



International Course and Field Seminar
Characterization and Engineering of Karst Aquifers
Trebinje, Bosnia & Herzegovina

REPORT

of the Third International Course and Field seminar
“Characterization and Engineering of Karst Aquifers”
Trebinje, Bosnia & Herzegovina, 30 May - 6 June, 2016



The third international course and field seminar *Characterization and Engineering of Karst Aquifers* was held in Trebinje, Bosnia & Herzegovina, between 30 May - 6 June, 2016. As during the previous years, the course was organized by the Centre for Karst Hydrogeology of the Department of Hydrogeology, University of Belgrade, the Faculty of Mining & Geology (hereafter FMG) and the Geological Survey of the Republic of Srpska, Zvornik, with sponsorship of UNESCO. This year, the Course was attended by 16 participants, and, as in the previous years, lectured by 10 professors.

Experts who delivered their lectures during the course this year were: Prof. Dr Zoran Stevanović, University of Belgrade, Serbia; Dr Neven Krešić, Hydrogeology Practice Leader, AMEC, USA; Dr Petar Milanović, Ret. Assoc. Prof. University of Mostar, Bosnia & Herzegovina; Dr Ognjen Bonacci, Prof. Emer. University of Split, Croatia; Abraham Springer, Ph.D. Professor School of Earth Sciences and Environmental Sustainability Northern Arizona University, USA; Dr Mario Parise, Researcher National Research Council-Institute of Research for Hydrological Protection (CNR-IRPI), Bari, Italy; Prof Dr Dragan Milovanović, University of Belgrade, Serbia; Dr Hermann Stadler, Senior scientist at Joanneum Research Institute for Water, Energy and Sustainability Water Resources Management Austria Graz; Dr Neno Kukurić, Head UN-IGRAC, Delft, the Netherlands; Dr Vesna Ristić Vakanjac, University of Belgrade, Serbia.

First meeting of the participants was held on May 30, when after common dinner and a welcome note all participants together with organising team took a walking tour of Trebinje, followed by a welcome cocktail during which Prof. Stevanović introduced some of the lecturers as well as the organising team from FMG.



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Walking tour of the Trebinje city



Welcome cocktail

The registration of participants was the next day (31st May) at 8³⁰ AM, at the hall of the HET (Hydro-Electro System Trebišnjica River) in Trebinje, Obala Luke Vukalovica 2. All participants received accreditations with their name, Tutorial with printed lecture notes and other course materials (notebook, pencil, T-shirt and cap with the logo of the Course), as well as DVD with PowerPoint presentations of all course lectures.



Entrance to the HET and the conference hall



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Registration of participants

Opening ceremony started at 9⁰⁰ AM with the welcome speech of Mr Radovan Grdinić, Head of Department for Development and Survey of the HET, Željko Zubac, Technical Director of HE Dabar and Dragan Mitrović, Director of Geological Survey of the Republic of Srpska, Zvornik, who wished a productive work and pleasant stay in Trebinje and at HET to the participants of the course. Also, prof. Zoran Stevanović once again wish welcome to all participants as well as to all lecturers and officially open the Course.



Opening ceremony

After the welcome address, Prof. Stevanović provided an introductory lecture "*Introductory note about course; Historical development of karstology and karst hydrogeology; Importance of karst and karst distribution worldwide; Geo-heritage sites; Dinaric karst*". He described the system of education at the Faculty of Mining & Geology to the participants and presented all course topics, a table of content and the course schedule. Also, he explained characteristics of Dinaric karst and its importance.



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First lecture of Professor Zoran Stevanović

After the first lecture, the students introduced themselves and presented their interests and the reasons for attending the course. 16 participants from 5 countries, namely: Bosnia & Herzegovina, Montenegro, Croatia, Slovenia and Serbia, attended the course. After their introduction, the participants had a coffee break.

List of participants

	Name and Surname	City and State	Institution/Company/School	
1	Danica STEVANOVIĆ	Sečanj, Serbia	Faculty of Mining and Geology, Belgrade	
2	Blaž KOGOVSĚK	Postojna, Slovenia	Karst Research Institute, Research Centre of the Slovenian Academy of Sciences and Arts	
3	Marko MITROVIĆ	Radalj, Serbia	Faculty of Mining and Geology, Belgrade	



4	Sanja MARKOVIĆ	Belgrade, Serbia	Faculty of Mining and Geology, Belgrade	
5	Milan ZELOVIĆ	Foča, Bosnia & Herzegovina	Faculty of Mining and Geology, Belgrade	
6	Jovan MILOŠEVIĆ	Vrbas, Serbia	Faculty of Mining and Geology, Belgrade	
7	Marina POLEDICA	Ivanjica, Serbia	Faculty of Mining and Geology, Belgrade	
8	Daniel JAKOBOVIĆ	Nova Gradiška, Croatia	Faculty of Mining, Geology and Petroleum Engineering, Zagreb	
9	Jovana RADANOVIĆ	Podgorica, Montenegro	The Jaroslav Černi Institute for the Development of Water Resources (JCI)	
10	Natalija ĆIRICA	Kraljevo, Serbia	Faculty of Mining and Geology, Belgrade	
11	Peđa KOSTIĆ	Pirot, Serbia	Faculty of Mining and Geology, Belgrade	
12	Ninoslav SPASOJEVIĆ	Bijeljina, Bosnia & Herzegovina	AD "Waterworks and sewerage system" Bijeljina,	



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13	Tena KOLAR	Koprivnica, Croatia	Faculty of Mining, Geology and Petroleum Engineering, Zagreb	
14	Matija KORDIĆ	Belgrade, Serbia	Faculty of Mining and Geology, Belgrade	
15	Ivan DRAKULIĆ	Belgrade, Serbia	Faculty of Mining and Geology, Belgrade	
16	Dražen TUMARA	Zagreb, Croatia	Faculty of Mining, Geology and Petroleum Engineering, Zagreb	

The next lecture was delivered by Prof. Dragan Milovanović: *Carbonate and non-carbonate rocks: mineralogy, depositional environments and classifications.*



Professor Dragan Milovanović

After lunch, participants received a financial support provided by UNESCO in amount of 30 euros for students from Bosnia & Herzegovina, Montenegro and Serbia and 50 euros for students from Croatia and Slovenia. This rate was calculated in accordance with the travel distance, available funds, and the number of attendants.



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Participants receiving support

Three more lectures were held from 2 to 5³⁰ PM. Prof. Milovanović lectured on *Chemical factors of karstification and Role of tectonics*, and after him Prof. Stevanović continued with two lectures: *Porosity and permeability of karstic rocks; Karstification process and its features: Surface and subsurface karst landforms*, and the last lecture for that day was *Groundwater circulation in karst: recharge, flow types and directions, discharge*.

The next day (June 1st), in the morning session, presentations were carried out by Prof. Stevanović and prof. Vesna Ristić Vakanjac, who spoke about Methods in karst hydrogeology. The first lecture was presented by prof. Stevanović: *Methods in karst hydrogeology – an overview; Geology, field reconnaissance and mapping, water occurrences inventory, remote sensing, geophysics and tracing tests, water occurrences inventory, GIS and database*. After him prof. Vesna Ristić Vakanjac provided her first lecture: *Methods in karst hydrogeology – climate, hydrology, water chemistry, statistics*. After coffee break prof. Stevanović continued with lecture about *Methods in karst hydrogeology – exploratory drilling, groundwater tapping, hydrogeological properties and field tests*.



Lectures of Prof. V. Ristić Vakanjac

In the afternoon session, prof. Stevanović continued with presentations about methods in karst hydrogeology: *Groundwater tapping, hydrogeological properties and hydrodynamics of karst aquifers, field tests & Characterization of karst aquifers; Groundwater budget and catchment delineation; Specific regime of karstic groundwater (quantity, quality)*. After



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presentations about Methods in karst hydrogeology, Dr Abraham Springer gave a lecture: Spring hydrology: catchment delineation, inventory, assess, manage springs ecosystems. Students had the opportunity to hear how hydrogeologist in America deal with springs investigations. After his presentation, students watched the movie “Waters of Trebišnjica” at HET.



Lectures of Prof. A. Springer

On the next morning (2nd June), students, together with professors, had field work on Lušac spring, located in Trebinje city, where prof. Springer showed directly on the spring how to make inventory of the spring.





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Hydrometry on the Lušac spring – guided by prof. A. Springer

After field work, participants had an opportunity to learn practical aspects of karst hydrogeology, engineering concepts, and solutions. The first part was reserved for lectures, and the afternoon for a half-day excursion. Morning lecture was presented by Prof. Petar Milanović who lectured about *Problems related to construction of dams, reservoirs and other structures and buildings in karst; Investigation, design, corrective measures, case studies.*



Morning lecture on 2nd June: Petar Milanović

In the afternoon, during the half-day field trip, the students, together with the lecturers, visited intake for water supply of Trebinje (spring “Oko”) and Grančarevo and Gorica dams. First stop was at the Oko spring, situated several meters above the riverbed of the Trebišnjica River, upstream of the town of Trebinje, where prof. Petar Milanović gave a presentation about the spring and reconstruction of tapping structure after initial spring site was submerged by new reservoir.



“Oko” tapping structure



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Next stop was Grančarevo dam, where prof. Milanović delivered a presentation about hydrogeology and geophysical survey, dam design, constructive and monitoring elements as well as remedial works for leakage prevention. After visiting Grančarevo dam, students were transferred to another smaller dam – Gorica dam, situated 3 km upstream from Trebinje on Trebišnjica River. The elements of water transfer to HE Plat near Dubrovnik as well as remedial works to reduce leakage from reservoir in an average amount of 5 m³/s were explained at the dam site.



Visit to Grančarevo dam





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Visit to Gorica dam

Next day (3th June) was reserved for an all-day field trip starting at 9⁰⁰ AM. The field trip was guided by Prof. Petar Milanović, who provided explanations to students at every field observation points. The trip started in Popovo Polje, one of the world's largest karst poljes. The first field point was at the Trebišnjica River in Popovo Polje, the largest sinking stream in entire Europe which is today completely regulated. The students had an opportunity to see riverbed which nowadays is covered with concrete blanket, and ponors that were previously utilized for water mills. After that, the excursion continued to the Vjetrenica cave, known for its extreme windiness in the entrance area, as well as for the presence of protected endemic specie *proteus anguinus* ("human fish") in its deep channels.



Popovo polje and Trebišnjica river





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Vjetrenica cave

After the cave tour, course participants visited the Buna Spring near Blagaj (Mostar) which, with its discharges in range of 3-300 m³/s, is listed among the thirty world's largest springs (Ford and Williams, 2007).



“Vrelo Bune” Spring

Further on, the students were able to shortly see Mostar city, and after that the Bregava River, Dabarsko and Fatničko polje with spring Vrijeka and estavelle Obod, as well as Trebišnjica River spring (Dejanova cave), which is submerged and flooded by the Bilećko Lake (Reservoir). Later on, one of the field points was the tunnel connecting Fatnica polje and the Bilećko Lake.



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Mostar city



Bregava river and new small hydropower plant



Dabarsko and Fatničko polje



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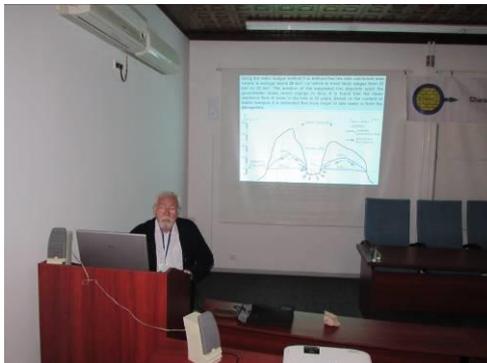
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Bilećko Lake and Tunnel Fatničko polje – Bilećko Lake

The next day (4th June) the lectures continued and were performed by Prof. Zoran Stevanović, Prof. Emeritus Ognjen Bonacci, Dr Mario Parise and Dr. Neno Kukurić. The first lecture was held by Prof. Stevanović who spoke about: *Characterization of karst aquifers; Groundwater budget; Specific regime of karstic groundwater (quantity, quality); Safe yield; Aquifer control and sustainability.* After him, Prof. emeritus O. Bonacci gave next lecture: *Water resources cycle in karst; Surface-groundwater interaction; Feasibility studies and engineering design; Environmental impact assessment; Case studies.* After lunch break M. Parise hold presentation: *Karst aquifer vulnerability; Anthropogenic impact and hazards; Karst Disturbance Index; Sustainable management of karst environment and features; Case studies.*



Lectures of Prof. Ognjen Bonacci and Dr Mario Parise

In pause between lectures, students have opportunity to watch movie made by S. Milanović about protecting the nature: “Forgotten species”. After movie, Dr Neno Kukurić closed afternoon session with lecture: *Transboundary aquifers in karst: problems, solutions and experiences.*



Lecture of Dr N. Kukurić



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On the last lecturing day (5th June), lectures were performed by Dr Neven Krešić, prof. Vesna Ristić Vakanjac, and Dr. Hermann Stadler. First lecture was performed by Dr Neven Krešić who spoke on *Modelling of karst aquifers – conceptualization for numeric models, software, EPM, CFP, case studies*. After him, prof. Vesna Ristić Vakanjac presented *Modeling of karst aquifer – Springs hydrograph analysis and stochastic models*. In the afternoon session Dr Neven Krešić continued with lecture about *Karst aquifer sustainability; Aquifer restoration (groundwater remediation); case studies*. The last lecture was performed by Dr Hermann Stadler. He lectured about *Quality dynamics at karst-springs. A challenge for drinking water supplies. Automated microbial sampling at event-scale*.



Presentations of Dr Neven Kresić and Dr Hermann Stadler

Concluding remarks were given by prof. Stevanović, who officially closed the international course and field seminar *Characterization and Engineering of Karst Aquifers* highlighting that all activities and lectures were provided timely and efficiently as initially planned. He expressed his gratitude to lecturers, students, FMG organising team and HET as a host. He also delivered questionnaire to students asking them to evaluate the course so that future courses could be improved based on their feedback and asked them to declare which of them will take part at the final exam.

The final exam was conducted on the next day (6th June). It consisted of written test with 33 questions and verbal discussions. All students attended the exam. Members of the examination panel were professors from the University of Belgrade Zoran Stevanović and Vesna Ristić Vakanjac and Dr Neven Krešić from USA.



Written part of exam

After the written exam, the panel reviewed the test and called students to improve their grades by taking part in the verbal discussion. All of students that entered the written test passed the exam with grades in range from 6-10 (obtained points were from 52 to 91, out of 100 maximum).



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Verbal discussion

The closing ceremony was held in the afternoon on June the 6th. All attendants who completed the course received a Certificate of Attendance, and an additional Certificate which included final grade and credits (6 ESTC) issued by the University of Belgrade – FMG. All lecturers received Certificate of Appreciation for teaching in the course. Finally, Prof. Stevanović noted that the results of questionnaire indicated high overall evaluation of the course (see at the end of this Report).





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Closing ceremony

The awards consist of several books in hydrogeology for the best score shown on the final exam were given to the following students:

First Prize: Dražen Tumara – Croatia (grade 10, excellent)

Second Prize: Blaž Kogovšek – Slovenia (grade 10, excellent)

Third Prize: Marina Poledica – Serbia (grade 9, very good)



Awards: from left to right first prize, second prize and third prize

After the closing ceremony, good atmosphere has transferred to a local ethnic restaurant “Stara Hercegovina” on farewell party, where the participants and lecturers were able to enjoy local food and wines. They also enjoy in music and dance, which continued till late hours.



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Farewell party

It is important to emphasize that, as during the last two years of course in Trebinje, social life of participants, lecturers and the organising team was very active with all of them spending a lot of time together, during and after the lectures. Almost every evening they made their own parties in the Trebinje's local pubs and clubs, talked, exchanged life and scientific experiences, and danced. But, the next morning they regularly attended the lectures and participated actively.



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Social events of the participants, lecturers and organising team

Reported by
Ljiljana Vasić, PhD student



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Questionnaire – Results of respond

1. The quality of content for the workshop

Poor	
Fair	
Good	20%
Excellent	80%

2. The quality of presentation

Poor	
Fair	6.6%
Good	60%
Excellent	33.3%

3. The level of technical material presented in the workshop

Poor	
Fair	
Good	33.3%
Excellent	66.6%

4. In terms of benefitting my professional/academic practice, the workshop was

Not useful	
Somewhat useful	
Very useful	100%

5. Will you use some of the knowledge that you have learnt on the course?



No, unlikely	
Maybe, possible	33.3%
Yes, likely	66.6%

6. The length of the workshop

Too long	20%
Too short	13.3%
Just right	66.6%

7. How do you like field trips, and were they too long for you?

They were good, but lasted too long	6.6%
The time we spent on stops was too long	6.6%
Everything was fine	46.6%
I would like to have more excursions than lectures	40%

8. I would recommend this workshop to others interested in karst

No, unlikely	
Maybe, possible	
Yes, likely	93%

9. How much you are satisfied with accommodation and transfer to hotel:

Poor	
Fair	6.6%
Good	33.3%
Excellent	60%

10. How do you like Trebinje city and the time you spent in the evening:

Poor	
Fair	
Good	20%
Excellent	80%

11 What is your overall evaluation of the course (1- worst; 5-best)?

1	
2	
3	
4	46.6%
5	53%