TRANSNATIONAL EDUCATION ON FLOOD MANAGEMENT IN THE DANUBE REGION

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SUMMARY

The international postgraduate course on flood management in the Danube Basin is planned to harmonize the necessary level of education, information and preparedness before announcing the floods on the Danube, as a wider phenomenon within the EU Danube Strategy. Also for the timely exchange of experience and knowledge, as well as better coordination of the relevant institutions immediately prior to the occurrence, during the duration of large waters and floods on the Danube and its tributaries, as a basis for a unique system of cross-border management coordination. The aim is adequate preparation and greater mutual harmony during floods, cross-border assistance to establish a sustainable Danube system for the protection of people and property throughout the basin. Based on the analysis of historical data on floods on the Danube, hydrological and hydraulic considerations and risk models, as well as aspects of floods and flood forecasting, flood regulations and regulations are presented. Finally, through an overview of possible models and means of protection against floods and impacts on infrastructure river and city systems, the environmental impacts and effects of climate change in the domain of floods on the Danube basin were assessed. The international postgraduate course on flood management in the Danube Basin is planned to harmonize the necessary level of education, information and preparedness before announcing the floods on the Danube, as a wider phenomenon within the EU Danube Strategy. Also for the timely exchange of experience and knowledge, as well as better coordination of the relevant institutions immediately prior to the occurrence, during the duration of large waters and floods on the Danube and its tributaries, as a basis for a unique system of cross-border management coordination. The goal is adequate preparation and increased interconnection during floods, cross-border assistance to establish a sustainable Danube system for protecting people and property across the entire basin.

KEY WORDS:
Danube Basin, Danube Strategy, Floods, Education, Governance, Coordination.

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1. INTRODUCTION

The Danube Strategic Project Fund (DSPF) was founded with the idea to serve as facility that will support the implementation of transnational strategic projects which are aligned with the objective of the EU Strategy for the Danube Region (EUSDR). The most significant activity in the Priority Area 5 is in the field of environmental risks. The activity should facilitate the flood protection of the Region and to enhance the flood safety of the whole Danube Basin.

The lack of the dissemination of specific knowledge and practical solutions in flood protection hinders the implementation of EU Floods Directive and the Danube Basin Flood Risk Management Plan. Floods are amongst the major issues in the Danube river basin, if not the most important one.

Numerous floods have happened in the last two decades in almost all countries in the Danube River basin. Many of them were very huge, although there had been even larger ones during the long history [1]. In addition to huge floods in the Danube River (2006, 2010, 2013, 2014), even larger ones had happened along the major tributaries of the Danube River in its middle course such as those in the Tamiš River (2005), the Tisza River (2006), the Sava River (2005, 2010, 2013, 2014), as well as in the Sava River's principal tributaries: the Drina River (2010), the Kolubara River in 2014. Damages topped billions of EUROs, and the casualties were even worse.

Management of floods is usually based on harmonized flood defense planning, forecast procedures and co-ordination of the activities of different institutions on the national and international level. Basic documents related to flood issues, that have been already developed in the EU, include the EU Floods Directive and the Danube Basin Flood Risk Management plan. The EU Strategy for the Danube Region (EUSDR) recognizes the importance of flood management. Thus, the Danube Strategic Project Fund (DSPF) supported the InterFloodCourse Project which aimed at the development of a curriculum and training material for the international, basin-wide course on flood management.

The curriculum within the InterFloodCourse Project is developed by experts from 7 countries basin-wide, who have long experience in water management education, research and engineering practice. Apart from the course curriculum, the team of experts prepared course materials in the book of which covers numerous aspects of the flood management Additionally, the course material provides an overview of impacts of climate change on floods and those of flood duration and magnitude on the environment, navigation, urban infrastructure systems and flood control structures. Various topics are complemented with examples demonstrating practical experience on the Danube River and its tributaries in Hungary and Serbia. This has been prepared, co-ordinated and edited by the two Project partners: the Faculty of Water Sciences of the National University of Public Service of Baja and the Faculty of Civil Engineering of the Belgrade University.

The Course is offered at provision to interested parties and state agencies, who will benefit both from general and advanced knowledge in river hydrology and hydraulics, including statistics, sediment, soil and ground data, and different flood forecast aspects.

The Course will be divided into two parts in accordance with the curriculum. The first half of the course, which roughly covers 8 topics/chapters of the book, will be held at the University of Belgrade - Faculty of Civil Engineering, and the second half, covered by additional 8 topics/chapters, at the Faculty of Water Sciences in Baja. In addition to class trainings, one field trip is included in each host country. It should be stressed that the course aims at preparing flood management professionals for the prevention and hopefully reduction of damages and casualties in the entire Danube River basin.

It should be emphasised that there is a strong need for harmonization of flood risk management in the entire Danube River Basin which is approximately 800.00 sqkm large (Figure 1).

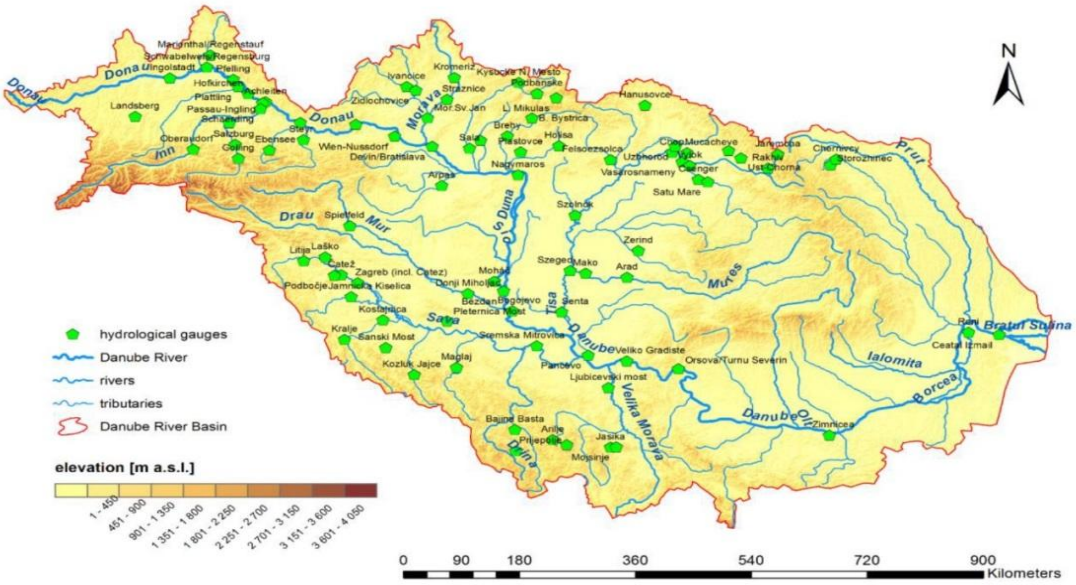

Figure 1. Gauging stations on the Danube River and its tributaries

2. CONCEPT AND CONTENTS OF THE INTERFLOODCOURSE

A brief description of the 16 chapters/courses within the International Postgraduate Course on Flood Management that lasts 2 semesters is given. It is assumed that course participants will have general civil engineering background.

2.1. Historical floods on the Danube

The chapter is intended to present a comprehensive overview of the major flood events in the Danube River Basin based on the available hydrologic data, starting from the flood event in 1012. Specifically, major flood events in the mediaeval period (1501 - 1820) and events that have occurred since the founding of gauging systems (1821. onwards) will be presented chronologically at several locations in the Danube River Basin. Tendencies and periodicities

in flood occurrence and changes in flood properties along the Danube River will be outlined. Particularly, propagation of the flood wave along the river course will be illustrated for few major events. The course stems from the draft of the project "Flood Regime of Rivers in the Danube River Basin", being prepared by the Slovak National Committee for IHP UNESCO at the Institute of Hydrology [1].

2.2. Flood frequency analysis

This course covers theory and practice of the analysis of flood frequencies. It summarizes statistical methods used in hydrology (hydrological statistical methods) as tools for better understanding of flood events. Information on data acquisition and statistical evaluation of the acquired data that are used for the description of flood magnitudes and evaluation flood probabilities are given. Consequently, the methods for evaluation and interpretation of the results that are used as an input for flood management planning and flood risk management are presented. This is followed by the quantification of the flood probability and overview of tangible and intangible damages. Then, basics of the flood - risk mapping are given together with the forecasting, warning and system response.

2.3. Hydraulic modelling

The quality of flood risk assessment and consequent flood defence planning and management highly depends of the proper definition of flood hazard maps. The level of confidence of these maps is governed both by the quality of the hydrologic and hydraulic models. This course is focused on the hydraulic modelling of floods.

The course shall provide a state-of-the-art in hydraulic modelling of floods. It shall confine to 1D models due to their robustness. The quality of different models shall be assessed by comparison with experimental and field data. The following topics shall be included:

- characteristics of flow structure in compound channels,
- role of vegetation, its effect on flow structure and its environmental effect,
- floodplain processes,
- overview of 1D-models for compound channel flow modelling,
- comparative analysis of traditional and new, improved models and the assessment of their performance.

2.4. Water retention and localization

Water retention measures in the prevention of extreme flood stages. How to design and operate reservoirs in the upper catchment in order to lower peak discharges/stages on the lower stretches of the tributaries, and how to manage flash floods with retention facilities. Localization of flood spills with reservoirs. The methodological bases of the emergency flood retention, the practice of application (the required water quantity from the point of view of detention, the most effective period of the filling up of the flood detention reservoir, the flood peak reductive effect of the emergency flood retention, the effect of the emergency flood retention in the river system, the hydrologycal viewpoints of the selection of the emplacement and the building-up of the emergency flood reservoir, the possible technical solutions of the

filling-up and the return flow, the operation management of the flood detention reservoirs and the operational plan of their utilization, hydrologycal observations, measurements, perceptions). The concept of the flood localization, its role and its types (static localization, dynamic localization, preventive and operative localization, hydrological bases of the localization plans, primary parts of the new localization plans - register plans, primary parts of the new localization plans - operational plan, approval and application of the localization plans, validity of the localization plans and their regular revision, viewpoints of the development of the localization plans, proposals to the selection of the certain localization opportunities, selection of the places of return flow and technologies, examination of the endangerment of the inhabited areas and their localization opportunity, methodology of hydraulic examinations needed to the localization plans).

2.5. Flood risk assessment

Flood risk assessment is a rather challenging task as it combines the results of hydrologic and hydraulic simulations with assessment of corresponding flood damages and negative impacts of human health and lives in an area of interest. As such, it combines hydrologic-hydraulic modelling with economic indicators of e.g. asset values in a considered area. Flood risk is communicated to the decision makers and communities by means of flood risk maps. Although challenging and fraud with uncertainties, flood risk assessment is necessary for effective flood management and mitigation of flood consequences.

This course is intended to familiarize the attendees with the basic concepts and definitions of flood risk, flood probability and hazard, depth-damage curves, etc. The methodology for flood risk assessment will be presented, including the following sections:

- Basics of hydrologic modelling,
- Estimation of flood probability and flood hazard,
- Assessment of asset value and derivation of depth-damage curves,
- Flood risk assessment,
- Flood risk classification,
- Application of GIS tools to obtain flood risk maps.

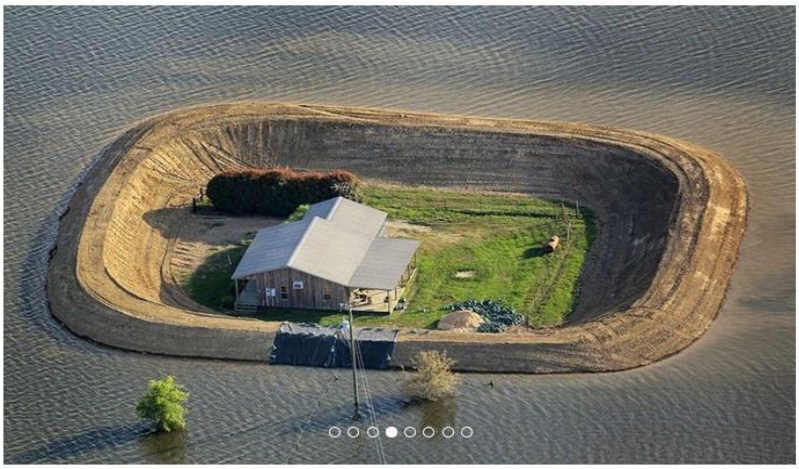

Figure 2. Flood protection of particular locations planned in GIS tools

2.6. River engineering / training, sediment processes

General subject of river engineering. Planning of river training facilities with special regard to flood management. Questions of traditional river training and non-structural measures. Dyke systems, localization systems. Sediment issues related to river training and flood management. Reservoir sedimentation. Riverbed incision of large regulated rivers. Floodplain aggradation and its possible consequences. Floodplain roughness. Principles of land-use planning. Changes of flood conveyance capacities. Highly responsible technical-economical decisions. Risk perception, acceptance and communication. Definition of participants of integrated river management. Classification of tasks (possible utilization) due to the interests.

2.7. Logistics of flood and excess water control

The typical logistical setup in emergency situation. Main tasks of organization of flood management. Most important logistical activities: transport, loading, storing, packing, material management, stockpiling, collection, distribution, information management. Assurance of the personal, material and functional conditions. Hierarchy of flood control measures. Tasks of authorities and water management bodies. Other intervening bodies and institutions. Communication (including cross-border communications). Involvement of the public and volunteers.

2.8. Flood forecasting

This course is in line with the project's overall objective as stipulated in the DSFP project document, which is to develop lecture notes for an international postgraduate course on flood protection and flood risk management with particular focus on the Danube River Basin (DRB). The end result should be a comprehensive flood management curriculum that offers further specialization and professional development possibilities for practicing (civil) engineers involved in flood management in the Danube River Basin.

The course will provide an overview of types and causes of floods in the Danube River Basin (illustrated with typical real-world examples from various catchments within the DRB and/or elsewhere). The course will also include following:

- Highlighting the role and the importance that flood forecasting plays in flood protection and flood risk management.
- Types of FFWS depending on catchment size, physical processes, lead time of forecast, type of service required, etc.
- Description of key components of a well-organized and competent FFWS; elaborate on relative importance of each component (illustrated with examples of real-world FFWS within the Danube river basin and/or elsewhere).
- Model types; Choice of appropriate models for real time flood forecasting; Model accuracy and reliability of forecasts; Major trends and methods/models used nowadays

for operational real time flood forecasting; focus in particular on models and approaches used in Europe and the DRB (illustrated with real-world examples).
- End users (water resources and flood managers) and their requirements; Type of disseminated flood warnings; timeliness of issued warnings; role of thresholds; flood warning and society; media awareness; organizational aspects. Examples of flood warning systems in existence in the DRB and/or elsewhere.
- Description of EFAS, newly developed Sava FFWS, etc.
- New trends and developments concerning flood forecasting in the DRB and/or elsewhere.

2.9. Soil mechanics of flood control structures

Dykes and other earth structures used in flood control. Special planning and investigation methods in the daily practice. Geological mapping. Soil mapping. Geotechnical investigations. Design criteria. Design consideration (e.g. consideration of the stability of the structure, avoid unstable and weak subsoil). Economic aspects. Engineering aspect: materials shall be with well-grained condition, high shearing strength, permeability of materials (high impermeability), good workability, durability against environmental variation (reiteration of wet and dry condition, it is very important to know the possibility of compressive deformation or expansion, moisture content, grain-size and fractions.

2.10. Policies and regulative (such as directives, planning, design)

The purpose of this chapter is to provide options for communities that want to implement during flood management regulations which reduce flood damage and the overall impacts of floods. These impacts include human risk, environmental damage, property damage, flood insurance claims, displacement of residents, and burden on community infrastructure and services. General introduction to EU legislation in relation to flood management and flood control. Relevant implications of the EU Water Framework Directive and its implementation. The Floods Directive and its implementation. International and inter-governmental bodies in flood management and flood risk management in the Danube river basin. International treaties and regulations, roles and responsibilities (the community role, the state role).

2.11. Flood and excess water control techniques and technologies

General subject of floodwater and excess water control. Sources of excess water (runoff and local rainfall) and the cause of its. Relation of the cause and effect. Runoff control. The management of excess water within floodplains/along the rivers. The management of excess water outside the flood protection dykes (in agricultural land etc.). Insurance against damage. Building flood protection dykes. Water retention and water detention reservoirs. Forecast. Highly responsible technical - economical decisions. Risk perception, acceptance and communication.

2.12. Flood and excess water control techniques and technologies

Floods are natural disastrous events, which can be triggered by various causes. Flood events can differ according to their properties, such as the flooding extent (the size of a flooded area) and consequent damages. Specifically, flooding of urbanized or industrial areas causes tremendous damages, while flooding of uncultivated land causes minimal damages. Hence, flood damages are one criterion for flood categorization. Probability of flooding can seldom be decreased. Therefore, flood protection activities should also be pointed towards mitigation of flood damages.

This course is designed to include description of various flood protection measures and the need for the establishment of effective flood protection system. The flood protection system should be adjusted to provide a robust defense of urban areas and valuable assets. The course shall also highlight increasing tendencies of flood probability and vulnerability. Innovative flood protection measures will be elaborated, including the application of the "L" elements, a validated European patent. Water holding barriers and measures for reinforcement of dykes will be also presented, as well as the procedure for establishment and implementation of effective flood protection system.

Figure 3. Constructions erection aiming at high water protection

2.13. Management of navigation during floods

This course is based upon the author experience and expertise in the fields of navigation management, navigation safety improvement, and with the operational implementation of the River Information System (RIS) in the mid Danube and the Sava basins that are either within the territory of the Republic of Serbia or in the sectors managed jointly by the Republic of Serbia and neighboring countries. In addition to the improvement of the navigation safety, importance of environmental issues related to the management of the boat waste is highlighted.

Advancements of navigation safety and adequate boat waste management during flood events require additional efforts in future, and these topics represent the core of this course. Measures that improve navigation safety during high water levels are presented, and also is RIS with its features and possible extensions, including the issue of boat waste management.

2.14. Management within urban infrastructure hydraulic systems during floods

Typical tasks and situations of the preparation for flooding and in flood circumstances within urban environment. Major and minor flow. Best management practices (BMPs). Green infrastructure (GI). Integrated urban water management (IUWM). Low impact development (LID), low impact urban design and development (LIUDD). Stormwater control measures (SCMs). Sustainable urban drainage systems (SUDS). Practices in water sensitive urban design. Problems to manage. Case studies and examples of urban flood protection measures (active and passive). Highly responsible technical-economical decisions. Risk perception, acceptance and communication. Preparation for defense. Post event tasks. Insurance against damage. Risk perception, acceptance and communication. Urban flood risk management. Urban land use.

Figure 4 . Facilities for fighting floods in urban conditions

2.15. Climate change and effects on floods

As the Earth's climate changes due to Climate Changes, floods will occur more often and will become more devastating. Based on physical reasoning, however, many studies predict that Climate change has contributed to an increase in the intensity and frequency of floods. A recent report from the European Environment Agency (EEA) echoes this, predicting increases in both river and coastal flooding in the Europe.

The question is how to quantify those statements and calculate how much flood frequency and magnitude will increase? It's pretty difficult to assess the effect climate change has on flooding. While in theory warmer temperatures may lead to more rain, the climate system is pretty complicated in practice. Studies that quantified climate change impacts on flood are quite rare. They are based on predicted precipitation increase with some frequency or empirical based on flood samples observed in the past. Basic reports about climate change and floods from the Danube region I will presented including my own research on the Sava river. Different climate change scenarios will be discus also. Several methodologies and case studies of climate change impact on floods I will present and discuss.

2.16. Environmental aspects management during floods

Effects of floods to aquatic organisms are still not properly addressed, although there are many studies. There are two general types of effects - mechanical and pollution. Floods mechanically disturb communities, affect behavior of organisms, feeding, breeding, etc. For example, for macroinvertebrate and fish communities it was demonstrated that the abundance, density, richness, and diversity experienced statistically significant decreases following the extreme events. The other aspect, effect of mobilized pollutants on aquatic biota during floods, especially in the case of large rivers, is also an open issue. Floods play important role in the transport of pollutants associated with particulate matter. Generally, concentrations of suspended particulate matter and pollutant contents increase with increasing discharge, particularly in the early stage of floods. Based on our study on mussels, aquatic worms and two fish species, flooding had diverse effects on the level of DNA damage.

2.17. Field trips / study trips

There are two field/study trips scheduled for Belgrade and Hungary, dedicated at introducing participants to combined effects of fluvial and pluvial floods.

In Belgrade are designed several construction of bridges, highways and other ones equipped for prevention of floods, such as experimental site at the Ostruznica Bridge and the flood and pollution control facilities. The facilities are equipped with storm filters for control of accidental pollution and the system that conveys excess treated water towards the infiltration fields for recharge of the local aquifer used for water supply.

Another is the Topcider river and its flood control structures. Also is a visit to the factory that produces mobile equipment for flood defense. Visit to the right Sava River bank – learning from mistakes: the storm sewer system outlets whose operation is critical during floods, and the new Belgrade Waterfront.

A visit to the levees which were under reconstruction at the Kolubara river after the catastrophic floods in 2014.

In the second semester participants will visit measurements profiles at the river Danube Hungary, for a 3-day short introduction of measurement technologies. The subject is to be carried out according to the existing curricula of the National University of Public Service, Faculty of Water Sciences. No new course materials will be given in frame of DSPF project.

Firstly, a general introduction to the concept of different flow and sediment measurements on large rivers. Introduction to organization and preparation of measurements and equipment

In addition, a practice of bathymetry (different technologies). Practice of discharge measurement (ADCP). Practice of sediment sampling.

Lastly, participants will receive a brief theory and practice of the evaluation of measurements and introduction to modelling theories based on field data.

3. CONCLUSION

The target of the project is to harmonize methodologies and foster academic mobility of engineers in training. The result is a comprehensive flood management curriculum that offers a professional development for engineers. The DSPF project will provide the possibility for common education based on EU directives, EUSDR PA5 and DFRMP needs, as well as on the extensive operative experience of lecturers.

The International Postgraduate Course on Flood management will be implemented in co-operation of the two partners, Hungarian National University of Public Service Faculty of Water Sciences, Baja, Hungary, and University of Belgrade, Faculty of Civil Engineering, Serbia. The course will be offering an international overview for participants.

The DSPF project ended in January 2019. The start of the International Postgraduate Course on Flood management is planned for the academic year 2019/2020. The application procedure will be managed by the lead partner, so applications for student admitting will be at National University of Public Service (NUPS) Faculty of Water Sciences, Baja, Hungary.

The International Postgraduate Course on Flood management will involve postgraduate Engineers (preferably Civil engineers) with a BSc degree or higher.

Seeking of additional partner institutions is planned having in mind that number of the existing water authorities' management of floods is not enough, nor well educated.

During last floods it was obvious that governmental and private companies were not prepared. Designed education for preparation, forecast and mobility of people and knowledge is needed for flood management in the Danube River Basin.

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