International Course and Field Seminar

Characterization and Engineering of Karst Aquifers

Trebinje, Bosnia & Herzegovina

REPORT

of the Second International Course and Field seminar

"Characterization and Engineering of Karst Aquifers"

Trebinje, Bosnia & Herzegovina, 1-7 June, 2015

The second international course and field seminar *Characterization and Engineering of Karst Aquifers* was held in Trebinje, Bosnia & Herzegovina, between 1-7 June, 2015. 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 partnership of the project DIKTAS (Dinaric Karst Transboundary Aquifer System) and sponsorship of UNESCO. Same as the last year, the Course was attended by 21 participants, and 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 & Hercegovina; Dr Ognjen Bonacci, Prof. Emer. University of Split, Croatia; Geary Schindel, Chief TO, Edwards Aquifer Authority, San Antonio, TX, USA; Dr Petar Malik, Geological Survey of Slovakia, Bratislava, Slovakia; Prof Dr Dragan Milovanović, University of Belgrade, Serbia; Dr Neno Kukurić, Head UN-IGRAC, Delft, the Netherlands; Dr Saša Milanović, University of Belgrade, Serbia; Dr Vesna Ristić Vakanjac, University of Belgrade, Serbia.

First meeting of the participants was held on May 31. After common dinner and a welcome note all participants 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.

Walking tour of the Trebinje city


Welcome cocktail

The registration of participants was the next day (1st June) at 8^{30}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, 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

Registration of participants

Opening ceremony started with the welcome speech of Mr Radovan Grdinić, Head of Department for Development and Survey of the HET 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.


Opening ceremony

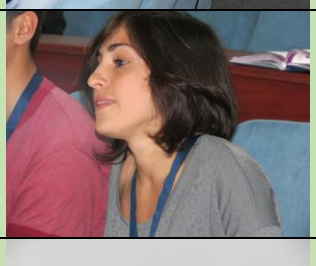
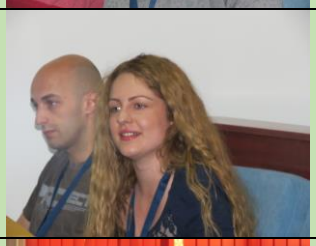
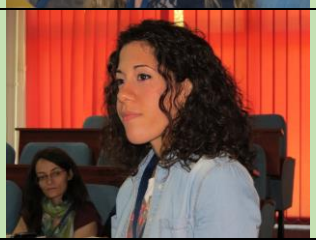
After the welcome address, Prof. Stevanović provided an introductory lecture "*Introductory note about course; Historical development of karstology and karst hydrogeology; Importance of karst and karst distribution worldwide; Geo-heritage sites; Dinaric karst*". He described the system of education at 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.

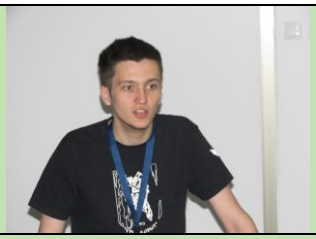
First lecture of Professor Zoran Stevanović

After the first lecture, the students introduced themselves and presented their interests and the reasons for attending the course. 21 participants from 8 countries, namely: Bosnia & Herzegovina, Croatia, Iran, Italy, France, Serbia, Ukraine and United States of America attended the course. After their introduction, the participants had a coffee break.

List of participants

	Name and Surname	City and State	Institution/Company/School	Introducing
1	Silvana Magni	Genova, Italy	University of Mainz	

2	Marijana Petrović	Lazarevac, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
3	Mehrdad Rahnemaei	Shiraz- Fars Province, Iran	Fars Water Authority , Shiraz, Iran Islamic Azad University , Shiraz Branch, Water Resources Engineering Dept.	
4	Mihailo Šević	Belgrade, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
5	Snežana Radosavljević	Lazarevac, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
6	Marion Nicolé	Vincennes, France	Unemployed	
7	Sanja Oljača	Kikinda, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
8	Marianna Mazzei	Lecce, Italy	University of Salento, Lecce, Italy	

9	Oles Ridush	Chernivtsi, Ukraine	Yuiry Fedkovych Chernivtsi National University	
10	Nikola Nikolić	Smederevo, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
11	Mirko Drašković	Trebinje, Bosnia & Herzegovina	Civil Engineering Institute "IG" BC Trebinje	
12	Miloš Stamenić	Pančevo, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
13	Graham Schindel	San Antonio, Texas, USA	Northern Arizona University, Flagstaff, Arizona, USA	
14	Đurđa Bogićević	Lučani, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
15	Jovanka Šćepanović	Trebinje, Bosnia & Herzegovina	"Hercegovinaputevi" a.d. Trebinje	
16	Slobodan Prohaska	Zrenjanin, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	

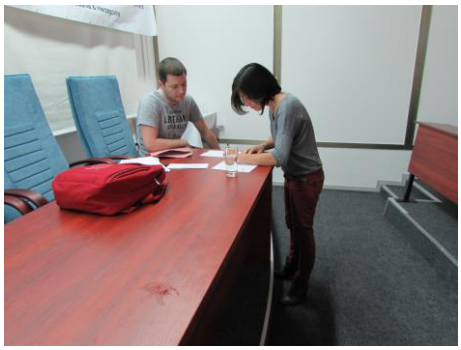
17	Giuseppe Repetto	Genova, Italy	Italian Society of Speleology	
18	Milica Đurđević	Lazarevac, Serbia	Faculty of Mining and Geology, Dept. for Hydrogeology, Belgrade, Serbia	
19	Vanja Bosanac	Daruvar, Croatia	Faculty of Mining, Geology and Petroleum Engineering, Zagreb	
20	Igor Karlović	Varaždin, Croatia	Faculty of Mining, Geology and Petroleum Engineering, Zagreb	
21	Boris Vakanjac	Belgrade, Serbia	Faculty of Applied Ecology Futura, Singidunum University	

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, Croatia and Serbia, 80 euros for students

from Italy and France and 100 euros for students from Iran, Ukraine and USA. This rate was calculated in accordance with the travel distance, available funds, and the number of attendants.

Participants receiving support

Three more lectures were held from 2 to 5^{30} 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 *Groundwater circulation in karst: recharge, flow types and directions, discharge*.

The next day (June 2nd), in the morning session, presentations were carried out by Prof. Stevanović, prof. Vesna Ristić Vakanjac and Dr. Saša Milanović, who spoke about Methods in karst hydrogeology. The first lecture was presented by prof. Stevanovic: *Methods in karst hydrogeology – an overview; Geology, field reconnaissance and mapping, water occurrences inventory, remote sensing, geophysics and tracing tests*. After him prof. Vesna Ristić Vakanjac provided her first lecture: *Methods in karst hydrogeology – climate, hydrology, water chemistry, statistics*. After coffee break Dr Saša Milanović continued with lecture about *Methods in karst hydrogeology – geomorphology, speleology, hydrogeology maps, GIS and database, exploratory drilling*.


Lectures of Prof. V. Ristić Vakanjac and Dr Saša Milanović

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 presentations about Methods in karst hydrogeology, Dr Neno Kukurić gave a lecture: *Transboundary aquifers in karst: problems, solutions and experiences*. Dr Saša Milanović

closed afternoon session with presentation: *Leakage from reservoirs and remedial measures, case studies*, with special reference to the case study of leakage below the Višegrad dam, Ourkiss and Salman Farsi dam and applied remediation measures. Lectures on the second day ended at 6^{30} PM.


Lecture of Dr Neno Kukurić

On the 3th June, participants had an opportunity to learn practical aspects of karst hydrogeology, engineering concepts, and solutions. The first part of the day was reserved for lectures, and the afternoon for a half-day excursion. Morning lecture was presented by Prof. Petar Milanović 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 3th 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. Prof. Petar Milanović gave a presentation about the spring and removal of tapping structure after initial spring site was submerged by new reservoir.


First stop at spring "Oko" tapping structure

Next stop was Grančarevo dam, were 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 m^3/s were explained at the dam site. After the completion of field visit of the aforementioned sites, the students returned to Trebinje and watched the movie "Waters of Trebišnjica" at HET.


Visit to Grančarevo dam



Visit to Gorica dam

Next day (4th June) was reserved for an all-day field trip starting at 8^{30} AM. The field trip was guided by Prof. Petar Milanović, who provided explanations to students at every field observation point. 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



Vjetrenica cave

After the cave tour, course participants visited the Buna Spring near Blagaj (Mostar) which, with its discharges in range of 3-300 m^3/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.


Mostar city


Bregava river



Dabarsko and Fatničko polje



Bilećko Lake and Tunnel Fatničko polje – Bilećko Lake

The next day the lectures continued and were performed by Prof. emeritus Ognjen Bonacci, Dr Petar Malik, Geary Schindel and Prof. Stevanović. The first lecture was held by Prof. emeritus Ognjen Bonacci: *Water resources cycle in karst; Surface-groundwater interaction; Feasibility studies and engineering design; Environmental impact assessment; Case studies*. After coffee break P. Malik hold presentation: *Karst springs as indicator of aquifer behaviour: measurements, assessment methods, spring hydrographs and case studies*.

Lectures of Prof. emeritus Ognjen Bonacci and Dr Peter Malik

In the afternoon session, Geary Schindel continued with lecturing, giving presentation about *Management of karst aquifers; Legislation, control, monitoring, over-extraction consequences; Hazardous material in urban karst and case studies*. The last presentation that day gave prof. Stevanović: *Water extraction in karst; Safe yield and sustainability; Aquifer control in discharge zones and drainage areas*. He also delivered questionnaire to students asking them to evaluate the course so that future courses could be improved based on their feedback.

Presentation of Geary Schindel

On the last lecturing day (6th June), lectures were performed by Dr Neven Krešić, prof. Vesna Ristić Vakanjac, Branislav Petrović PhD student (instead of Prof. Stevanović) and Dr. Saša Milanović. First lecture was performed by Dr Neven Krešić who spoke on *Modeling 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 Branislav Petrović PhD student presented lectures *Karst aquifer vulnerability: assessment methods, visualization, sanitary protection zones, case studies*. Dr Neven Krešić continued with lecture *about Karst aquifer sustainability; Aquifer restoration (groundwater remediation); case studies*. The last lecture was performed by Dr. Saša Milanović. He lectured about *Protecting the nature: Endemic species in karst* and presented his movie *"The forgotten species"*.

Presentations of Dr Neven Kresić and Branislav Petrović

Concluding remarks were given by Dr. Saša Milanović, 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 asked students to declare which of them will take part at the final exam.

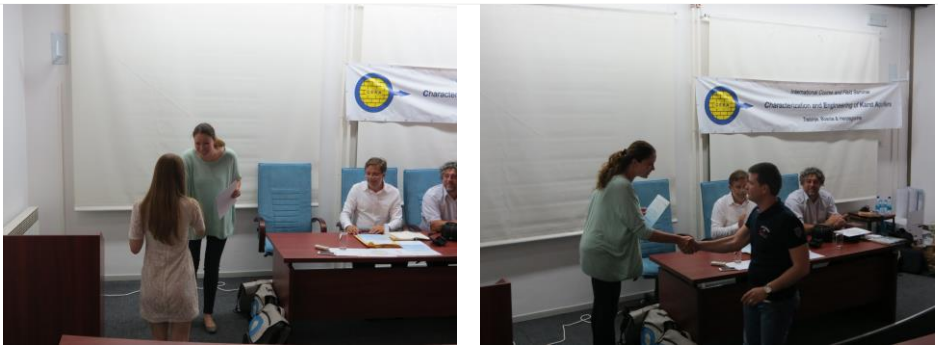
The final exam was conducted on the next day (7th June). It consisted of written test with 30 questions and verbal discussions. In total, 13 students attended the exam. Members of the examination panel were professors from the University of Belgrade which certifies the course: Zoran Stevanović, Vesna Ristić Vakanjac and Saša Milanović.


Written part of exam

After the written exam, the panel reviewed the test and called students who wanted to improve their grades to take 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).

The closing ceremony was held in the afternoon on June the 7th. All attendants who completed the course received a Certificate of Attendance, and those that passed the exam received 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 participation 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).



Closing ceremony

The awards for the best score on the final exam were given to the next students:

First Prize: Mehrad Rahnemaei – Iran (grade 10, excellent)
Second Prize: Marion Nicolé – France (grade 9, very good)
Third Prize: Mihailo Šević – 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 winery (this year winery Petijević), where the participants and lecturers were able to enjoy local food and taste local wines. After the winery, farewell party continued in ethnic restaurant "Studenac" with local cuisine and music which continued till late hours.





Farewell party

It is important to emphasize that, during the this course, same as the last year, 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.




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	47%
Excellent	53%

2. The quality of presentation

Poor	
Fair	
Good	53%
Excellent	47%

3. How much of the presented lecture material were you already familiar with – write your estimation:

familiar with 10% of material : responded 4% of interviewed; 20% : 4%; 30% : 9%; 40% : 4%; 50% : 4%; 60% : 4%; 70% : 41%; 80% : 26 %; 90% : 0%; 100% : 4%

4. The level of technical material presented in the workshop

Poor	
Fair	4%

Good	33%
Excellent	63%

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

Not useful	
Somewhat useful	27%
Very useful	73%

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

No, unlikely	
Maybe, possible	19%
Yes, likely	81%

8. The length of the workshop

Too long	14%
Too short	14%
Just right	72%

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

They were good, but lasted too long	9%
The time we spent on stops was too long	
Everything was fine	44%
I would like to have more excursions than lectures	47%

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

No, unlikely	
Maybe, possible	9%
Yes, likely	91%

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

Poor	
Fair	4%
Good	69%
Excellent	27%

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

Poor	
Fair	4%

Good	33%
Excellent	63%

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

1	
2	
3	
4	38%
5	62%