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SUMMER/WINTER SCHOOL AT INSTITUTO SUPERIOR TÉCNICO, LISBON UNIVERSITY,  
PORTUGAL

JANUARY/FEBRUARY 2022

WATER RESOURCES MODELING: FLOOD AND DROUGHT ANALYSIS AND RESERVOIR  
OPERATION

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

University of Nis



[www.swarm.ni.ac.rs](http://www.swarm.ni.ac.rs)

Strengthening of master curricula in water resources  
management for the Western Balkans HEIs and stakeholders

Project number: 597888-EPP-1-2018-1-RS-EPPKA2-CBHE-JP



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SUMMER/WINTER SCHOOL AT IST, LISBON UNIVERSITY, PORTUGAL

31<sup>st</sup> JANUARY to 11<sup>th</sup> FEBRUARY 2022

WATER RESOURCES MODELING: FLOOD AND DROUGHT ANALYSIS AND RESERVOIR  
OPERATION

### Teaching staff

Maria Manuela Portela (Associated Professor with Habilitation)

Rodrigo Oliveira (Auxiliary Professor)

Teresa Melo (Auxiliary Professor)

Luis Espinosa (Post-doc researcher)



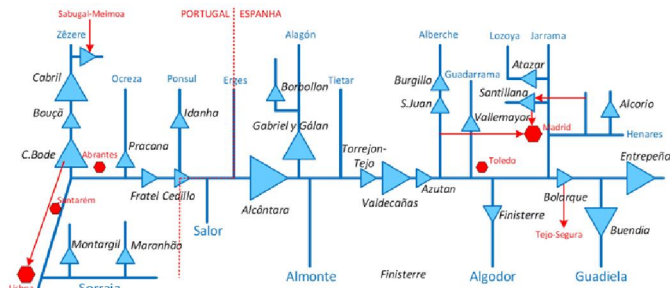
## EXTREME HYDROLOGICAL EVENTS



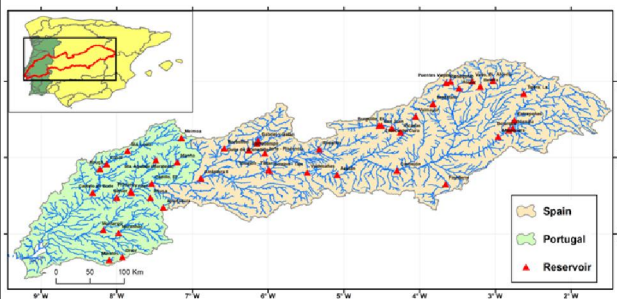
FLOODS AND DROUGHTS

GENERAL CONCEPTS AND MODELS

## RESERVOIR OPERATION

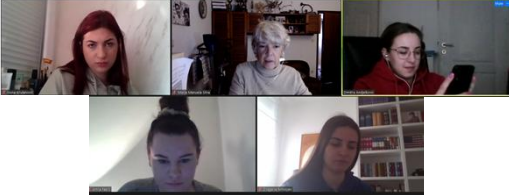


SIMULATION AND OPTIMIZATION



SURFACE AND GROUND WATER MANAGEMENT

SWORM		AGENDA			Co-funded by the Erasmus+ Programme of the European Union
<b>WATER RESOURCES MODELING: PART 1: FLOOD ANALYSIS – 31<sup>st</sup> January to 4<sup>th</sup> April</b>					
Monday – 31/Jan 2022 Topic – <b>Flood analysis</b>	Tuesday – 1/Feb 2022 Topic – <b>Flood analysis</b>	Wednesday – 2/Feb 2022 Topic – <b>Drought analysis</b>	Thursday – 3/Feb 2022 Topic – <b>Other hydrological extremes</b>	Friday – 4/Feb 2022 Topic – <b>Synthesis and discussion</b>	
<b>Lectures:</b> • Basic concepts of flood analysis • Floods and risk analysis • Peak flood discharges and flood hydrographs models • Relevant factors • Models • Statistical models • Empirical formula	<b>Lectures:</b> • Components of the flood hydrographs • Rainfall losses • Models (cont.) • Unit hydrograph model • Brief presentation of the HEC-HMS Program	<b>Lectures:</b> • General concepts • Types of droughts • SPI-based approach • Some previous results	<b>Lectures:</b> • Changes in hydrological extremes	<b>Lectures:</b> • HEC-HMS program • Application exercises	
Students work	Students work	Students work	Students work	Students work	
<b>WATER RESOURCES MODELING: PART 2: RESERVOIR OPERATION – 7<sup>th</sup> to 11<sup>th</sup> April</b>					
Monday – 31/Jan 2022 Topic – <b>Introduction to water management</b>	Tuesday – 1/Feb 2022 Topic – <b>Simulation of reservoirs operation</b>	Wednesday – 2/Feb 2022 Topic – <b>Optimization of reservoir operation</b>	Thursday – 3/Feb 2022 Topic – <b>Optimization of reservoir operation</b>	Friday – 4/Feb 2022 Topic – <b>Groundwater management</b>	
<b>Lectures:</b> • The importance of water for human development. • Fundamentals of water management and the challenges of integrated watershed and water resources management. • Water and civilization. • Consumptive and non-consumptive water uses. • Types of dams and reservoirs and its main structures.	<b>Lectures:</b> • Flow duration curves and empirical distribution curves • Reservoir sizing • Reservoir simulation • Performance indicators for reservoir operation • Reservoir operation rules. • Risk management and the concept of hedging. • Reservoir operation simulation models and integrated water management models.	<b>Lectures:</b> • Simulation vs optimization models. • Linear programming for water management.	<b>Lectures:</b> • Dynamic programming for water management.	<b>Lectures:</b> • Basic concepts of groundwater resources. • Types of aquifers and aquitards. • Aquifer characterization. • Recharge estimation. • Surface water / groundwater interaction. • Groundwater models.	
Students work	Students work	Students work	Students work	Students work	
Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders			Winter course at IST (Podgorica, March 2022) ---- 5		

SWORM		Participants			Co-funded by the Erasmus+ Programme of the European Union
✓	<b>Dragana Milivojev</b>	Faculty of Technical Sciences in Novi Sad, Serbia			
✓	<b>Ehlimana Sendo</b>	University of Sarajevo, Bosnia and Herzegovina			
✓	<b>Amra Fazlic</b>	University of Mostar, Bosnia and Herzegovina			
✓	<b>Ivona Krulanović</b>	Faculty of Civil Engineering – University of Montenegro, Montenegro			
					
Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders			Winter course at IST (Podgorica, March 2022) ---- 6		



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**CERTIFICATE OF ATTENDANCE**

This is to confirm that

*Dragana Miletic*

from

*Faculty of Technical Sciences in Novi Sad, Serbia*

attended the winter school at Institute Superior Technic, University of Liège

from the 31<sup>st</sup> of January 2022 to the 11<sup>th</sup> of February 2022,

within the framework of ERASMUS+ CBHE KA2 SWARM project

(Grant no. 597688-EPPI-2018-1-RS-EPPIKA2-CBHE-EP)



This is to confirm that

*Olivera Stokic*

from

*University of Srepski, Bratstvo and Kragujevac*

attended the winter school at Institute Superior Technic, University of Liège

from the 31<sup>st</sup> of January 2022 to the 11<sup>th</sup> of February 2022,

within the framework of ERASMUS+ CBHE KA2 SWARM project

(Grant no. 597688-EPPI-2018-1-RS-EPPIKA2-CBHE-EP)

IST, Liège, 2022.02.14




**CERTIFICATE OF ATTENDANCE**

This is to confirm that

*Amra Topfic*

from

*University of Novi Sad, Bratstvo and Kragujevac*

attended the winter school at Institute Superior Technic, University of Liège

from the 31<sup>st</sup> of January 2022 to the 11<sup>th</sup> of February 2022,

within the framework of ERASMUS+ CBHE KA2 SWARM project

(Grant no. 597688-EPPI-2018-1-RS-EPPIKA2-CBHE-EP)

IST, Liège, 2022.02.14



This is to confirm that

*Amra Stokic*

from

*Faculty of Civil Engineering - University of Montenegro*

attended the winter school at Institute Superior Technic, University of Liège

from the 31<sup>st</sup> of January 2022 to the 11<sup>th</sup> of February 2022,

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IST, Liège, 2022.02.14





Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders

Winter course at IST (Podgorica, March 2022) ---- 7







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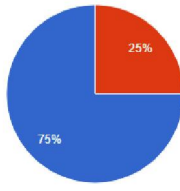
Co-funded by the Erasmus+ Programme of the European Union



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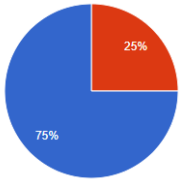
### Evaluation results (12 questions; 4 answers)

**1) Logistic preparation and organization of the school**



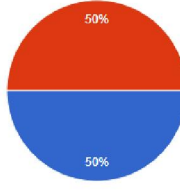
Category	Percentage
Excellent	75%
Very good	25%

**2) Content of the agenda**



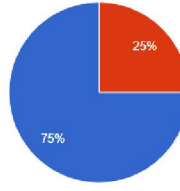
Category	Percentage
Excellent	75%
Very good	25%

**3) Arrangements of the event**



Category	Percentage
Excellent	50%
Very good	50%

**4) Quality of the delivered documentation**




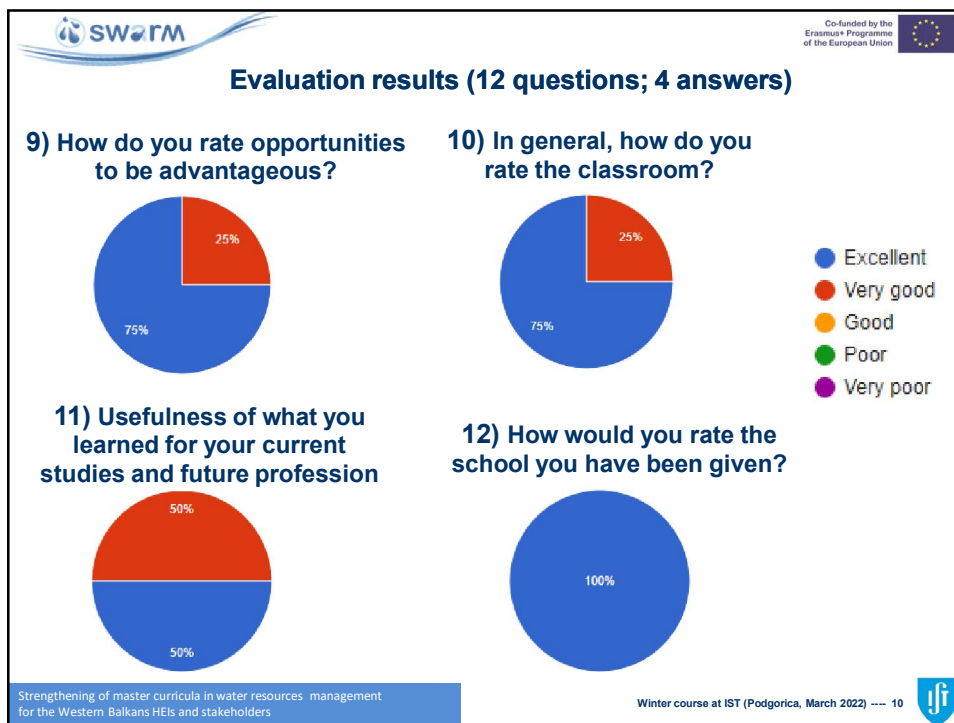
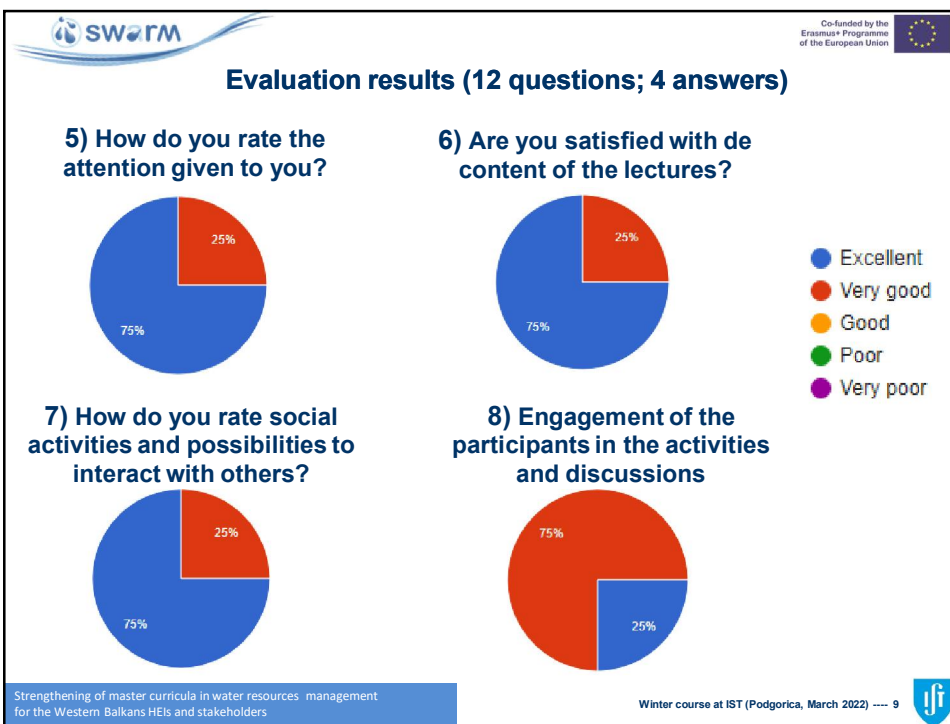
Category	Percentage
Excellent	75%
Very good	25%

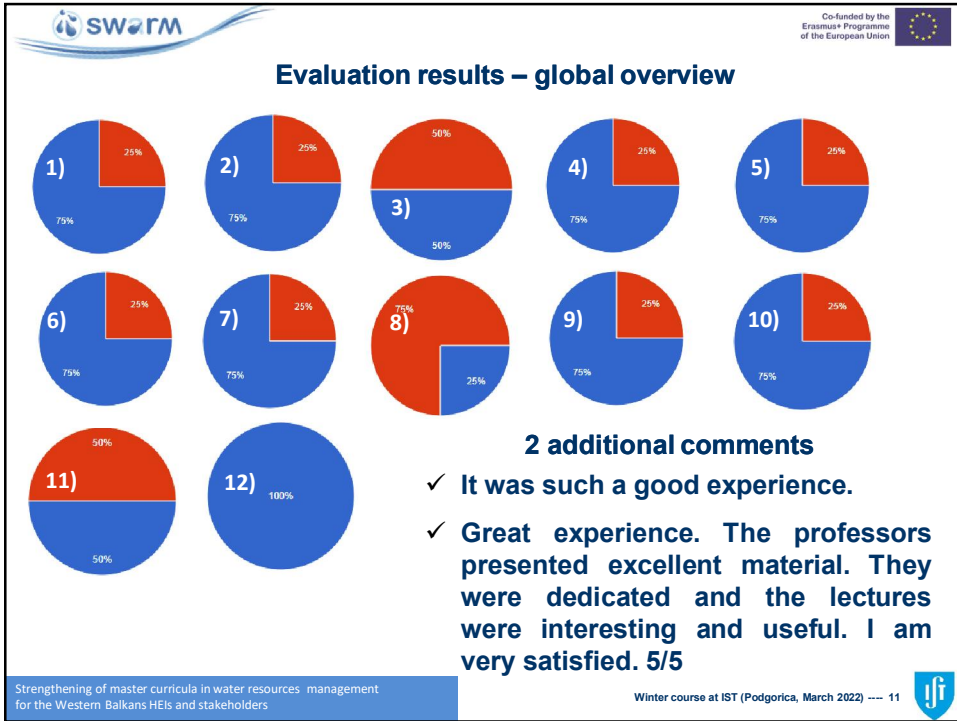
- Excellent
- Very good
- Good
- Poor
- Very poor

Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders

Winter course at IST (Podgorica, March 2022) ---- 8







**Agenda – Training for WB Teaching Staff at IST**  
18<sup>th</sup> – 22<sup>nd</sup> April

Project title: Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders

**Upcoming Training for WB Teaching Staff at IST 18<sup>th</sup> to 22<sup>nd</sup> April**

University of Nijmegen


Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders


Project number: 657698-EPPI-2018-1-WS-EPPI02-CRHR-UP

Training for WB Teaching Staff at IST

Date	Topic	Speaker
Monday 18 <sup>th</sup> April 2022	Introduction	Prof. Dr. Sc. Vesna Stokich
Monday 18 <sup>th</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Tuesday 19 <sup>th</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Tuesday 19 <sup>th</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Wednesday 20 <sup>th</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Wednesday 20 <sup>th</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Thursday 21 <sup>st</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Thursday 21 <sup>st</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Friday 22 <sup>nd</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich
Friday 22 <sup>nd</sup> April 2022	Water resources management in the Western Balkans	Prof. Dr. Sc. Vesna Stokich





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## Agenda – Training for WB Teaching Staff at IST

### 18<sup>th</sup> – 22<sup>nd</sup> April


**Project title:** Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders

**Acronym:** SWARM

**Project number:**  
597888-EPP-1-2018-1-RS-EPPKA2-CBHE-JP


Work package	Title
6	Dissemination and exploitation
6.5	Winter/summer schools

<b>Dates</b>	18 <sup>th</sup> to 22 <sup>nd</sup> April 2022
<b>City</b>	Lisbon, Portugal
<b>Meeting venue</b>	Instituto Superior Técnico, Lisboa, Portugal
<b>Address</b>	Avenida Rovisco Pais, 1, 1040-001 Lisboa

University of Nis 

**Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders**

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Training for WB Teaching Staff at IST

Monday, 18 <sup>th</sup> April 2022		
<small>Instituto Superior Técnico, Lisboa, Portugal</small>		
<b>Welcome Session</b>		
10:00-11:00	Welcome	María Manuela Portela
11:00-12:00	Hydrological extreme events analysis: annual maximum series versus partial duration series	María Manuela Portela
<b>Hands-on teaching methods in hydrodynamics</b>		
14:00-16:00	Visit to the laboratories	María Manuela Portela
Tuesday, 19 <sup>th</sup> April 2022		
<small>Instituto Superior Técnico, Lisboa, Portugal</small>		
<b>E-Learning</b>		
10:00-12:00	Practical challenges of large hydropower	José Pedro Matos
<b>Afternoon – R/Exams</b>		
14:00-16:00	Drought analysis concepts	María Manuela Portela
Wednesday, 20 <sup>th</sup> April 2022		
<small>Instituto Superior Técnico, Lisboa, Portugal</small>		
<b>R/Exams: installation</b>		
10:00-12:00	I am going to make a PowerPoint and an oral presentation	María Manuela Portela
<b>R/Exams: question definition</b>		
14:00-16:00	Rainfall trends assessment – the Portuguese case study	María Manuela Portela
Thursday, 21 <sup>st</sup> April 2022		
<small>Instituto Superior Técnico, Lisboa, Portugal</small>		
<b>R/Exams: exams on paper</b>		
10:00-12:00	Integrated river basin modelling	Rodrigo Oliveira
<b>R/Exams: online exams</b>		
14:00-16:00	Group discussions	María Manuela Portela
Friday, 22 <sup>nd</sup> April 2022		
<small>Instituto Superior Técnico, Lisboa, Portugal</small>		
<b>Wrap-up</b>		
10:00-12:00	Grid-Point Rainfall Trends, Teleconnections and Regionalised Droughts	Luis Angel Espinosa
12:00-13:00	Closing session	María Manuela Portela



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**WATER RESOURCES MODELING: FLOOD AND DROUGHT ANALYSIS AND RESERVOIR OPERATION**

María Manuela Portela  
Rodrigo Oliveira  
Luis Angel Espinosa

## Thank you for your attention!

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