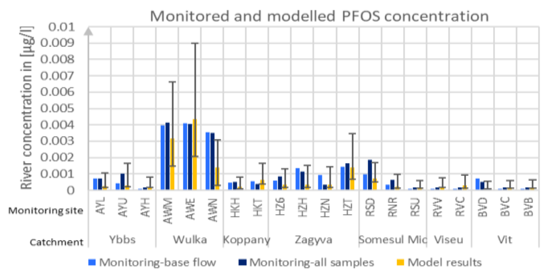


Figure 4. Monitored and modelled (MoRE) river concentration of PFOS at the outlets of the pilot regions

Modelling results show the contribution of single pathways (Figure 5) as well as regional hot spots (see e.g. Figure 6 for PFOS).

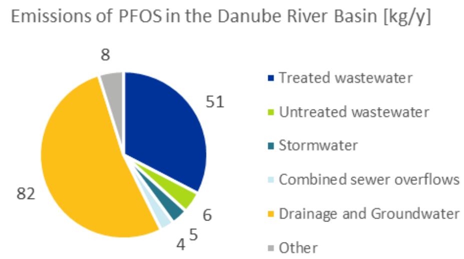


Figure 5. The relative share of simulated pathways of PFOS (DHSM)

Figure 6. Estimated concentrations of PFOS at DRB scale (values below EQS are displayed in blue)

Substance specific conclusions

Carbamazepine and Diclofenac are mainly used in human medicine and therefore are mainly emitted to natural water systems via municipal wastewater. As they have poor adsorbability and poor degradability, they are hardly removed by biological wastewater treatment and the main emission pathway is direct emissions from sewer systems without wastewater treatment or treatment plant effluents. Future measures to reduce river pollution from pharmaceutical as Carbamazepine and Diclofenac will mostly rely on advanced waste water treatment as use regulations may fail due to the high social advantages of their use.

The industrial chemicals PFOS, PFOA, BPA, NP and 4tO differ widely in application and in chemical-physical properties. They enter the water systems via multiple pathways. Due to their mobility and high persistence, PFOS and PFOA and other „new" substances of the large group of Per- and Polyfluoroalkyl Substances (PFAS) are of major emerging environmental concern. Water pollution control for these chemicals must be based on a very strong use regulation as already implemented for some. But these regulations should not only address only single substances but the whole with similar properties. Even after use regulations are in place legacy pollution might still be present for decades. Appropriate measures will have to implement advanced treatment steps for waste water and for remediation of contaminated sites.

The agricultural pesticides Metolachlor and Tebuconazole are predominantly emitted into surface waters either directly via surface runoff and erosion or indirectly via groundwater runoff. Main measures for water pollution control need to address use regulations, best pesticide application practices and integrated pest management.

PAHs such as Benzo(a)pyrene or Fluoranthene are produced as side products of combustion processes, but are contained in some products (e.g. tires) as well. The main emission pathways are via atmospheric transport, which leads to accumulation in soils. This in turn makes soil erosion abatement together with air pollution control and use regulations in traffic as well as storm water management from roads to the most important measures for water pollution control.

Cd, Pb, Cu, Ni, Hg, Zn and As naturally occur in the environment. If their safe thresholds in the environment are exceeded, they may adversely affect aquatic life and humans. Different activities (traffic, impurities in fertilizers, air emissions from heating, corrosion) lead to their enhanced distribution into the environment and enrichment in soils. Thus, soil erosion is the main direct input pathway to water bodies. For effective policies following aspects shall be considered: (1) in many cases the soil has a legacy contamination; and (2) the atmospheric transport can be significant, i.e. pollution transport over long distances (e.g. mercury). In addition, specific pollution hotspots from some industrial activities (e.g. metallurgy or combustion plants) and mining may lead to high levels of local to regional pollution and should be addressed by emission reduction measures.

For more details see the following **OUTPUTS** available at the project website:
https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs

- **Harmonized MoRE model adapted to specific territorial characteristics within the DRB**

The final version of the model developed in the project, accompanied by technical documentation, is made freely available. It can be used by research institutes or water management authorities to model regionalized emissions at catchment scale.

- **Report on improved system understanding as basis for adapted transnational emission modelling at DRB scale**

This document describes the results of the MoRE model for the pilot regions. It highlights the knowledge and understanding gained with respect to the role played by different emission pathways for the considered groups of substances depending on different catchment characteristics.

- **Demonstration of the management plan development process at watershed level for HS pollution based on detailed emission modelling in 7 pilot regions**

This document reports the results of the MoRE model for selected management scenarios in the pilot regions. In this way it showcases how the MoRE model can be applied to quantitatively assess the effectiveness of different measures and thus to assist in the development of river basin management plans.

- **Upgraded version of the SOLUTIONS model (now called DHSM) adapted to territorial needs for transnational modelling of HS emissions in the DRB**

The final version of the DHSM model developed in the project, accompanied by technical documentation, is made freely available. It can be used by research institutes or water management authorities for detailed water pollutants modelling at the transnational scale.

- **Technical guidance manual on HS management for stakeholders**

This document provides, in addition to practical support to water quality management experts regarding inventory databases and monitoring programmes, also a technical support in emissions modelling at catchment scale. The focus lies in proving guidance in the selection of the modelling approaches depending on the objectives and in creating awareness of the different needs of input data and IT-related knowledge.

❖ Project achievements in capacity building

A tailor-made program of capacity building activities was carried out to enhance institutional capacities in monitoring, inventorying and modelling of HS pollution. Through national, regional and transnational trainings, a final workshop, and a set of new tools that are made available DH m³c strives, among others, to achieve progress in the harmonization of data and methods used for pollution control among all DRB countries. Having comparable results at the basin level requires common methodological approaches for HS measurements and modelling. How to best achieve these goals was the leading subject discussed during these events.

8 national trainings on monitoring and inventorying

The main purpose of the national and regional trainings held in eight Danube River Basin countries was to improve the knowledge and skills of experts working in the field of water management. They focused especially on innovative smart monitoring strategies for the effective assessment of concentrations and loads through different emissions pathways and in rivers, as well as on the assessment of the chemical status of water bodies. The photos below provide some impressions from those lively events with more than 400 participants in total. One of the important achievements of these events was the improvement of the understanding of the concepts, approaches and methodologies for developing harmonized inventories for HS emissions, including their relevance for HS modelling.

3 transnational trainings on modelling

A more in-depth insight into the HS modelling was the main topic of the three transnational trainings held in Bucharest, Budapest and Vienna. It was clear from the beginning that HS modelling is a new approach very modestly implemented in the countries of the DRB. The goal of this event was to share knowledge and improve relevant skills and competencies of the participants from the Danube region regarding HS modelling, and to present the potential of this approach to improve future HS pollution control and management. Thus, the trainings included both theoretical parts and hands-on exercises.

International final DH m³c workshop

The results of the project were presented and discussed with international experts in the framework of a conference and a workshop in Vienna, both embedded into the 25th International River Symposium (Figure below). In total, 40 participants, representing 13 countries, attended the workshop and discussed the draft version of the policy recommendations elaborated in the project.

Training packages

In line with the project aims, the project partners jointly developed learning material packages that covered the main topics addressed in the frame of the capacity building events.

Figure 7. Impressions of the national trainings on monitoring and inventorying

Figure 8. Presentation of the results at the 25th International River Symposium (left) and final project meeting (right) in Vienna

For more details see the following **OUTPUTS** available at the project website:
https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs

- **Training material packages on monitoring and inventorying in 9 official languages of the DRB and on emission modelling and scenario evaluation in English**

Packages of presentations summarising the material developed, presented and discussed during the national and transnational trainings.

- **Reports of the capacity building events**

Short reports describing the different trainings, the number and type of participants in relation to the target groups of the project, the partial different focuses due to territorial needs, the discussions held during the different event on the following three topics, and the lessons learned during the interaction with the different groups of participants.

❖ Project achievements in support of policy making

The policy guidance

In the frame of the project a guidance document recommending sound policy instruments and effective measures for managing HS pollution has been developed. The target audience of the document are decision-makers in the water management policy field. It offers Danube countries support for the preparation and implementation of tailor-made national water management policies. Selected recommendations worked out in the framework of the guidance and the proposed way forward are presented here.

The guidance and the first ideas for recommendations were presented and discussed with experts representing various countries and sectors at the international workshop embedded within the 25th International River Symposium.

1. Need for harmonization

Monitoring approaches of the Danube countries and the evaluation of the measurements need to be better harmonized.

- Danube countries should designate together an updated list of river basin specific pollutants (RBSPs) for the DRB, which are intensively used and problematic for the waters in the basin.
- Danube countries may consider harmonizing the immission and emission targeted monitoring programs as appropriate.
- Danube countries are advised to harmonize the sampling and analytical methods towards using standardized methods for the common parameters and including wider application of methods for assessing the impacts of mixtures of HS on water bodies and ecosystems.
- It is suggested to harmonize the Environmental Quality Standards (EQS) of the compounds of transboundary importance based on total or bioavailable concentration values in water as well as concentrations in sediment and biota, as appropriate.
- It is recommended to harmonize the respective emission standards for urban and industrial wastewater discharges as well as to incorporate the evaluation and control of the discharges from combined sewer overflows into the regulations.

2. Towards a sound knowledge base: emission inventory

Developing a comprehensive and sound knowledge base is a prerequisite towards an effective control of HS pollution. On one hand, it should include consistent emission inventories for indicator substances, especially targeting the major emitters such as industrial facilities and urban wastewater treatment plants but also diffuse sources that are difficult to monitor. Diffuse emission inventories should be based on catchment-scale water quality models with appropriate emission factors, representing all relevant pathways, while maintaining the link to sources. These models are able to trace back water emissions to pathways and sources and can assess the impact of measures on water status and their efficiency to reduce emissions.

In addition, there is a strong need for well-designed and targeted monitoring efforts throughout the DRB over longer periods, focusing on a limited number of substances. Well-designed investigative monitoring programs for establishing an emission inventory should be started at least where there is already an identified problem or pollution risk is relevant. It is recommended to develop and use a harmonized, comprehensive transboundary database including HS concentrations in all relevant environmental media and emission pathways, considering that relevant pollution sources could be located beyond national borders.

These data would provide a good empirical basis and system understanding for the modelling, for identifying the emission sources but also for the selection of the most-effective combination of measures. A list of indicator substances for emission inventories has to be carefully selected and established at the basin-wide level based on thorough discussions and consensus. All relevant pollutant groups should be represented in the inventory.

Application of modelling-based risk assessment at river basin scale can help optimizing the overall surface water monitoring process. Emission monitoring, modelling and inventory development can reduce the immission monitoring costs by orienting surface water monitoring to those water bodies where the pollution pressure is significant. They can also help focusing monitoring efforts on new and problematic compounds for which little knowledge is available. Importantly, better or even free access to the monitoring and inventory data as well as on registered emitters should be provided.

Action plan to develop a comprehensive emission inventory

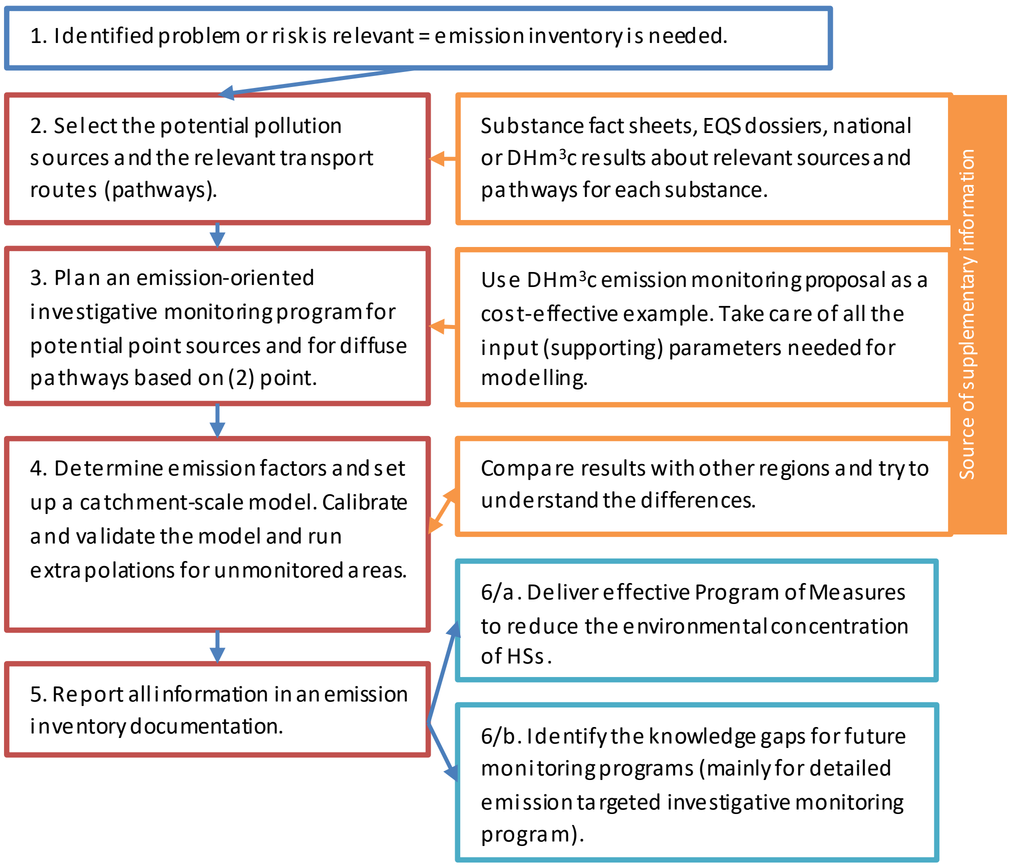


Figure 9. Development of emission inventories

3. Towards an efficient management: Program of Measures

Future water management efforts on HS pollution should change the paradigm by shifting the focus from substances to pathways through:

- defining "priority pathways"
- defining "marker substances".

The Program of Measures on controlling HS pollution should address the following aspects:

- Designing and implementing pollution
- control measures in all relevant sectors, in a harmonized and coordinated way and in line with the pollution control hierarchy.
- Providing regulatory incentives to the emitters to substantially reduce the discharge of HS through limiting or banning the use of certain persistent substances or setting appropriate pollution fees.
- Considering the extended producer responsibility approach targeting the main polluters, along with strengthening the inspection mechanism over the production chain.
- Providing economic incentives for developing and implementing up-to-date technologies and substituting harmful substances.
- Raising awareness on the negative effects of chemicals on the environment and provision of information and facilities for safe disposal of harmful substances at the local level.

Action plan to implement efficient measures

Measures should be implemented in accordance with the pollution control hierarchy, represented by an inverse pyramid.

- Priority should be given to prevention at the source. This can be ensured by banning or limiting the production and market placing of certain hazardous chemicals but also improved waste and pest management. Moreover, behavioural change of people, education and awareness raising in society are also crucial to ensure the reasonable and responsible use of chemicals in daily life.
- Since many of the chemicals are widely used and their presence cannot be prevented, measures controlling the emission pathways and the mobilization of pollutants are of utmost importance. Appropriate treatment of municipal and industrial wastewater, best available techniques at industrial sites, controlling combined sewer overflows and rainwater inlets, water retention in urban areas, reducing runoff and soil loss from the field by constructional measures and best management practices are the most important interventions.
- Finally, the chemical fluxes can be further retained by applying retention measures both on the field and in the river, for example, buffer zones, green infrastructure measures, wetlands and floodplains.

For more details see the following **OUTPUTS** available at the project website:
https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs

- **Report on existing policies and management plans regarding HS water pollution in the DRB**

Critical review of the current policies, and of their implementation, in the field of HS pollution in surface water bodies across the DRB. The major focus lies in the identification of critical gaps and challenges towards a harmonized and effective transnational control of HS pollution.

- **Policy guidance document for improved representation of HS in the DRBMP and NRBMPS**

The document presents the recommendations elaborated by the project for the improvement of policies and their implementation both at national and transnational scale in the DRB. This includes recommendations for a HS management strategy and a catalogue of mitigation measures including an assessment of their potential effects. It also includes an assessment of the status of water pollution in the DRB, of the main responsible pathways, which was produced by applying the DHSM model.

❖ Communication activities

Numerous communication activities were carried out during the project by the team at national and international scale. At this final stage, we would like to draw your attention to the following:

- **Image film**

Short video presenting the motivation and the main achievements of the project.
https://www.youtube.com/watch?v=CMZpUgRFoMI

- **Layman's report**

A document presenting the background, methodology, achievements of the project as well as open challenges in a non-technical way.
https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs

❖ Brief Information on the Danube Transnational Programme

The Danube Transnational Programme is a financing instrument of the European Territorial Cooperation (ETC), better known as Interreg. ETC is one of the goals of the European Union cohesion policy and provides a framework for the implementation of joint actions and policy exchanges between national, regional and local actors from different Member States.

The Danube Transnational Programme[2] (DTP) promotes economic, social and territorial cohesion in the Danube Region through policy integration in selected fields. In order to achieve a higher degree of territorial integration of the very heterogeneous Danube region, the transnational cooperation programme acts as a policy driver and pioneer to tackle common challenges and needs in specific policy fields where transnational cooperation is expected to deliver tangible results. Considering its geographical coverage, this highly complex programme provides a political dimension to transnational cooperation which is unique in Europe, successfully facing challenges such as ensuring good mechanisms to contract partners who receive funding from different EU instruments.

The Danube Transnational Programme finances projects for the development and practical implementation of policy frameworks, tools and services and concrete small-scale pilot investments. Strong complementarities with the broader EU Strategy for the Danube Region (EUSDR) are sought. The Danube Transnational Programme defines itself as a "financing instrument with a specific scope and an independent decision-making body. It supports the policy integration in the Danube area ... below the EU-level ... and above the national level in specific fields of action."[3]

The DTP cooperation is structured across four priority axes:

- Innovative and socially responsible Danube region
- Environment and culture responsible Danube region – the priority axis that includes the DanubeSediment and Danube Hazard m3c projects
- Better connected and energy responsible Danube region and
- Well-governed Danube region.

For more information on the European Territorial Cooperation (ETC):
http://ec.europa.eu/regional_policy/de/policy/cooperation/european-territorial/
For more information on the Danube Transnational Programme:
http://www.interreg-danube.eu/

This newsletter was coordinated by TU Wien and by Center for Ecotoxicological Research Podgorica

For questions or comments, please send us an e-mail at: danubehazard@tuwien.ac.at

2 The programme area covers nine Member States (Austria, Bulgaria, Croatia, Czech Republic, Hungary, the states of Baden-Württemberg and Bayern in Germany, Romania, Slovakia and Slovenia) and five non-EU Member States (Bosnia and Herzegovina, Moldova, Montenegro, Serbia and 4 provinces of Ukraine).

3 See the DTP cooperation programme, pg. 4: http://www.interreg-danube.eu/uploads/media/default/0001/08/81e933247b2bb1449c467f4cd1bd55cf0e734948.pdf