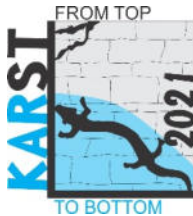




Characterization and Engineering of Karst Aquifers



REPORT of the Event “A week with Karst” in



“International Year of Caves and Karst”,
1 – 7 June, 2021

Including reports on:

The traditional Eighth International Course and Field seminar
“**Characterization and Engineering of Karst Aquifers**”

Special Session of CEKA 2021 Course “**Lecturing by Distinguished Guests**”, and
Online Conference “**Karst: From Top to Bottom**”

The special event “A week with Karst” was dedicated to the International Year of Caves and Karst. It contained the 8th course „*Characterization and Engineering of Karst Aquifers*“ (CEKA), a special thematic session of CEKA 2021 Course “*Lecturing by Distinguished Guests*“ and online multidisciplinary conference for young karst researchers and professionals “*Karst: From Top to Bottom*”. The Organizer of event “A week with Karst” was the Centre for Karst Hydrogeology of Belgrade University, Serbia.

Traditional 8th course „*Characterization and Engineering of Karst Aquifers*“ (CEKA) took place virtually from 1 to 5 June 2021 via Zoom platform. The CEKA 2021 course was under the auspices of UNESCO-IHP and supported by the Regional Waterworks of Montenegro Coast, City of Trebinje, Hydro-Energy system “Trebišnjica”, Geological Surveys of Montenegro and Republic of Srpska, Bosnia & Herzegovina, Northern Arizona University and Edwards Aquifer, TX.

During the first five days, 11 professors provided 18 lectures ranging from basic karst hydrogeology to special engineering solutions and their environmental impacts. The Course was attended by 93 participants from 24 countries, from all over the world.

Experts who delivered their lectures during this year course were: Prof. Dr Zoran Stevanović, University of Belgrade, Serbia; Dr Petar Milanović, Ret. Assoc. Prof. University of Mostar, Bosnia & Hercegovina; Prof. Dr Dragan Milovanović, Ret. Prof. University of Belgrade, Serbia; Prof. Dr Vesna Ristić Vakanjac, University of Belgrade, Serbia; Prof. Dr Igor Jemcov, University of Belgrade, Serbia; Dr Neven Krešić, Hydrogeology Practice Leader, GeoSyntec, USA; Dr Neno



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Kukurić, UN-IGRAC, Delft, the Netherlands; Ass. Prof. Dr Ivo Andrić, University of Split, Croatia; Ass. Prof. Dr Saša Milanović, University of Belgrade, Serbia; Ass. Prof. Dr Vladimir Živanović, University of Belgrade, Serbia and Dr Ljiljana Vasić, Scientific Researcher, University of Belgrade, Serbia.

Opening ceremony took place at 9⁰⁰ AM (1th June) with the welcome speech of Prof. Dr Zoran Stevanović, Prof Dr Vesna Ristić Vakanjac, Vice Dean (FMG, University of Belgrade), and Dr Petar Milanović, President of Nat. Com. of IAH for Serbia who wished welcome to all participants as well as productive work and pleasant time together.



Opening ceremony

Prof. Stevanović started lecturing part with 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 for this year.

The next two lectures were delivered by Prof. Dragan Milovanović: "*Carbonate and non-carbonate rocks: mineralogy, depositional environments and classifications*" and "*Chemical factors of karstification and Role of tectonics*". After Prof. Milovanović lectures, two more lectures were held by Prof. Stevanović: "*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*".

Morning session on the second day of course was reserved for presentations about methods in karst hydrogeology. Firstly, Prof. Stevanović gave a lecture: "*Methods in karst hydrogeology – an overview; geology, remote sensing, geophysics, water points inventory, groundwater tapping, hydrogeological properties and field tests*". After him, Prof. Vesna Ristić Vakanjac provided lecture titled: "*Methods in karst hydrogeology – climate, hydrology, springs hydrograph analysis and stochastic models (exercise)*", and finally, morning session and lectures about methods in karst



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hydrogeology Prof. Saša Milanović finished with lecture *Methods in karst hydrogeology – geomorphology, speleology, speleo diving, hydrogeology maps, GIS and database*. In the afternoon session participants had an opportunity to learn about practical aspects of karst hydrogeology, engineering concepts, and solutions. Two lectures were presented by Prof. Petar Milanović: *Problems related to construction of dams, reservoirs and other structures in karst; and Investigation, design, corrective measures in dams functioning – global experience*.

The next morning (3rd June) started with the lecture and case study from professional practice of Ass. Prof. Saša Milanović titled: *Specific research methods to identify and prevent leakage from reservoirs in karst*. After him, Ass. Prof. Ivo Andrić held a lecture titled: *Water resources cycle in karst; Surface-groundwater interaction; Feasibility studies and engineering design; Environmental impact assessment*. Morning session was finished with the presentation of Dr Neno Kukurić: *Transboundary aquifers: problems, solutions and experiences*. In the afternoon session, participants had opportunity to watch DVD movies “*Karst*” and “*Karst of Montenegro*” “*Trebišnjica- the largest sinking river of Europe*”. “*Protecting the karst: Forgotten species*”.

On the fourth lecturing day, morning session started with Prof. Stevanović, who provided lecture: *Characterization of karst aquifers; Groundwater budget; Specific regime of karstic groundwater (quantity, quality); Safe yield; Aquifer control and sustainability*, after whom Ass. Prof. Vladimir Živanović gave lecture titled: *Karst aquifer vulnerability – assessment and visualization; Sanitary protection zones and measures*. After them Dr Ljiljana Vasić delivered the last presentation in morning session titled “*Quality dynamics at karst-springs. A challenge for drinking water supplies. Isotopic methods in karst, GW ageing*”. In afternoon session, participants had the opportunity to listen two presentations: “*Modeling of karst aquifers – conceptualization for numeric models, software, EPM, CFP, case studies*”, presented by Dr Neven Krešić and lecture: “*Stochastic modelling of karst hydrogeological systems and water resources assessment: Challenges and solutions*”, by Prof. Igor Jemcov.

At the last day of the CEKA 2021 course, on 5 June 2021, a special thematic session “*Lecturing by Distinguished Guests*” took place on Zoom platform starting from 10 AM (CET). This session was dedicated to 40 years of work of Prof. Zoran Stevanović in karst hydrogeology and his retirement from the University of Belgrade.

A total of 11 eminent karst experts mostly members of the Karst Commission of IAH (Augusto Auler, Jianhua Cao, Francesco Fiorillo, Nico Goldscheider, Chris Groves, John Gunn, Hervé Jourde, Attila Kovács, Peter Malik, Bartolomé Andreo Navarro, Abe Springer), gave their lectures



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at the special thematic session “*Lecturing by Distinguished Guests*“. It had excellent attendance, by 113 participants from all over the world.

Sessions were moderated by Prof. Zoran Stevanović and Prof. Saša Milanović. There were a total of 6 lectures in the morning session. The session started with presentation of Dr Nico Goldscheider from the Karlsruhe Institute of Technology, Germany. He presented lecture: „*Global distribution of karst aquifers and a holistic perspective on their water resources and ecosystems*“.

After him, Prof. Hervé Jourde from the University of Montpellier, France delivered lecture about modelling in karst titled: „*Modelling karst functioning: advances, challenges and perspectives*“. Dr Petar Malik from the Geological Survey, Slovakia gave next presentation about recharge in karst: „*Recharge in karst: example of unexpectedly long response of karstic groundwater-level upturn to precipitation*“.

Prof. Francesco Fiorillo from University of Sannio, Benevento, Italy presented “*Hydrologic features of karst aquifers under recharge-discharge processes: examples from southern Italy*“.

Prof. Attila Kovacs from the University of Miskolc and the Budapest University of Technology and Economics, Hungary was speaking about complexity of karst systems in „*Complex karst systems - Physical hydrograph analysis*“. The last presentation in morning session was presented by Prof. Bartolomé Andreo-Navarro, from University of Malaga, Spain. He was speaking about groundwater vulnerability and groundwater protection. His lecture was titled: “*Protecting groundwater in karst aquifers, combining vulnerability mapping, protection zoning and early warning systems*“.

In afternoon session, a total of 5 eminent karst experts gave their lectures. The first lecture was presented by Prof. John Gunn from University of Birmingham, UK. He presented „*Exploring internal complexity in an apparently simple karst groundwater system*“. The authors of the following presentation were Dr Jianhua Cao from Ministry of Land & Resources in China and Prof. Chris Groves from Western Kentucky University, USA. Dr Cao delivered presentation about carbon cycle titled: „*Carbon cycle origin the carbonate weathering: evidences from the geological and ecological processes*“.

Next presentation was about tracing methods in karst hydrogeology and was presented by Prof. Chris Groves from Western Kentucky University, USA. The title of the lecture was: „*Methods in karst hydrogeology: dye tracing and evaluation of carbonate chemistry*“. Dr Augusto Auler from

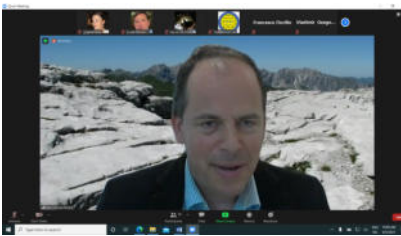


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Carste Ciência e Meio Ambiente / Karst Institute Brazil, presented lecture about protection zones for caves: „*A protocol for establishing protection zones for caves: Physical stability and hydrogeological connections*”. The next and final presentation of the afternoon session was presented by Abe Springer from Northern Arizona University, USA. He was speaking about ecohydrogeology of karst springs based on examples from the Grand Canyon National Park: „*Karst springs ecohydrogeology with examples from the world class karst of Grand Canyon National Park*”.

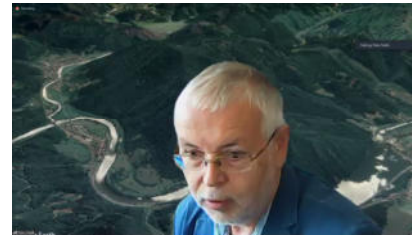
After his presentation, professors Stevanović and Milanović thanked the lecturers and closed the special thematic session “*Lecturing by Distinguished Guests*”.



Nico Goldscheider



Hervé Jourde



Petar Malik



Francesco Fiorillo



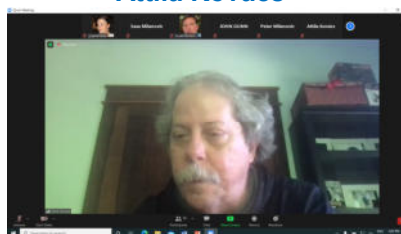
Attila Kovacs



Bartolomé Andreo-Navarro



John Gunn



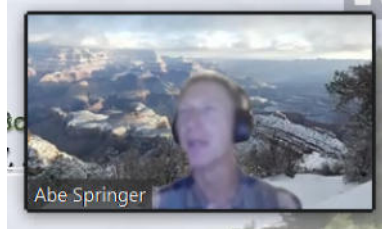
Chris Groves



Augusto Auler



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Abe Springer

Special thematic session “Lecturing by Distinguished Guests “

After the course, virtual Multidisciplinary Conference for karst researchers and professionals “**Karst: From Top to Bottom**” took place on Zoom platform on 6 June 2021. The Conference covered many aspects of research in karst and was especially devoted to younger and talented karst researchers. In total, 19 abstracts have been submitted, and are published in the Book of Abstracts.

Conference was attended by 64 participants from all over the world. It was consisted of three sessions. Opening ceremony started at 10 AM with welcome speech of Prof. Saša Milanović, who wished welcome to all attendances and productive work during conference.

During first session the convener was Dr Guanghui Jiang from Institute of Karst Geology, Guilin, China. During this session, 5 lectures were presented.

1. Luka Vučinić, David O’Connell, Donata Dubber, Patrice Behan, Quentin Crowley, Catherine Coxon, Laurence Gill: *Source Apportionment of Human Wastewater Contamination Impacts on Karst Springs in Ireland*
2. Alena Gessert, Imrich Sládek: *Comparison of Karst Relief Denudation Using the Method of Limestone Tablets and Ionic Runoff (Case Study Jasov Plateau, Slovak Karst)*
3. Nikolay Maksimovich, Olga Meshcheriakova: *The Uniqueness of The Karst Lake Cherek-Kel (Blue Lake) in Kabardino-Balkaria (Russia)*
4. Bibiána Pasternáková, Tomáš Kuchovský, Kateřina Chroustová, Adam Říčka: *Hydrogeochemistry of Mineral Waters from Deep-Seated Jurassic Karst Aquifer in The South Moravia – Lower Austria Region*
5. Ljiljana Vasić: *Groundwater genesis of the Krivi Vir karst system (Eastern Serbia)*

The second session started after lunch break, where the Convener was Ass. Prof. Olga Meshcheriakova from Perm State University, Russia. During this session 6 lectures were presented.



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1. Fang Guo, Guanghui Jiang: *Hydro-Ecological Processes of Hyporheic Zone in a Karst Spring-Fed Pool: Effects of Groundwater Decline and River Backflow*
2. Jelena Krstajić: *Climate Change Effects on Groundwater Resources Case study: Rijeka Crnojevića*
3. Branislav Petrović: *Simulation of Migration of Nitrate Contamination in Epikarst Groundwater: A Column Laboratory Method*
4. Milica Trifković, Vujadin Blagojević, Petar Milanović: *Main Features of the Integrated Water Management of Karst Poljes in Eastern Hercegovina, Case Study: Ljubinsko Polje in the Trebišnjica River Basin*
5. Majedeh Sayahi, Jayson Gabriel Pinza, Yining Zang, Thomas Reimann, Alireza Kavousi: *Significance of Turbulent Flow Regime in Discrete-Continuum Flow and Transport Models of Karst Systems*
6. Jie Shi: *Spectral Characteristics of Dissolved Organic Matter in Foot Cave Aquifer System of Zengpiyan Site*

The last session had 4 presentations. The convener was Assoc. Prof. Milan Radulović, from University of Montenegro.

1. Max G. Rudolph, Raoul Collenteur, Markus Giese, Alireza Kavousi, Thomas Wöhling, Andreas Hartmann, Steffen Birk, Thomas Reimann: *Evaluation of Transfer Function Noise Modelling and Dimensionality Reduction Techniques for Karst Systems*
2. Veljko Marinović: *Linearization of Input Signal as a Necessary Tool in Stochastic Modeling of Karst Groundwater*
3. Kateřina Chroustová, Adam Říčka, Bibiána Pasternáková, Tomáš Kuchovský: *Conceptual Hydrogeological Model of Deep Karst Aquifer in South Moravia – Lower Austria Region*
4. Veljko Marinović, Branislav Petrović: *Stochastic Prediction of Temporal Variations of Karst Groundwater Regime in Function of Sustainable Management: Case Study Mokra Karst Spring (SE Serbia)*

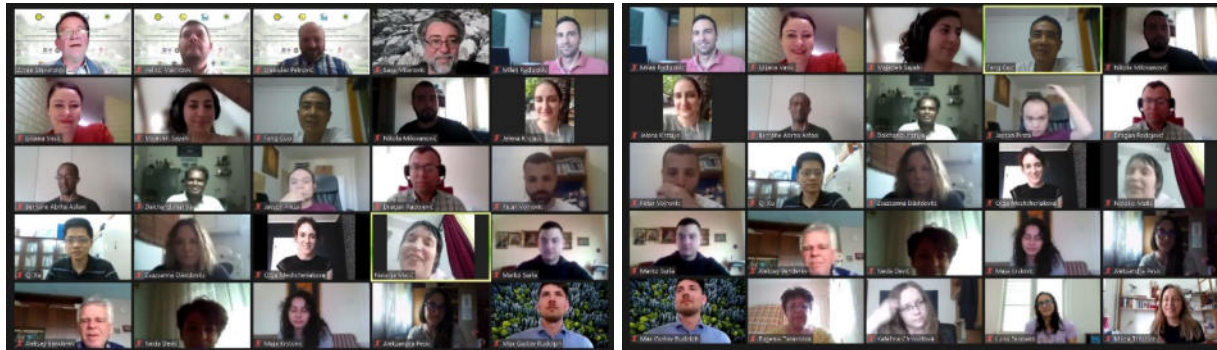
After last presentation, Prof. Zoran Stevanović thanked to all young researcher who presented results of their investigations and stated that authors of the selected abstracts and presentations will be invited to submit a full paper which, after peer review, would be published in the special issue of Springer SI journal "Carbonates and Evaporites" (<https://www.springer.com/journal/13146>) edited by Zoran Stevanović, Saša Milanović and Ljiljana Vasić or in one of international geological journals published in Serbia "Annales géologiques de la péninsule Balkanique"



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(<http://gabp-dl.rgf.rs>) or "Compte rendu de la Société Serbe de géologie" (<https://sgd.rs/en>). The Book of Abstracts is available for download on the CKH website.



Attendances at the end of Conference ***“Karst: From Top to Bottom”***

Once again, Prof. Stevanović commended all participants and wished them good luck in their future work and officially closed the Conference ***“Karst: From Top to Bottom”*** and 7 days lasted event ***“A week with Karst”***.

The success of the event can be confirmed by number of attendants. The lecturing days as well as the online conference has been followed by 60 participants in average, while the number is almost doubled during ***“Lecturing by Distinguish Guests”***. In total, 43 Certificates of attendance and successful completion of the CEKA has been issued to students and professionals from 24 countries from 5 continents.

There is a great wish of all, lecturers and attendants to meet next year in the ***“heart of karst”*** in Trebinje, Bosnia & Herzegovina and Virpazar, Montenegro where the course is regularly taking place and continue common work in understanding of complex Dinaric karst aquifer system.

Reported by

Dr Ljiljana Vasić, Scientific Researcher