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PREFACE

Institutional Capacity-Building in Water Management and Climate Change Adaptation in Selected Countries in Asia and Africa – The WaSo project - is coming to an end after 7 years of a unique partnership between 8 counties from Asia, Africa and Norway. A collaboration among teachers and graduate students from 11 universities.

The project presented challenging ambitions and deliverables. Through innovative approaches and active collaborations, we achieved beyond these targets and expectations. We invite you to visit the project webpage www.wasoproject.org to learn more about our outcomes.

The WaSo 2020 Final Conference presents a bouquet of scientific results achieved by staff, students and alumni of the extended WaSo family. This document presents a collection of abstracts and manuscripts from the conference.

All addresses and presentations are recorded and available for your viewing on www.WaSo2020.net and the WaSo project webpage.

We would like to express our sincere thanks to all session chairs, session secretaries, keynote speakers and presenters, as well many others who contributed to the success of this conference. We also wish to thank NORAD, Norwegian Agency for Development Cooperation, for their generous support and encouraging follow-up throughout the project.

We are confident that the solid foundation created by this project will continue to build and strengthen our unique international network and reach new hights in the time to come.

The conference team.

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WATER RESOURCES MANAGEMENT EDUCATION IN THE WESTERN BALKAN REGION
WRM EDUCATION IN THE WB REGION

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Abstract: Water as the most precious resource needs strong cooperation across countries and different sectors and requires an innovative and interdisciplinary approach. On the other hand, water resources are under constant pressure produced by climate change, urbanization, and population growth. According to the European Integration Facility reports, the Western Balkan (WB) countries should above all develop new or improve the existing education in this field, raise technical capacity, and accomplish the creation of more efficient systems in the field of water resources management.

In order to be competitive in the world scientific area, the WB higher education institutions should introduce an advanced teaching and learning process as well as new and up-to-date laboratory equipment, library units, and software necessary for performing of study programmes, continue creation of the internship programmes in cooperation with the industry and the SME sector, involve experts from the industry in the education process, and enhance teaching and learning activities using digital technologies and tools.

Keywords: competence, education, water resources management, water sector, Western Balkan region

Highlights: 1. Water resources management education is important in the Western Balkan region.
2. Defining competences in water resources management is a starting point for the course development in this field.
3. Course content should be in line with the developed competence, course objectives and learning outcomes.
4. More activities should be done to help higher education institutions in the Western Balkan with their digital capacity building.

1. INTRODUCTION

Carefully manage water as a limited resource is urgent due to plenty of statistical facts such as 1.8 billion people will live in water-scarce regions by 2025, and by the year 2030, the global demand for water will increase by 30 percent (UN-Water, 2007; Watkins et al., 2006). Also, water resources are under increased pressure produced by climate change, urbanization, and population growth (Haener et al., 2018; Moro et al., 2019; Northey et al., 2019; Schmidt et al., 2018). According to the IPCC (Intergovernmental Panel on Climate Change) predictions, the number of people living under water stress in Europe will rise from 28 million to 44 million by the 2070s (WWAP, 2012). Therefore, sustainable management of water resources is needed requiring strong cooperation between diverse countries and sectors. At the same time, to be effective the water resources management (WRM) should incorporate an interdisciplinary and trans-boundary approach. Also, the tailor-made and innovative solutions should be applied in the water sector.

Interwoven nature of water-related issues is reflected in global socio-economic development and can cause socio-economic imbalance. Sustainable water solutions as a product of public-private research funding in water and investing in technology should be found ranging from basic water safety, through water quality and sanitation, to food supply and generation of renewable energy (Barraque, 2011; Kazner et al., 2012). Required solutions should be global in character considering also national idiosyncrasies and have to be based on the most up-to-date scientific knowledge, strategies, and action plans.

Water resources management should be based on preventive and precautionary actions and hence is a major focus on EU Strategy 2020, General Union environment action programme to 2020, Strategic plan 2016-2020 for the environment, EU Water Framework Directive, Urban Waste Water, Drinking Water, Groundwater, or Water Quality Standards directives. Also, further action towards more efficient water use and coherent policy approaches is urgent. EU policy in the field of WRM is particularly necessary and productive at the regional level especially in developing countries.

Strategic Plan 2016-2020 for environment suggests that candidate countries in its pre-accession acts must "make gradual progress towards transposition and implementation of the EU acquis". Western Balkan (WB) countries on their path to EU accession should harmonize procedures with EU water management requirements in line with Chapter 27 - to converge national rules and standards towards a single framework of EU water legislation. EC Progress Reports states that the WB national strategies and action plans on water protection should be adopted and carefully implemented. Also, further substantial efforts in the areas of water management, water protection, and wastewater treatment should be done. Thus, it is important to develop and implement public awareness campaigns and LLL courses for professionals in the water sector, with the intention to educate them on how to use up-to-date water technologies and inform about trends in the EU water sector and legislation. Early identification of all aspects of WRM will allow the national experts more time in preparing Western Balkan countries' position in the transitional period. It requires strengthening of knowledge base and scientific domain dealing with WRM by introducing advanced courses that promote EU water management regulatory environment.

WB countries should above all develop new and improve the existing education in WRM, raise technical capacity, and accomplish the creation of more efficient WRM systems applying innovative water technologies. Thus, motivated by this idea, the University of Nis made a consortium involving 14 partners and got the grant for the realization of Erasmus+ capacity building project titled "Strengthening of master curricula in water resources management for the Western Balkans Higher Education Institutions (HEIs) and stakeholders (SWARM)" in 2018 (www.swarm.ni.ac.rs). The consortium of the SWARM project was put together because the higher education institutions (HEIs) from WB identified the need to invest in upgrading their existing capacities in WRM improving technical innovations and equipment, infrastructure, information and technological systems based on EU standards and constantly strengthening the personnel competences by education and training. As a result, this will reduce inadequate professional qualification and the lack of specialized personnel in the water sector in WB countries.

The research presented in this paper is based on the reports created during the realization of the SWARM project co-funded by the Erasmus+ programme of the European Union.

2. IMPORTANT AND RELEVANT ACTIVITY OF WATER RESOURCES MANAGEMENT EDUCATION

Water resources management requires well-developed professionals with appropriate knowledge, competences, skills, and expertise. It is the responsibility of national institutions including universities to educate the mentioned specialists. In order to ensure that state-of-the-art knowledge is brought to bear on the problems in the water sector, the HEIs should be in direct connection with water-related companies, while experts from the water sector should be involved in the education process.

WB HEIs lack the necessary skills to build state-of-the-art laboratories supporting higher education in WRM as well as adequate financial resources which could significantly raise their maturity level. Therefore, it is necessary to transfer innovative and newly developed technologies, know-how best practices achieved in modern laboratories for simulating WRM solutions, and rich experience in development and modernisation of study programmes from EU to WB HEIs in WRM developing comprehensive curricula in the WB region. Transfer of experiences from EU to WB HEIs is the necessity to speed up the introduction of up-to-date courses in curricula in the WB region.

Requirements for employees dealing with water resources management are wide-ranging and demanding. They should have knowledge and understanding of science in conjunction with applied and practical skills. Dealing with the complex topic of WRM, future master curricula should include knowledge about water phenomena, specific modern and innovative technologies, and balance the social and economic needs. The graduated students with acquired applicable knowledge, skills, and competences will be directly involved and what is more important they will improve the process of solving problems in the water sector using advanced technologies. They should take advantage of opportunities to benefit from connection to other EU HEIs that should be open and transparent in all aspects of their operations (European Commision, 2020). Using laboratories equipped with up-to-date equipment will allow the students to gain hands-on experience directly transferrable to the water sector. The COVID-19 situation has highlighted the importance of the digital education including development of digital teaching materials, providing access to virtual learning platforms both to teachers and students, and strengthening of quality of digital infrastructure (European Union, 2020).

The theoretical part of master curricula in WRM should critically follow the very rapid pace of innovation in WRM related to the scientific and technical domains. In addition, graduates with a civil

engineering background should have a technical understanding of planning, prevention, designing, construction, or damage assessment that are a significant part of the development of different water resources systems. Also, the graduates should be aware that measures for dealing with water resources are part of a wider scope and have to consider that in planning processes.

In general, the modernisation of WRM education in the WB region is achievable through I) the advanced approach to curricula development using interdisciplinary communication, analysing the society and enterprises needs and problems, mobilising university resources and capacity for their solving, II) the creation of new educational topics harmonized between WB and EU HEIs, III) the introduction of innovative teaching and learning methodologies, IV) the promotion of excellence in the use of ICT in HE purchasing the most advanced laboratory equipment.

3. COMPETENCES IN WATER RESOURCES MANAGEMENT

Holistic approach to water resources management requires professionals with multiple competences. After the conducted analyses of the water sector and the needs of water-related companies, the catalogue of competences was developed including three types of competences i.e. generic, engineering, and water resources management competences (http://www.swarm.ni.ac.rs/activities?id=43). The competences were identified by the heterogeneous team consisting of stakeholders such as curriculum developers, teachers, educational managers, WRM experts, and representatives from the water sector. The competences were obtained based on the required competences by the labour market in the WB countries i.e. researching the existing water sector competence models and job profiles.

The generic competences are needed for the application of academic knowledge, cognitive abilities and technical skills to situations in the field of WRM. The students will gain some of the generic competences such as critical and strategic thinking, working in multidisciplinary teams, generation of new ideas, experience-based critical decision making, staying up-to-date with technological development or development of professional ethics and responsibility. Also, the students can be in a position to achieve some of the engineering competences such as using appropriate equipment competently and safely, preparing, processing, and interpreting data, developing innovative solutions to complex issues, mastering methods, procedures and processes of risk identification or using computer systems to access learning resources. They will be able to optimize and manage available resources in WRM systems, use mathematical models for the simulation of water-related processes, identify and analyse problems in WRM or implement water supply and water efficiency plans and programs.

The acquired competences should meet both students' goals and societal needs. On the other side, the teaching staff should be equipped with the necessary digital competences in order to enhance teaching and learning activities using digital technologies and tools, and prepare future students to dive into a digital society. Digital competences should be developed in line with the Digital Competence framework for Educators (Redecker, 2017) that defined 22 competences in 6 areas.

4. DEVELOPED COURSES IN WATER RESOURCES MANAGEMENT

Seven WB higher education institutions have agreed to adapt their academic teaching to the requirements of the water sector and related industry in order to ensure that their graduates are the most employable and to increase their competitiveness in the international education market. Therefore, they selected a competence-based approach to reduce the gap between the labour market i.e. water-related companies in the WB countries that will employ the SWARM students and the current WB curricula in the field of WRM. Creation of competence-based master study programs in WRM focused on core learning areas and outcomes perceived the following requirements: I) the specificity of the topic on water resources management, II) European Higher Education Area requirements, III) WB HEIs conditions, IV) social and economic needs, V) students' needs for better employment, and VI) national legislation, strategies, and action plans.

Developed or modernized master curricula are in line with the European Credit Transfer System (ECTS) and the European Standards and Guidelines for ESGs for Quality Assurance. The number of credits is 60 ECTS for one year master programme or 120 ECTS for two year study programme that are recognised by the national agencies for accreditation and co-financed by the national ministries for education. The curricula are integrated into national efforts for regulation and improvement in the field of WRM through the national legislative, strategic and institutional framework which are in the process of harmonizing with EU strategies and legislations within the WB countries' accession. Also, they are based on the integration of ICT in the

teaching and learning process and focused on student-centred learning and innovative teaching methods. The water resource graduate programs are interdisciplinary and allow students to choose a track and courses most suited to their career goals. Students interested in this type of graduate degree should have a strong background in the natural, physical, and social sciences related to the field of water resources in order to be competitive in the graduate school admission process.

The total number of courses presented as a SWARM unique set of courses is 32 out of which 20 have been developed and will be taught for the first time. A form for courses description was used to describe course status, number of ECTS, course objectives, learning outcomes, course content, literature, number of classes of active teaching, teaching methods as well as pre-exam and final exam requirements. In the design of courses, competences and learning objectives took priority. The Bloom's taxonomy (Bloom, 1956) was used i.e. a verb that determinates an action that student should be able to perform in order to achieve defined competence. Also, a matching matrix between developed courses and competences was created.

The main words that the courses contain in their titles are water resources management, groundwater use, water and wastewater treatment, water quality, water protection, drinking water, water supply, technologies in the water sector, water policy, hydraulic or river engineering.

All master students will carry out internships as a mandatory part of the curricula. They will acquire the competences that are in accordance with policy and operational frameworks, have the capabilities for managing multidisciplinary holistic approaches, and capable of developing and executing mid-term or long-term strategies necessary for coping with the different problems in WRM. The students can search for, collect, process, and apply the information critically and systematically, and use different ICT tools for critical thinking, creativity, and innovation. Up-to-date laboratory equipment will support teaching and work especially practical exercises.

Each of the curricula will be evaluated twice per school year (in autumn and spring semester) collecting the data regarding student's expectations, quality of teaching and teaching material, access to literature, learning obligations, laboratory equipment used in teaching activities and developed practical exercises. According to Jones et al. (2002), each competency-based curriculum can be evaluated based on assessment of learning activities that helps students to achieve competences and learning objectives, learning resources used to achieve defined competences, accessibility and usability of learning materials.

5. RELATIONSHIP BETWEEN COMPETENCES, OBJECTIVES AND LEARNING OUTCOMES

The relationship between competence, course objectives, learning outcomes, and course content is presented in Table 1. As an example of competence in the area of wastewater treatment, the following example is given: *The student should be able to implement treatment methods and technologies to solve a wastewater problem*. Starting from this competence, four course objectives and three learning outcomes are derived. It is evident that the learning outcomes specify what it is expected that the student will be able to do after the end of this course. In the end, the course content is defined as a connection with previously defined terms.

Table 1. *Relationship between competence, course objectives, learning outcomes and course content in the area of wastewater treatment*

Competence	The student should be able to implement treatment methods and technologies to solve a wastewater problem.
Course objectives	By the end of this course, the student will be able to (I) determine the environmental impact of the pollutant, (II) forecast the transport of pollutants, (III) calculate treatment lines, and (IV) use various treatment methods and technologies.
Learning outcomes	After the course student should be able to (I) apply innovative technologies for new systems and improvement of old systems to get better function,

	(II) operate and optimize treatment plants, and (III) manage different processes involved in sustainable water and wastewater treatment.
Course content	Introductory definitions (concept of pollution and water protection). Legislation and limits of water pollution. The characteristics of wastewater (physical, chemical, and biological). Classification of water (the water I, II, III and IV class). Fundamentals of wastewater treatment processes (mechanical, chemical, and biological). Basic methods of sludge treatment and sludge disposal. Different processes in water and wastewater treatment in natural and constructed systems, biological treatment processes particularly for the removal of phosphorus and nitrogen, processes based on filtration. Sludge treatment technologies. Systems and methods for recovery of nutrients from sewage. Methods for process control and optimization.

6. CONCLUSIONS

Modernised curricula based on transfer best practices from EU to WB HEIs, trained teaching staff through the theme-based training for acquiring new teaching and learning methods, educated professionals in the water sector through the organised LLL courses, equipped laboratories with the up-to-date laboratory equipment and software where the students will gain practical knowledge that can be immediately applied, and in general improvement of quality in teaching will strengthen not only the WB HEIs but also the water sector in the WB region.

In this paper, the water resources management courses developed based on the competences are explained. Three different types of competences i.e. generic, engineering and WRM are analysed and the relationship between competence, course objectives, learning outcomes, and course content is highlighted.

Future activities will be oriented to the development of an open online platform (in English and local mother tongues) including e-learning courses with virtual laboratories that can be used by students, teaching staff, and water professionals not only in the WB region but worldwide. It can be used especially in situations such as the COVID-19. The various e-learning platforms including gamified content and applications are expected to play a pivotal role in the public's behavioural modification and awareness. Due to the fact that using digital tools for teaching and learning is a challenge, more activities should be done to help HEIs in the WB with their digital capacity building.

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