International Course and Field Seminar

Characterization and Engineering of Karst Aquifers

Trebinje, Bosnia & Herzegovina

REPORT

of the 10th International Course and Field seminar
"*Characterization and Engineering of Karst Aquifers*"
Trebinje, Bosnia & Herzegovina, 28 May – 04 June, 2023

Participants of the CEKA 2023 course with certificate of attendance

The 10th International Course and Field Seminar ***Characterization and Engineering of Karst Aquifers*** **(CEKA)** was held in Trebinje, Bosnia & Herzegovina, between 28 May – 04 June, 2023. This year's jubilee course was followed by another ceremony - 15 years since the establishment of the Center for Karst Hydrogeology **(CKH)** of the Faculty of Mining and Geology.

The ceremonial academy on the occasion of the 15th anniversary of the establishment of CKH and the 10th anniversary course of CEKA was held on May 29, 2023 in the Great Hall of the Hydrosystem on the Trebišnjica River (HET). On that occasion, welcome speech was given by **Dr. Saša Milanović**, *Assistant Professor of the Faculty of Mining and Geology* and *Head of the Center for Karst Hydrogeology*, **Dr. Cvjetko Sandić**, *Deputy Director of the Geological Survey of the Republic of Srpska from Zvornik*, **Gordan Mišeljić**, *General Director of HET*, and **Dr. Dragoslav Banjak**, *President Assembly of the city of Trebinje*. Afterwards, the founder and former head of CKH, **Dr. Zoran Stevanović** gave a short talk on the history of CKH and the CEKA course.

Speeches at the ceremonial academy by Dr. Dragoslav Banjak (left) and Dr. Zoran Stevanovć (right)

The jubilee celebration was an ideal opportunity for CKH to thank its partners and lecturers for all the support they received in previous years. The plaque and charter as a sign of gratitude for cooperation, support in the organization and/or lectures held during the previous 10 years of the course were given to: **Gordan Mišeljić** *on behalf of HET*, **Dr. Dragoslav Banjak** *on behalf of the city of Trebinje*, **Dr. Zoran Vuković** *on behalf of MH Power Utility of Republic of Srpska*, **Slaviša Stajić** *on behalf of HPP Dabar*, **Dr. Abe Springer** *on behalf of Northern Arizona University*, **Dr. Petar Milanović**, **Dr. Zoran Stevanović**, and **Mladen Tomić** *on behalf of the Geological Survey of the Republic of Srpska from Zvornik*.

Awarding of plaques and charter

At the end of the awarding ceremony, members of CKH awarded a special award and plaque to **Dr. Zoran Stevanović**, for his immeasurable contribution to Serbian and world karstology and the establishment and development of CKH.

Members of CKH award a special award and plaque to Dr. Zoran Stevanović

After the ceremony and awarding of plaques and charters, two plenary lectures were held: **Karst of Eastern Herzegovina** by **Dr. Petar Milanović** and **Karst Hydrogeology Applied to Oil Reservoirs** by **Dr. Augusto Auler**. After the welcome address and plenary lectures, the

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10th International Course and Field Seminar *C**haracterization and Engineering of Karst Aquifers* **(CEKA)** was officially opened.

Plenary lectures by Dr. Petar Milanović (left) and Dr. Augusto Auler (right)

The day after the ceremony, i.e. on May 30 the course officially started. As it was the case in previous year, the CEKA 2023 course was organized by the **Centre for Karst Hydrogeology** of the Department of Hydrogeology, University of Belgrade - Faculty of Mining & Geology, the **Geological Survey of the Republic of Srpska**, Zvornik, our hosts **HET** and with support of **Municipality of Trebinje** and **MH Power Utility of Republic of Srpska**. This year, the Course was attended by 37 participants from 9 countries (Brazil, Spain, Philippines, Belgium, Poland, Serbia, Bosnia & Herzegovina, North Macedonia, Togo), while lectures were provided by 10 professors and experts.

Experts who delivered their lectures during this year course were: **Dr Zoran Stevanović**, Ret. Prof. University of Belgrade, Serbia; **Dr Petar Milanović**, Ret. Prof. University of Mostar, Bosnia & Hercegovina; **Dr Vesna Ristić Vakanjac**, University of Belgrade, Serbia, **Asst. Dr Saša Milanović**, University of Belgrade, Serbia, **Dr. Abe Springer**, Northern Arizona University, **Dr. Matías Mudarra Martínez**, Center of Hydrogeology of the University of Malaga, Spain, **Dr. Augusto Auler**, Carste Ciência Ambiental / Instituto do Carste, Brazil, **David Evans**, CEO FloGlobal / General Manager Peru, FloSolutions Peru, **Dr. Neno Kukurić**, Advisor groundwater to governments and international organisations.

The registration of participants took place on 29nd May, at the hall of the HET in Trebinje. All participants received course materials (bag, notebook, pencil, T-shirt and Trebinje touristic promotive materials).

Entrance to the HET and the conference hall

Registration desk

A course CEKA 2023 started at 900 AM with the welcome speech of Dr Saša Milanović, Head of the Centre for Karst Hydrogeology, who expressed his pleasure that the course is being held again in Trebinje, at the heart of the karst and also wished a productive work and pleasant stay in Trebinje and at HET to the participants. After welcome words, Dr Saša Milanović invited Dr. Zoran Stevanović, founder of the Centre for Karst Hydrogeology and this Course as well. After the welcome address and introductory note of **Dr. Stevanović**, the Course was officially opened. First session was reserved for **Dr. Stevanović** who provided lecture "*Historical development of karstology and karst hydrogeology and karst distribution worldwide*, *Porosity and permeability of karstic rocks; Groundwater circulation in karst: recharge, flow types and directions, discharge*". After lunch break, Dr. Stevanović continued with lecture in second session titled "*Methods in karst hydrogeology – an overview; geology, remote sensing, geophysics, water points inventory, groundwater tapping, hydrogeological properties and field tests*".

After the lunch break, **Dr. Abe Springer** had a talk about *Spring hydrology: catchment delineation, inventory, assess, manage springs ecosystems*.

First lecture of Professor Zoran Stevanović (left); Dr. Abe Springer giving lecture (right)

After him, **Dr Saša Milanović** continued with methods in karst hydrogeology, presenting lecture titled "*Specific investigation and research techniques of complex karst systems as a base for hydrotechnical construction and remediation problems in karst - monitoring, tracing tests, speleodiving, spatial modeling etc*". This lecture closed the first day of the CEKA 2023 course.

Lectures of **Dr Saša Milanović**

On the next morning, focus was mainly on the practical aspects of karst hydrogeology, engineering concepts, and solutions. The morning session was reserved for lectures of Dr. P. Milanović, who delivered a presentation titled *"Problems related to construction of dams, reservoirs and other structures and buildings in karst; Investigation, design, corrective measures, case studies".* Afterwards, a half-day field trip took place, when students, together with the lecturers,visited Grančarevo dam and intake for water supply of Trebinje (spring "Oko"). First stop was Grančarevo dam, were Dr. P. Milanović talked about hydrogeology and geophysical survey, dam design, constructive and monitoring elements as well as remedial

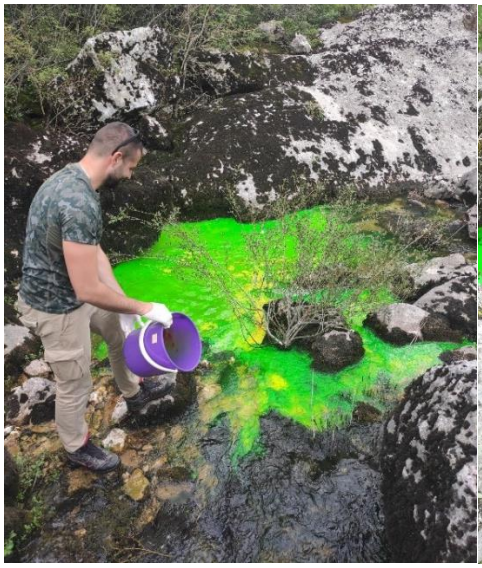
works for leakage prevention. After visiting Grančarevo dam, next stop was at the Oko spring, situated several meters above the riverbed of the Trebišnjica River, upstream of the town of Trebinje. Dr. P. Milanović briefly explained hydrogeology characteristics of the "*Oko*" spring catchment area and talked about of tapping structure after initial spring site was submerged by new reservoir. After the completion of field visit of the aforementioned sites, the students returned to Trebinje and watched the movie "Waters of Trebišnjica" and "Forgotten species" by Dr. S. Milanović at HET facility.

Lectures by **Dr. Milanović** (upper left); Half-day field trip to Grančarevo Dam (upper right) and the Oko Spring (down photo)

Third day of the course was dedicated to the all-day field trip, when the participants visited Korićka jama, Cernica karst polje and the Ključka Rijeka River, well known because of a surface flow only 300 meters long from the Vilina pećina karst spring to the ponor of Ključka Rijeka river. In the spring zone, Dr. Saša Milanović gave lectures on the basic characteristics of the Cernica field and the spring of Ključka Reka from the hydrogeological aspect. On this spot, Prof. Springer showed directly on the spring how to make an inventory of the spring. Participants had opportunity to measure physico-chemical characteristics of the Ključka Reka river with field portable laboratory equipment and to perform tracer test with sodium-fluorescein as a tracer.


First stop on the all-day field trip – Korićka jama (left); **Dr. Abe Springer** providing lecture about spring ecosystem on the spring of the Ključka Reka river (right)


Dr. **Saša Milanović** providing lectures about basic hydrogeological characteristic of the Cernica Polje and the spring of the Ključka Reka river (left); Participants measure physico-chemical parameters of the Ključka Reka river under the guidance **of Dr. Ljiljana Vasić** (right)



Performing of tracer test on the Ključka Reka river in Cernica Polje

Further on, participants moved to the next stop – Gacko Polje, where **Dr. Saša Milanović** and **Dr. Zoran Stevanović** gave short explanations about the function of the karst aquifer and about the neogene basin of Gatačko polje as well as about the nearby coal mine and thermal power plant in Gack.

Gatačko karst polje

Finally, participants reached the last stop on the all-day field excursion on the Klinje dam, where **Dr. Saša Milanović** gave short talk about the dam and the system, while afterwards all attendees had lunch.

Dr. Saša Milanović providing a lecture about the Klinje dam (left); Lunch break on the Klinje dam (right)

Morning session on the fourth day of the CEKA 2023 course was reserved for presentations of **Dr. Matías Mudarra Martínez**, who provided lectures titled: "*Natural tracers and natural responses of springs: monitoring strategies and hydrogeochemical and isotopic approaches to characterize the functioning of karst aquifers*, and **Dr. Augusto Auler** titled *"Karst geomorphology and speleology related to karst evolution, hydrogeological processes and climate change"*. After the lunch break, the course was continued with the lecture titled *"Mining hydrogeology in complex karst systems - related to tailings, waste dumps, water supply etc"* by **David Evans**, *"Modeling of karst aquifer – Springs hydrograph analysis and stochastic models"* by **Dr. Vesna Ristić Vakanjac** *and "Transboundary aquifers in karst:*

specifics, challenges and experience" by **Dr. Neno Kukurić**, who closed the last day of lecturing on this year's course.

Dr. Matías Mudarra Martínez (left) and **Dr. Augusto Auler** (right) providing lectures on CEKA 2023 course

Dr. Vesna Ristić Vakanjac (left) and **Dr. Neno Kukurić** (right) providing lectures on CEKA 2023 course

Fourth and the last day of course was reserved for another all-day field trip. The field trip was guided by **Dr. Saša Milanović**, who provided explanations at every observation point. The trip started in Popovo Polje, one of the world's largest karst poljes. The first stop was at Dračevo in Popovo Polje, where participants had opportunity to see the Plitica estavelle. After this stop, 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.

The Plitica estavelle in Dračevo, Popovo Polje

Vjetrenica Cave in Popovo polje

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. Further on, the students were able to see Dabar and Fatnica poljes with springs Vrijeka and Susica and estavelle Obod. On the way to Trebinje Dr. S Milanović showed to participants from bus where is the Trebišnjica River spring (Dejanova cave), which is submerged and flooded by the Bileća Reservoir and the tunnel that connecting Fatnica Polje and the Bileća Reservoir.

Buna Spring (left) and Dabar karst polje (right)

The last day of the course was reserved for the exam, which was taken by 10 students, 7 from Faculty of Mining and Geology, 1 from the Philippines and 2 from Poland. After the successful completion of the exam, the closing ceremony was held. Attendants who completed the course received a Certificate of Attendance, and all lecturers received Certificate of Appreciation for participation in the course.

Exam on the CEKA 2023 course

Closing ceremony and awarding of certificates

After the closing ceremony, we moved to a local ethnic restaurant “Studenac” on farewell party, where participants and lecturers were enjoyed local food and wines. They also enjoyed music and dance, which continued till late hours.

Farewell party

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CEKA Team of the year 2023 !