

Univerzitet u Beogradu, Rudarsko-geološki fakultet
Departman za Hidrogeologiju, Centar za Hidrogeologiju Karsta

CENTAR ZA HIDROGEOLOGIJU KARSTA
15 GODINA NAUKE I STRUKE

CENTRE FOR KARST HYDROGEOLOGY
15 YEARS OF SCIENCE AND PRACTICE



Beograd, 2023

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15 GODINA NAUKE I STRUKE**

***CENTRE FOR KARST HYDROGEOLOGY
15 YEARS OF SCIENCE AND PRACTICE***

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Predgovor

Pisati predgovore nije lak zadatak. Sličan je ulozi koju imaju revidenti. Treba konkretno i jezgrovito izneti bitne činjenice. Uz to dati i opštu ocenu potpisnika o delu koje će čitalac potom detaljnije proučiti i zauzeti svoj lični, neretko i različit stav. Ovaj zadatak nešto je lakši kada pisac predgovora analizira i ocenjuje tuđe delo i rad. Ali, u ovom slučaju u pitanju je neposredni učesnik i svedok stvaranja i rada Centra za hidrogeologiju karsta na Departmanu za hidrogeologiju Rudarsko-geološkog fakulteta. Dakle pred vama je jedan pokušaj "navijača" da ostane objektivan, čemu donekle u prilog ide činjenica da već duže od godinu dana nakon penzionisanja nije na njegovom čelu i nije neposredno uključen u svakodnevne nastavne i istraživačke aktivnosti.

Naš Centar još uvek je mlad, a punoletan postaće tek za koju godinu. Ali rezultati ostvareni od osnivanja i naponi koje su njegovi članovi uložili za dalju afirmaciju naše škole karsta, smatramo da zaslužuju poštovanje. U ovoj publikaciji prikazan je najveći deo tih rezultata, koji uključuju ostvarenu nastavnu aktivnost, međunarodnu naučno-tehničku saradnju, projekte koje smo inicirali ili po pozivu u njima učestvovali, štampane publikacije, organizovane naučne skupove, nabavljenu i korišćenu opremu.

Centar za hidrogeologiju karsta čine njegovi članovi koji se naravno aktivno bave ovom užom naučnom disciplinom. Iako malobrojni, uspešno su realizovali sve postavljene ciljeve. Pored ostalog i četiri odbranjena doktorata, svi na temu hidrogeologije karsta, sagledane sa različitih aspekata i uz primenu različitih metoda. Time je ojačana ne samo naučna struktura Centra, već i osnova za dalje širenje i prenošenje znanja u ovoj multidisciplinarnoj disciplini.

Pored zajedničkog rada u nastavi i na pojedinim projektima, članovi Centra su i kao individualno angažovani konsultanti u međunarodnim organizacijama i kompanijama, ili kao autori naučnih radova, dali značajan doprinos afirmaciji naše škole karsta prepoznate i tradicionalno uvažavane u međunarodnoj naučnoj zajednici. Svaki rezultat člana je dakle i doprinos radu i afirmaciji Centra.

Sve navedeno ne bilo moguće ostvariti da u Centru od momenta njegovog formiranja do danas nisu bili uspostavljeni prijateljski odnosi u kojima je uvek bilo aktivne komunikacije, razumevanja i kolegijalne pomoći. Jer razmena iskustava i redovno konsultovanje - preduslov su za uspeh u svakoj naučnoj zajednici.

No, prostora za samozadovoljstvo nema. Još je mnogo zadataka i obaveza pred članovima Centra, ako žele da zadrže i dobar glas i status. Praksa pokazuje da se u mnogim oblastima visoka pozicija lakše stiže nego održava. Ostaju i važni zadaci u pogledu saradnje sa

Foreword

Writing forewords is not an easy task. It is similar to the role of the reviewers. The essential facts should be stated concretely and concisely. In addition, give the signatory's general assessment of the work, which the reader will then study in more detail and take his own personal, often different, position. This task is somewhat easier when the foreword writer analyses and evaluates someone else's work. But, in this case, the writer is a direct participant and witness of the creation and work of the Centre for Karst Hydrogeology at the Department of Hydrogeology of the Faculty of Mining and Geology. So, in front of you is an attempt by a "fan" to remain objective, which can be facilitated to some extent by the fact that he has not been at the helm for more than a year after his retirement and is not directly involved in daily teaching and research activities.

Our Centre is still young and will come of age only in a few years. But the results achieved since its establishment and the efforts made by its members for the further affirmation of our karst school, we believe deserve respect. This publication presets the largest part of those results, which also include realized teaching activities, international scientific and technical cooperation, projects that we initiated or participated in upon invitation, printed publications, organized scientific meetings, acquired and used equipment.

The Centre for Karst Hydrogeology consists of its members who, of course, are actively engaged in this scientific discipline. Although few in number, they successfully realized all the set goals. In addition to the rest, four doctorates were defended, all on the topic of karst hydrogeology, but viewed from different aspects and with the application of different methods. This strengthened not only the scientific structure of the Centre, but also the basis for further expansion and transfer of knowledge in this multidisciplinary discipline.

In addition to working together in high education and on individual projects, members of the Centre have also made a significant contribution to the affirmation of our karst school, recognized and traditionally respected in the international scientific community, as individually engaged consultants in international organizations or companies, or as authors of scientific papers. Each member's result is therefore also a contribution to the work and affirmation of the Centre.

All of the above would not have been possible if friendly relations had not been established and maintained in the Centre, in which there was always active communication, understanding and collegial assistance, from the moment of its foundation until today. But exchange of experiences and regular



ostalim kolegama Departmana za hidrogeologiju i fakulteta, učešće u projektima na nacionalnom, i što još važnije na internacionalnom nivou, izrada monografija, udžbenika, kao i naučnih radova u najznačajnijim časopisima. Tako će se i ispuniti zavet, često pominjan u nauci a posebno od Jovana Cvijića "svi se mi u nauci penjemo jedni drugima na ramena". Proteklih 15 godina jeste kratak period u životu organizacije kojoj želimo dug život i nove uspehe. Prikaz iznet u ovoj publikaciji nadamo se da će korisno poslužiti i njegovim budućim članovima i kolegama, ali i olakšati pisanje budućih hronika.

Zoran Stevanović

consultation are prerequisites for success in every scientific community.

But there is no room for complacency. There are still many tasks and obligations before the members of the Center, if they want to maintain their good reputation and status. Practice shows that in many areas a high position is easier to acquire than to maintain. Important tasks remain in terms of cooperation with other colleagues of the Department of Hydrogeology and the Faculty, participation in projects at the national, and even more importantly at the international level, the creation of monographs, textbooks, as well as scientific papers in the most important journals. This is how the declaration, often mentioned in science and especially by Jovan Cvijić, "we all climb on each other's shoulders in science" will be fulfilled.

The past 15 years is a short period in the life of an organization to which we wish long life and new successes. We hope that material presented in this publication will be useful to its future members and colleagues, as well as facilitate the writing of future chronicles.

Zoran Stevanović

Osnivanje i istorijat Centra za hidrogeologiju karsta

Okolnosti i uslovi formiranja Centra

Osnivanje Centra za hidrogeologiju karsta pri Departmanu za hidrogeologiju Rudarsko-geološkog fakulteta 2008. godine predstavlja značajan iskorak, koji je na neki način formalizovao ranije istraživačke aktivnosti univerzitetskih profesora i asistenata specijalizovanih za istraživanje karsta i njegovih podzemnih voda. Stvaranje ovakvog institucionalnog okvira u zemlji, koja je zahvaljujući radovima Jovana Cvijića i njegovih sledbenika, visoko rangirana u međunarodnom okruženju, otvorilo je nove perspektive za organizovano istraživanje i dalju promociju naše nacionalne škole hidrogeologije i posebno hidrogeologije karsta. Ovaj koncept je od prvog trenutka postavljen kao jedan od osnovnih ciljeva delovanja Centra.

Hidrogeologija karsta usko je vezana za ime Jovana Cvijića, iako se on prvenstveno smatra „ocem moderne karstologije“ (Ford, 2005) i osnivačem naše nacionalne geografske škole. Međutim, Cvijićev rad sa njegovim profesorom Jovanom Žujovićem i prve ekskurzije po karstnim terenima istočne Srbije počevši od 1889. godine (Stevanović, 1997; 2015) učinili su njegove dalje radove usko povezanim sa hidrogeologijom karsta, iako je on u to vreme koristio termin „podzemna hidrografija“. Stoga se, uz Svetolika Radovanovića, autora publikacije „Podzemne vode“, 1897. godine, knjige koju su srpski hidrogeolozi usvojili kao zvaničnu prekretnicu i rođenje nacionalne hidrogeologije, Jovan Cvijić i Jovan Žujović mogu se smatrati osnivačima srpske hidrogeološke škole u drugoj polovini 19. veka (Filipović & Dimitrijević, 1990; Filipović, 1997; Komatina 1997; Stevanović, 2012).

Cvijić je započeo postdiplomske studije geografije na Univerzitetu u Beču 1889, a završio ih 1892. godine odbranom disertacije „Das Karstphaenomen“, čiji je mentor bio čuveni profesor Albrecht Penk. Disertacija, koju je sledeće godine objavila Akademija nauka u Beču, izazvala je veliko interesovanje i pohvale naučnika širom sveta. I sam Cvijić je u svojim autobiografskim beleškama naveo da su ga one veoma ohrabrile i inspirisale da svoja istraživanja sprovede na čitavom Balkanskom poluostrvu, Sredozemlju i Evropi. Posle disertacije njegove dve studije od posebnog značaja, „Pećine i podzemna hidrografija u istočnoj Srbiji“ i „Izvori, tresave i vodopadi u istočnoj Srbiji“, objavila je Srpska kraljevska akademija (1895, 1896). U prvoj Cvijić daje klasifikaciju pećina u istočnoj Srbiji po hidrografskoj funkciji. Detaljni opisi i planovi pećina „iz kojih periodično izviru reke i potoci“, kao i prvi inventar i klasifikacija izvora, takođe su deo ovih studija.

Creation and history of the Centre for Karst Hydrogeology

Circumstances and reasons for creation of the Centre (Background)

Foundation of the Center for Karst Hydrogeology at the Department of Hydrogeology of the Faculty of Mining & Geology is an important step forward, which formalized many previous research activities conducted by the University professors and assistants specialized in research of karst and karst groundwater. Creation of such institutional frame in the country which is internationally well recognized thanks to works of Jovan Cvijić and his followers, opened new prospects for better organized research and further promotion of our national school in hydrogeology and karst hydrogeology. This concept from the very first moment has been set as one of the main goals of the Centre's activities.

The karst hydrogeology is closely linked to the name of Jovan Cvijić even though he has been primary considered as the “father of modern karstology” (Ford, 2005) and the founder of our national geographical school. However, Cvijić's work with his professor Jovan Žujović and first excursions in the karst terrains of eastern Serbia in 1889 (Stevanović, 1997; 2015) made his further works closely related to karst hydrogeology, although at that time he used the term “underground hydrography”. Therefore, along with Svetolik Radovanović, who wrote “Podzemne vode” (“Groundwater”, 1897), a book adopted by Serbian hydrogeologists as an official milestone and birthday of national hydrogeology, Jovan Cvijić and Jovan Žujović can be considered as the founders of the Serbian hydrogeological school in the second half of the 19th century (Filipović & Dimitrijević, 1990; Filipović, 1997; Komatina 1997; Stevanović, 2012).

Cvijić began his postgraduate study of geography at the University of Vienna in 1889 and finished it in 1892 with the dissertation “Das Karstphaenomen”, tutored by Professor Albrecht Penk. His dissertation, published in the following year by the Academy of Sciences in Vienna, aroused the great interest of geoscientists around the world. Cvijić himself mentioned in his autobiographic notes that they greatly encouraged and inspired him to carry out his investigations to the whole of the Balkan Peninsula, the Mediterranean, and Europe. After dissertation, his two studies of particular importance, “Caves and subterranean hydrography in eastern Serbia” and “Springs, peat bogs and waterfalls in eastern Serbia”, were both published by the Serbian Royal Academy (1895, 1896). In the first, Cvijić gives a classification of caves in eastern Serbia according to hydrographic function. Detailed descriptions and plans of caves “from which periodically rivers and streams



Portret Jovana Cvijića, rad Uroša Predića
Jovan Cvijić (by Uroš Predić)

Po povratku u Srbiju imenovan je za profesora geografije na Univerzitetu u Beogradu. Kasnije je kao rektor, član i predsednik Srpske kraljevske akademije dao neprocenjiv doprinos razvoju prosvete i nauke u Srbiji (Mijatović, 1997; Stevanović, 2000, 2012).

Najznačajniji doprinos Cvijić je dao teoriji cirkulacije vode i funkciji karstne izdani (Mijatović, 1989, 1997; Milanović 1979; Stevanović i Mijatović, 2005; Stevanović i Milanović, 2013). Cvijić (1918) je opisao i sopstvenu teoriju superpozicije „hidrografskih zona u karstu“ kao rezultat uticaja hidroloških i klimatskih faktora. Njegova koherentna sinteza uvela je tri glavne super pozicionirane zone u specifičnu dinamičku koegzistenciju. Vertikalna gravitaciona cirkulacija dominira u najgornjem delu, dok dublje zasićene zone karakteriše horizontalna i/ili sifonalna cirkulacija. Cvijić je napomenuo da je trajno spuštanje zasićenog dela u karbonatnim stenama logična posledica dinamičke evolucije karsta.

Nakon njegovih radova mnogi lokalni pojmovi na slovenskim jezicima kao što su polje, doline, uvala, ponor počeli su u svetu široko da se koriste za objašnjenje morfoloških i hidrogeoloških procesa u kršu.

Cvijić je dobio nagrade Kraljevskog geografskog društva iz Londona, Američkog geografskog društva i mnogih drugih akademija, geografskih društava i institucija zemalja među kojima su Čehoslovačka, Švajcarska, Rusija, Italija, Grčka, Nemačka, Poljska, Mađarska, Rumunija.

Cvijićeve radovi omogućili su uspostavljanje jake geomorfološke, ali i hidrogeološke škole u Srbiji. Centar obrazovanja bio je Univerzitet u Beogradu i njegovi fakulteti. Predmeti iz hidrogeologije sa objašnjenjima osnovnih elemenata hidrogeologije

flow out” as well as the first inventory and classification of springs are also part of these studies.

After returning to Serbia, he was appointed professor of geography at the University of Belgrade. Later, as a rector, member and president of the Serbian Royal Academy, he made an invaluable contribution to the development of education and sciences in Serbia (Mijatović, 1997; Stevanović, 2000, 2012).

Cvijić made the most significant contribution to the theory of water circulation and the function of karst aquifer (Mijatović, 1989, 1997; Milanović 1979; Stevanović & Mijatović, 2005; Stevanović & Milanović, 2013). Cvijić (1918) also described his own theory of superposition of “hydrographic zones in karst” because of the influence of hydrologic and climatic factors. His coherent synthesis introduced three main superpositioned zones into a specific dynamic coexistence. Vertical gravity circulation dominates in the uppermost part, while deeper saturated zones are characterized by horizontal and/or ascending circulation. Cvijić mentioned that permanent lowering of the saturated part of the carbonate rocks is a logical consequence of the dynamic evolution of the karst.



Fotografija vodopada na Ljuberadskim vrelima (jugoistočna Srbija) koju je napravio Cvijić (1896)

Photo of waterfall on Ljuberadja spring (southeastern Serbia) made by Cvijić (1896)

After his works many local terms in Slavic languages such as polje, doline, uvala, ponor began to be widely used to explain morphological and hydrogeological processes in karst.

Cvijić received awards from the Royal Geographical Society of London, from the American Geographical Society and many other academies, geographical societies and institutions of countries including Czechoslovakia, Switzerland, Russia, Italy, Greece, Germany, Poland, Hungary, Romania.

karsta prvi put su uvedeni u nastavne planove Rudarsko-geološkog fakulteta (Stepanović, 1962; Milojević, 1967). Njegovi profesori i istraživači su učestvovali u izradi i objavili brojne istraživačke projekte, karte, studije, kao i udžbenike, disertacije i monografije u kojima se razmatra problematika karsta (Filipović, 1997; Stevanović, 2011).

Pedesetih godina prošlog veka, u zemlji su vršena intenzivna i opsežna hidrogeološka istraživanja sa namerom da se što pre nadoknađi ono što je iz bilo kog razloga zapostavljeno u prethodnom periodu: za potrebe vodosnabdevanja, građevinarstva, rudarstva, šumarstva, poljoprivrede, zaštite životne sredine, kao i izrade odgovarajućih hidrogeoloških karata i studija na nacionalnom i regionalnom nivou (za prostorne planove, planove upravljanja vodama). Kasne šezdesete i sedamdesete godine prošlog veka su period kada se na međunarodnoj sceni pojavljuje nova generacija karstnih hidrogeologa. Borivoje Mijatović i Miomir Komatina bili su među osnivačima Komisije za Karst Međunarodne asocijacije hidrogeologa (IAH) kojima se ubrzo pridružio i Petar Milanović (Milanović & Stevanović, 2021). Monografija o Dinarskom karstu u izdanju IAH (Mijatović ur. 1983) pomogla je u širenju znanja i informacija o ovom „klasičnom karstu“ i za hidrogeologe uvek atraktivnom području. „Hidrogeologija karsta“ Petra Milanovića (objavljena 1979. na srpskom i 1981. na engleskom) ubrzo je postala važna referenca koja se bavi problemima distribucije i cirkulacije podzemnih voda u karstu i metodama istraživanja, i postala je prva knjiga te vrste objavljena na engleskom jeziku (Krešić, 2013).

Najznačajniju ulogu u hidrogeološkim istraživanjima tog perioda imao je Geozavod (Geološki zavod Srbije) osnovan u Beogradu posle Drugog svetskog rata kao sledbenik predratnog državnog instituta. Njegovi istraživači dali su značajan doprinos nacionalnoj hidrogeologiji ne samo kroz proučavanje odabranih oblasti, izradu odgovarajućih karata, već i u teorijskom domenu. Karst je nastavio da bude centar interesovanja hidrogeologa, zahvaljujući brojnim projektima koji su uključivali izgradnju velikih i srednjih brana u zemlji i inostranstvu. Izgrađeno je nekoliko ovakvih brana (Hercegovina, Crna Gora) i prvi put su u tako poroznim sredinama kao što je karst postignuti uspešni rezultati u akumulisanju voda. Tehničke mere za kontrolu i regulaciju karstne izdani kroz izgradnju galerija, baterija bunara i rezervoara (akumulacija) podzemnih voda predstavljale su značajan doprinos međunarodnoj hidrogeologiji. Konsultantske usluge i ugovoreni projekti Energoprojekta, Geozavoda, „Jaroslava Černog“, Geosonde, Hidroprojekta, Jugofunda omogućili su rad naših stručnjaka u Egiptu, Tunisu, Libiji, Alžiru, Maroku, Jordanu, Iranu, Iraku, Kipru, Peruu i drugim zemljama (Zogović et al. 1997; Stevanović, 2012; Stevanović i Milanović, 2013).

Kasne 1970-te su period kada stasava nova generacija hidrogeologa u okrilju novoformirane Katedre za



Zlatna medalja koju je Jovan Cvijić dobio od Američkog geografskog društva – Njujork, 1924. „Priznanje za izuzetne naučne rezultate i objavljene radove iz oblasti fizičke geografije Balkanskih zemalja“

Jovan Cvijić's gold medal from the American Geographical Society – New York, 1924 "The recognition obtained for exceptional scientific results and published works in the field of physical geography of Balkan countries"

Cvijić's works enabled the establishment not only a strong karst geomorphology but also hydrogeology school in Serbia. The center of education was the University of Belgrade and its faculties. Hydrogeology courses in with explanation of basic subjects in karst hydrogeology were first introduced into the curricula of the Faculty of Mining and Geology (Stepanović, 1962; Milojević, 1967). Its professors and researchers participated in creating and published many research projects, maps, studies as well as text-books, dissertations and monographs in which karst issues are considered (Filipović, 1997; Stevanović, 2011).

In the 1950s, intensive and extensive hydrogeological investigations were carried out in the country with the intention of compensating as soon as possible what was neglected for any reason in the previous period: for the needs of water supply, civil engineering, mining, forestry, agriculture, environment protection, as well as preparation of appropriate hydrogeological maps and studies at the national and regional levels (for spatial plans, water management plan). The late sixties and 1970s were the period when a new generation of karst hydrogeologists appeared on the international scene. Borivoje Mijatović and Miomir Komatina were among the founders of the Karst Commission of International Association of Hydrogeologists (IAH), who were soon joined by Petar Milanović (Milanović & Stevanović, 2021). The monograph on the Dinaric karst published by IAH (Mijatović ed. 1983) helped to spread the knowledge and information about this "classical karst" as always attractive area for hydrogeologists. "Karst Hydrogeology" by Petar Milanović (published in 1979 in SER; and 1981 in English) soon became not only an important reference dealing with problems of distribution and circulation of karst groundwater and research methods, but also the first book of its kind published in English (Krešić, 2013).

The most significant role in hydrogeological research of that period had the Geozavod (Geological Survey of

hidrogeologiju. Poseban doprinos formiranju i razvoju specijalnih disciplina dao je prof. Budimir Filipović, koji je, kao mentor, usmeravao razvoj naše hidrogeološke škole kroz izradu magistarskih teza i doktorskih disertacija (Stevanović, 2011). Od 1971. godine do danas odbranjen je veći broj doktorskih disertacija na temu snabdevanja podzemnim vodama i hidrogeologije karsta. Među njima je i autor ovog priloga, koji je odbranio doktorsku disertaciju 1987. godine. Krajem te godine doktorirao je i Neven Krešić sa temom iz hidrogeologije karsta. N. Krešić i nakon odlaska u SAD 1991. godine nastavlja saradnju sa našom školom i značajno doprinosi njenoj međunarodnoj afirmaciji i promociji. Nevenova knjiga „Voda u kršu“ (2013) u svom uvodnom delu predstavlja omaž školi koju je završio i u kojoj je radio više od jedne decenije.

Do kraja 20. veka pored brojnih diplomskih, odbranjeno je i nekoliko magistarskih i doktorskih teza (Mihajlo Simić), dok je još nekoliko asistenata takođe završilo doktorske disertacije tokom prve decenije 21. veka (Vesna Ristić, Igor Jemcov, Saša Milanović). Na ovaj način obezbeđeni su uslovi za kontinuitet rada jake škole karstne hidrogeologije u Srbiji.

U periodu koji prethodi osnivanju Centra za hidrogeologiju karsta u Srbiji je projektovano i izvedeno nekoliko uspešnih projekata sa merama kontrole i inženjerskog regulisanja karstnih izdani kroz izgradnju galerija, baterija bunara i rezervoara (akumulacija) podzemnih voda. Autor ovog priloga i nekoliko mlađih kolega radili su kao konsultanti UN ili specijalizovanih stranih kompanija. Njihovi rezultati dobijeni u istraživanju karstnih terena u Iraku, Iranu, Turskoj, Alžiru, Somaliji takođe predstavljaju značajan doprinos hidrogeološkoj nauci o karstu na međunarodnom planu. Takođe je realizovano nekoliko bilateralnih projekata o hidrogeologiji karsta (Slovenija-Srbija) i organizovano nekoliko konferencija i seminara. Među njima je Beograd bio domaćin velike međunarodne konferencije pod pokroviteljstvom IAH i UNESCO-a 2005. godine, posvećene Jovanu Cvijiću i 110-godišnjici njegove doktorske teze „Karst“ objavljene na srpskom jeziku (Stevanović i Milanović, 2013). Ovo je bila i najveća ikada organizovana međunarodna konferencija u našoj zemlji u domenu upravljanja resursima podzemnih voda.

Serbia) established in Belgrade as a state institute after the Second World War. Its researchers have made an important contribution to national hydrogeology not only through the studies of selected areas, practical applications, and provision of maps, but also in the theoretical domain. As karst has always been the center of interest of hydrogeologists, karst investigations have expanded to a larger scale due to numerous projects that included the construction of large and medium-sized dams in the country and abroad. Several such dams were built (Herzegovina, Montenegro) and for the first-time successful results were achieved in such porous media as karst. Technical applications for the control and regulation of karst aquifer through the construction of galleries, batteries of wells, and groundwater reservoirs (storage) represented an important contribution to international hydrogeological science. Consulting services and contracting works of Energoprojekt, Geozavod, „Jaroslav Černi“, Geosonda, Hidroprojekt, Jugofund enabled the work of our experts in Egypt, Tunisia, Libya, Algeria, Morocco, Jordan, Iran, Iraq, Cyprus, Peru and other countries (Zogović et al. 1997; Stevanović, 2012; Stevanović & Milanović, 2013).

The late 1970s is the period when a new generation of hydrogeologists grew up under umbrella of the newly formed Cathedra for Hydrogeology. A special contribution to the formation and development of special disciplines made by prof. Budimir Filipović, who, as a mentor, directed the development of our hydrogeological school through the preparation of master's theses and doctoral dissertations (Stevanović, 2011). From 1971 until today, a large number of doctoral dissertations have been defended on the topic of groundwater supply and karst hydrogeology. Among them is the author of this contribution, who defended his doctoral dissertation on karst topic in 1987. At end of that year Neven Krešić, also completed his doctorate in karst hydrogeology. Even after leaving for the USA in 1991, N. Krešić, continued to cooperate with our school and significantly contributed to its international affirmation and promotion. Neven's book „Water in Karst“ (2013) in its introductory part is a tribute to the school he graduated from and where he worked for more than a decade.

By the end of 20th century, in addition to numerous graduate theses, several master and doctoral theses were defended (Mihajlo Simić), while several assistants also completed their doctoral theses during the first decade of the 21 century (Vesna Ristić, Igor Jemcov, Saša Milanović). In this way, the continuation of work of a strong school of karst hydrogeology in Serbia are ensured.

During the period preceding the foundation of the Centre for karst hydrogeology in Serbia, several successful projects were designed and implemented in Serbia with technical applications for control and engineering regulation of karst aquifer through the



Grupa učesnika Međunarodne IAH konferencije KARST 2005 ispred spomenika Jovanu Cvijiću u centru Beograda

Group of participants of the IAH international conference KARST 2005 at the monument of Jovan Cvijić in downtown Belgrade

Sve navedene činjenice predstavljaju uvod u formiranje Centra za hidrogeologiju karsta (CKH). Formalni povod vezuje se za povratak dr Petra Milanovića iz jedne od njegovih brojnih poseta Međunarodnom istraživačkom centru za karst iz Guilina, Kina (IRCK - UNESCO Centar 2. kategorije). P. Milanović je preneo poruku kineskih kolega i njihovu želju da kroz formalni bilateralni aranžman ojačaju saradnju sa srpskim karstolozima. Autor ovog priloga, u to vreme ujedno i šef Departmana za hidrogeologiju, zajedno je sa asistentom Sašom Milanovićem pripremio predlog za osnivanje Centra, koji je prihvaćen na sednici Naučno-nastavnog veća 6. novembra 2008. godine.

U obrazloženju se navodi da je „glavni cilj CHK istraživanje, praćenje i zaštita podzemnih voda u karstu kroz inovativne metode istraživanja... U skladu sa članom 50 Statuta Rudarsko-geološkog fakulteta, osnovna svrha CHK je promovisanje naučnih i tehničkih disciplina, kao što je i hidrogeologija karsta. Takođe, unapređenje obrazovne, naučne, komercijalne i tehničke saradnje CHK sa domaćim i stranim institucijama koje se bave ovim ili sličnim problemima je još jedan od zadataka Centra.”

U trenutku osnivanja, u Centru su radili Zoran Stevanović, Saša Milanović i Vesna Ristić Vakanjac, a ubrzo im se pridružio i Branislav Petrović, stipendista Ministarstva nauke i tehnologije. Tokom 2009. godine tim je pojačala Ljiljana Vasić, u to vreme tehnički sekretar Departmana, ujedno i doktorand. U narednim godinama članovi CHK postaju i istraživači koje finansira Ministarstvo prosvete, nauke i tehnološkog razvoja - Veljko Marinović 2014, a Petar Vojnović 2021. godine. Obojica i dalje aktivno rade u CHK, dok je Marina Čokorilo provela nekoliko godina kao aktivna članica pre nego što je dobila novu priliku za zaposlenje. Imajući u vidu ambiciozne planove, uključujući međunarodnu saradnju i projekte, upućen

construction of galleries, batteries of wells, and groundwater reservoirs (storage). The author of this contribution and several younger colleagues worked as consultants for the UN or specialized foreign companies. Their results obtained in the research of karstic terrains in Iraq, Iran, Turkey, Algeria, Somalia also represent an important contribution to the international karst hydrogeology science. Several bilateral projects on karst hydrogeology (Slovenia-Serbia) were also accomplished and several conferences and seminars were organized. Among them, Belgrade hosted a large international conference sponsored by IAH and UNESCO in 2005, dedicated to Jovan Cvijić and 110th anniversary of his doctoral thesis "Karst" published in SER (Stevanović and Milanović, 2013). This was also the largest international conference ever organized in our country regarding the management of groundwater resources.

All the mentioned facts are an introduction to the formation of the Centre for Karst Hydrogeology (CKH). The formal occasion is related to the return of Dr Petar Milanović from one of his numerous visits to the International Research Centre for Karst from Guilin, China (IRCK – UNESCO Centre of 2nd Category). Petar Milanović conveyed the message of his Chinese colleagues and their desire to strengthen cooperation with Serbian karstologists through a formal bilateral arrangement. Following that idea, the author of this contribution, at that time also the Head of the Department of Hydrogeology, together with his assistant Saša Milanović prepared a proposal for the establishment of the Center, which was accepted at the session of the Department on November 6, 2008.

In justification document it is mentioned that “the main goal of CKH is research, monitoring and protection of karst groundwater through innovative research methods in karst... In accordance with Article 50 of the Statute of the Faculty of Mining & Geology, the main purpose of CKH is to promote scientific and technical disciplines, such as karst hydrogeology. Also, improving the educational, scientific, commercial and technical cooperation of CKH with domestic and foreign institutions dealing with these or similar problems is another of the tasks of the Center.”

At the time of its establishment, the core staff of the Center included Zoran Stevanović, Saša Milanović and Vesna Ristić Vakanjac, and they were soon joined by Branislav Petrović, a scholarship recipient of the Ministry of Science and Technology. During 2009, the team was strengthened by Ljiljana Vasić, at the time the secretary of the Department and at the same time a PhD student. In the following years, CKH members also become researchers funded by the Ministry of Education, Science and Technology Development - Veljko Marinović in 2014, and Peter Vojnović in 2021. Both are still active in CKH, while Marina Čokorilo also spent several years as an active member before getting a new job opportunity. In view of the ambitious plans,

je poziv grupi međunarodno priznatih naučnika i stručnjaka iz oblasti karsta, uglavnom iz jugoistočne Evrope (svaki predstavlja jednu državu) da postanu „Prijatelji CHK“. Svi su sa zadovoljstvom prihvatili ovaj poziv.

Jačanje Centra u prvih nekoliko godina bio je težak zadatak. Obaveze uspostavljanja odgovarajuće operativne osnove CKH, morale su da rade samo dve osobe – Saša i Zoran. Međutim, učešće u nekim međunarodnim projektima koje je finansirala Evropska unija rezultiralo je mogućnošću nabavke osnovne opreme za istraživanje i monitoring podzemnih voda, dobijanja licence za GIS softver i pokrivanja troškova nekih međunarodnih putovanja. Dok su Zoran kao vođa tima i Saša učestvovali u SUDEHSTRA projektu (Održivi razvoj mađarsko-srpske prekogranične izdani), u projektu CCWaterS (Klimatske promene i vodosnabdevanje) Zoranu i Saši pridružile su se Vesna i Ljiljana.

Jedan od prvih zadataka bila je i izrada veb sajta, koju su Saša i Ljilja uspešno izvršili. U kasnijim godinama održavanje veb stranice preuzeo je Veljko (<http://www.karst.edu.rs>).



Zoran i Saša prilikom hidrometrijskih merenja reke Mlave
Saša and Zoran during hydrometry of the Mlava River

Tokom 15 godina rada CHK četiri člana su uspešno odbranila doktorske disertacije, svi pod Zoranovim mentorstvom – Saša (2010), Ljiljana (2017), Branislav (2020) i Veljko (2023). Time je ojačana ne samo naučna struktura Centra, već je uspostavljena osnova za dalje širenje i prenošenje znanja iz hidrogeologije karsta. Prenosenje znanja kao jedan od glavnih zadataka CHK na najbolji način se ostvaruje kroz organizovanje međunarodnog kursa „Karakterizacija i inženjering karstnih izdani“, od 2014. godine.

Ovde se zaustavljamo jer su dostignuća i uspesi CHK predstavljeni u narednim poglavljima ove jubilarne publikacije. Da zaključimo, osnivanje specijalizovane organizacije za hidrogeologiju karsta logičan je nastavak solidne platforme koju su kreirale prethodne generacije istraživača. Mi, akteri i svedoci rođenja i

including international cooperation and projects, an invitation was sent to a group of internationally recognized scientists and experts in the field of karst, mostly from SE Europe (each represents one country) to become “Friends of the CKH”. Everyone accepted this invitation with pleasure.

Work and strengthening the Center in the first few years was a difficult task. Only two persons – Saša and Zoran had to do the duties of establishing the appropriate operational basis of CKH. However, participation in some international projects financed by the European Union resulted in the possibility of acquiring basic equipment for groundwater research and monitoring, obtaining a license for GIS software and covering the costs of some international trips. While Zoran as team leader and Saša participated in the SUDEHSTRA project (Sustainable Development of Hungarian-Serbian Transboundary Aquifer), in the project CCWaterS (Climate Changes and Water Supply) Zoran and Saša were joined by Vesna and Ljiljana.

One of first tasks was the creation of a website, which Saša and Ljilja successfully completed by. In later years, the maintenance of the website was taken over by Veljko (<http://www.karst.edu.rs>).

During the 15 years of works at CKH, four members successfully defended their PhD theses, all under Zoran’ mentorship – Saša (2010), Ljiljana (2017), Branislav (2020), and Veljko (2023). This not only strengthened the scientific structure of the Centre, but also established the basis for further expansion and transfer of knowledge in karst hydrogeology. Transferring knowledge as one of major tasks of the CKH is best achieved through the organization of the international course “Characterization and Engineering of Karst Aquifers”, since 2014.

We should stop here because the achievements and successes of CKH are presented in the following chapters of this jubilee publication. To conclude, the establishment of a specialized organization for karst hydrogeology is a logical continuation of the solid platform created by previous generations of researchers. We, the actors and witnesses of the birth and first steps of CKH, keep in our memory these days, similar to how parents well remember the first steps of their children. Let’s hope for a long life of the organization we belong to.

prvih koraka CHK, čuvamo u sećanju te dane, slično kao što se roditelji dobro sećaju prvih koraka svoje dece. Nadajmo se i dugom životu organizacije kojoj pripadamo.

Grupa studenata master studija Departmana za hidrogeologiju i eksperata sa DIKTAS projekta u Trebinju
Group of MS students of the Department of Hydrogeology and experts of DIKTAS project in Trebinje



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Naučno istraživačka delatnost Centra za hidrogeologiju karsta

Scientific research activities of the Centre for Karst Hydrogeology

Domaći i međunarodni projekti

Od osnivanja Centra za hidrogeologiju karsta do danas, odnosno u poslednjih 15 godina rada centra, njegovi članovi su učestvovali ili vodili veliki broj naučnih, istraživačkih i komercijalnih projekata. Naučno istraživački istorijat centra se može podeliti i prikazati generalno kroz tri celine. Prva celina se odnosi na rad centra i njegovih članova u domenu tzv. komercijalnih naučno istraživačkih projekata (saradnja sa privredom), kako u Srbiji i regionu, tako i u inostranstvu. Druga celina su projekti koji su finansirani od strane državnih institucija i definišu se kao projekti od nacionalnog značaja. Treća grupa projekata se odnosi na međunarodne naučne projekte finansirane od strane relevantnih institucija i fondova, kao što su projekti finansirani od strane EU ili projekti UN-a.

Saradnja sa privredom

Jedan od veoma važnih aspekata razvoja Centra za hidrogeologiju karsta je saradnja sa privredom, odnosno vođenje i učestvovanje na komercijalnim projektima kako u Srbiji i regionu, tako i širom sveta. Tokom prethodnih 15 godina, članovi centra su učestvovali na izvođenju preko 150 projekata, studija i elaborata koji su se u najvećoj meri bavili: hidrogeološkim istraživanjima karstnih podzemnih voda, vodosnabdevanjem podzemnim vodama (istraživanja i zahvati), istraživanjima za potrebe izrade ili sanacije hidrotehničkih objekata u karstu, projektovanjem i izradom hidrogeoloških objekata (bušotina, bunara i kaptaza), specijalističkim speleološkim i speleoronilačkim istraživanjima karstne podzemne morfologije, monitoringom podzemnih voda i izradom baze podataka, primenom GIS-a u hidrogeologiji, problemima u rudničkoj hidrogeologiji karsta, kao i menadžmentom karstnih izdani i zaštitom podzemnih voda u karstu. Iako je spisak projekata na kojima su učestvovali članovi CHK znatno veći, ovde je dat prikaz samo nekih od najbitnijih projekata u zemlji i inostranstvu od osnivanja centra.

Istraživanja za potrebe određivanja stepena karstifikacije ispod tela brane Ourkis u Alžiru

Hidrogeološka istraživanja za potrebe sanacije proviranja podzemnih voda ispod tela brane Višegrad

Hidrogeološka istraživanja za potrebe izrade Gornjih horizonata hidrosistema Trebišnjica

Specijalna hidrogeološka istraživanja za potrebe definisanja procurivanja iz akumulacije Bileća

National and international projects

The CKH members have participated in or managed many scientific, research and commercial projects in the last 15 years, since CKH was founded. The scientific research history of the CKH can be divided and presented generally into three groups. The first group refers to the work of the CKH's members in commercial scientific research projects both in Serbia and the region and abroad. The projects, which are financed by government institutions and defined as projects of national importance belong to the second group. The third group of projects refers to international scientific projects financed by relevant institutions and funds, such as projects financed by the EU or UN.

Commercial projects

One of the very important aspects of the CKH development is leading and participating in commercial projects both in Serbia and the region, and around the world. Over the past 15 years, the CKH' members have participated in the implementation of more than 150 projects and studies, which were mostly concerned with: hydrogeological research of karst groundwater, groundwater supply (research and tapping), research for the construction or rehabilitation of hydrotechnical facilities in karst, design and construction of hydrogeological facilities (boreholes, wells and tapping structures), special speleological and caving research of karst underground morphology, groundwater monitoring and database creation, application of GIS in hydrogeology, problems in karst mining hydrogeology as well as karst aquifer management, karst groundwater protection, groundwater management etc. Although the list of projects in which CHK members participated is much larger, only some of the most important projects in the country and abroad since the establishment of the center are listed hereafter.

Research to determine the karstification degree under the Ourkis dam in Algeria

Hydrogeological research for the remediation of groundwater seepage under the Višegrad dam

Hydrogeological research for the construction of the Upper horizons of the Trebišnjica hydrosystem

Special hydrogeological research for defining leakage from the Bileća reservoir

Hydrogeological research for defining the possible expansion of the tailings pond in the highly karstified limestones of the Antamina mine, Peru

Study of hydrogeological and special research for the needs of sustainable use of groundwater in the villages

Hidrogeološka istraživanja za potrebe definisanja mogućeg proširenja jalovišta u veoma karstifikovanim krečnjacima rudnika Antamina, Peru



Hidrogeološka i speleološka istraživanja visokih Anda (Peru) >4500 m nm

Hydrogeological and speleological investigations of high Andes (Peru) >4500 m asl

Studija hidrogeoloških i specijalnih istraživanja za potrebe održivog korišćenja podzemnih voda u selima opštine Žagubica sa autonomnim vodovodnim sistemima

Izrada Studije uticaja izgradnje akumulacije Komarnica, Crna Gora

Projekat istraživanja uranijuma "Dornod" i "Dornogovi" u Mongoliji

Hidrogeološka istraživanja za potrebe definisanja geneze cirkulacije podzemnih voda Istočnog jalovišta i oblasti Tukuš - Antamina, Peru

Projekat detaljnih hidrogeoloških istraživanja karstnog izvorišta Seljašnica (Opština Prijepolje) za ocenu podzemnih vodnih resursa i definisanja zona sanitarne zaštite



Opit trasiranja na platou Babine u sklopu istraživanja karstnog izvorišta Seljašnica

Tracer test at the Babine Plateau during hydrogeological investigation of karst spring Seljašnica

Projekat detaljnih hidrogeoloških istraživanja karstnih izvorišta Čelice i Bjeličkovica (Opština Priboj) za ocenu podzemnih vodnih resursa i definisanja zona sanitarne zaštite

of the municipality of Žagubica with autonomous water supply systems

Study of the impact of the Komarnica reservoir construction, Montenegro

Project of Uranium Exploration "Dornod" and "Dornogovi" u Mongoliji

Hydrogeological research for defining the genesis of groundwater circulation in the Eastern Tailings and the area of Tukuš - Antamina, Peru

Project of detailed hydrogeological investigation of Seljašnica (Prijepolje municipality) karst groundwater source for the assessment of groundwater resources and the definition of sanitary protection zones



Terenska istraživanja - Izrada Studije uticaja izgradnje akumulacije Komarnica, Crna Gora

Field work for - Study of the impact of the Komarnica reservoir construction, Montenegro



Istraživanja uranijuma u Mongoliji - Projekat "Dornod" i "Dornogovi"

Uranium Exploration "Dornod" and "Dornogovi" u Mongoliji
Project of detailed hydrogeological investigation of Čelice and Bjeličkovica (Priboj municipality) karst groundwater sources for the assessment of groundwater resources and the definition of sanitary protection zones

Project of detailed hydrogeological investigation of Zarudine (Sjenica municipality) karst groundwater source for the assessment of groundwater resources and the definition of sanitary protection zones

Environmental impact assessment study - Bekhme - Mindawa planning reports (Iraq)

Environmental impact assessment study - Khazer - Gomel (Iraq)

Projekat detaljnih hidrogeoloških istraživanja karstnog izvorišta Zarudine (Opština Sjenica) za definisanje zona sanitarne zaštite

Studija ocene uticaja na životnu sredinu - Bekhme – Mindawa (Irak)

Studija ocene uticaja na životnu sredinu Khazer – Gomel (Irak)

Preliminarni izveštaj o raspoloživosti podzemnih vodnih resursa aluvijalnih formacija reke Dunav u Bačkoj (Srbija)

Vodosnabdevanje crnogorskog primorja – izvorište Bolje Sestre (Sliv Skadarskog jezera)

Plan upravljanja slivom Drine - Ocena uticaja klimatskih promena na podzemne vode u slivu Drine u Crnoj Gori

Jačanje kapaciteta za implementaciju Okvirne direktive o vodama u Crnoj Gori – Plan upravljanja Dunavskim i Jadranskim slivom

Jačanje kapaciteta u sektoru voda – Plan upravljanja slivom reke Save u BiH (Hidrogeološka studija)

Monitoring, kontrola i zaštita regionalnog izvorišta „Bolje sestre“ za Crnogorsko primorje

Preliminary report on availability of groundwater resources in alluvial formations of Danube River in Backa region (Serbia)

Water supply of Montenegrin coast – Bolje sestre source (Skadar basin)

West Balkans Drina River Basin Management Project (WBDRB) Task 2. Assessment of climate change impacts on groundwater in Drina River Basin in Montenegro

Strengthening of Capacities for Implementation of the Water Framework Directive in Montenegro – Danube and Adriatic River Basin Management Plans

Capacity Building in Water Sector; River Basin Management Plan for Sava River in B&H (Hydrogeological part)

Monitoring, control, and protection of the regional water supply source “Bolje sestre” for Montenegro Coast



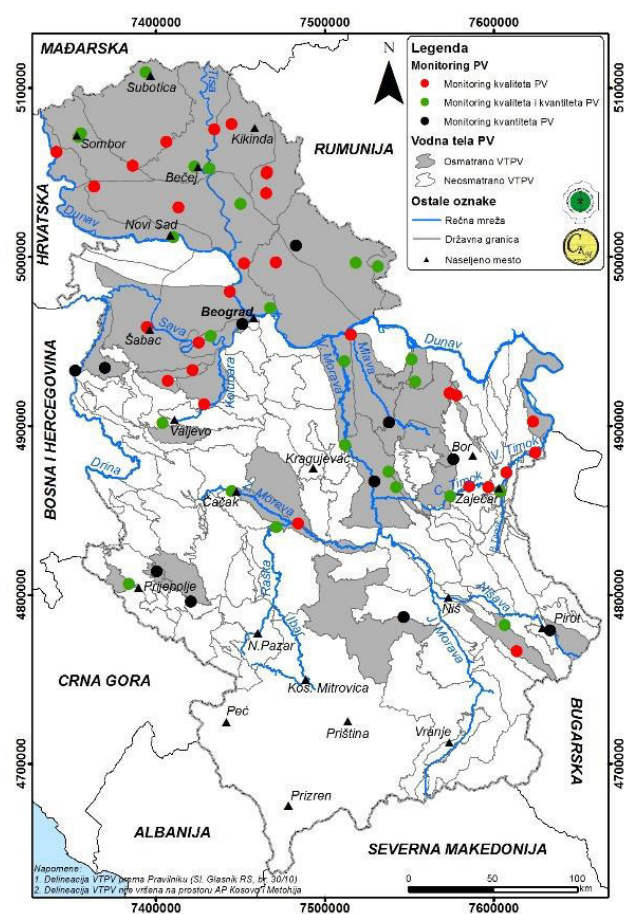
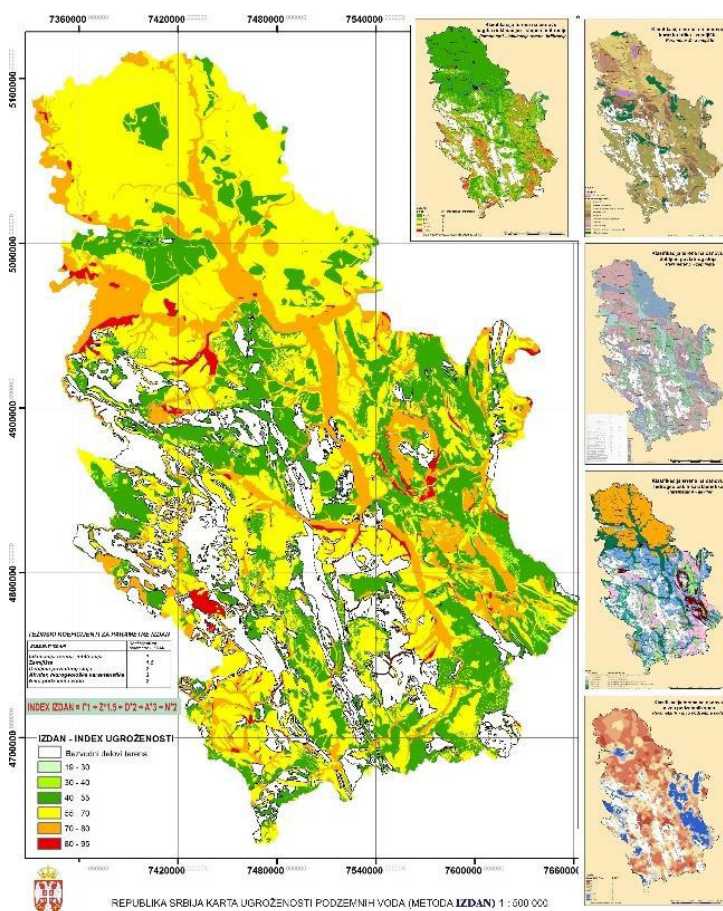
Opit obeležavanja Na-fluoresceinom kolapsa na lokaciji Orah – Bilećka akumulacija
Tracer tests with Na-fluoresceine on the Orah collapse location – Bileća reservoir

Projekti od nacionalnog značaja

Neki od značajnijih naučnih projekta od nacionalnog značaja na kojima su članovi Centra za hidrogeologiju karsta učestvovali i bili vođe projekata i potprojekata su: *Monitoring podzemnih voda Srbije (2007 – 2011)* podržan od strane Ministarstva za ŽS i PP i Direkcije za vode Srbije (u čijem sklopu je urađena i prva Karta ugroženosti podzemnih voda Srbije 1:500.000, metodom IZDAN, čiji su autori upravo članovi CHK), takođe i projekti *Istraživanje, ocena i značaj podzemnih vodnih resursa u konceptu održivog razvoja* - finansiran od strane Ministarstva za nauku i tehnološki razvoj, ON146018 (2008-2010), „*Potencijal i podloge za održivo korišćenje podzemnih voda*“ Min. nauke i prosvete, br 176022, „*Ocena uticaja klimatskih promena na vodne resurse Srbije*“, Min. nauke i prosvete, br 37005, Formiranje nove proširene mreže monitoringa podzemnih voda Srbije i „*Operativni monitoring podzemnih voda Republike Srbije*“ Ministarstvo zaštite životne sredine Republike Srbije (2017-2019).

Projects of national importance

Some of the important scientific projects funded by government bodies, in which CKH's members participated and led are: *Groundwater monitoring in Serbia (2007 - 2011)* supported by the Ministry of Environment and Spatial Planning and the Water Directorate of Serbia (within the first groundwater vulnerability map of Serbia in scale 1:500,000 was created, using the IZDAN method, whose authors are CKH members), and also projects *Research, evaluation and importance of groundwater resources in the concept of sustainable development* - financed by the Ministry of Science and technological development, ON146018 (2008-2010), "Potential and bases for sustainable use of groundwater" Min. of Science and Education, No. 176022, "Evaluation of the Impact of Climate Change on Water Resources in Serbia", Min. science and education, no. 37005, Formation of a new extended network of groundwater monitoring in Serbia and "Operational groundwater monitoring in the Republic of Serbia", Ministry of Environmental Protection of the Republic of Serbia (2017-2019).



Finalna Karta ugroženosti podzemnih voda Srbije prema metodi IZDAN (levo); Lokacije osmatranja podzemnih voda u sklopu projekta Operativni monitoring podzemnih voda Srbije (desno)
Final groundwater vulnerability map of Serbia according to the IZDAN method (left); Groundwater monitoring locations as part of the project "Operational Groundwater Monitoring of in Serbia" (right)

Međunarodni naučni i istraživački projekti

Posebna pažnja od osnivanja centra je fokusirana na učešće članova CHK u međunarodnim naučnim i istraživačkim projektima. Neki od najznačajnijih i najbitnijih projekata međunarodnog karaktera poslednjih 15 godina su:

Sustainable development of Hungarian – Serbian transboundary aquifer (SUDEHSTRA) - Cross-border cooperation programmes ERDF / Interreg IIIa (Community Initiative) and CARDS, finansiran od strane European Agency for Reconstruction (EAR)- 2007 – 2008



*Učesnici međugraničnog projekta na radionici na Paliću
Participants on Cross-border cooperation programmes during workshop in Palić*

*Karst and karst waters of Western Balkan - VUSPLAN (2007-2009). Bilateralni projekat Srpske akademije nauka i umetnosti i Bugarske akademije nauka
Climate changes and Impacts on Water Supply CCWaterS, SEE Programme, finansiran od strane EU Delegacije za Srbiju iz sredstava fonda IPA (2009-2012)*

UN FAO projekat SWALIM - Deo projekta za istraživanje podzemnih voda i potrebe vodosnabdevanja severne Somalije. SWALIM, OSRO/SOM/103/CHS, UN FAO (2010-2011 i 2016)

Rehabilitacija i modernizacija navodnjavanje Šida region Kartli, Gruzija, UN FAO (2009)

Preliminarna hidrogeološka ocena odabrane oblasti u Samtse Dzongkhag, Butan FAO NRL Rim u saradnji sa Ministry of Agriculture Royal Government of Bhutan (2011)

DIKTAS – Dinaric karst transboundary aquifer management, UNESCO & GEF (2011-2014)

WOKAM – World karst map, UNESCO, KIT – University of Karlsruhe, Germany and BRG –

Geological Survey of Germany (2012-2017)

COST projektu CA19120: WATSON – Water isotopes in the critical zone: from groundwater recharge to plant transpiration

International scientific and research projects

Since the establishment of the center, a special focus has been directed on the participation of CHK members in international scientific and research projects. Some of the most important international projects in the last 15 years are:

Sustainable development of Hungarian – Serbian transboundary aquifer (SUDEHSTRA) - Cross-border cooperation programmes ERDF / Interreg IIIa (Community Initiative) and CARDS, funded by European Agency for Reconstruction (EAR)- 2007 – 2008

Karst and karst waters of Western Balkan - VUSPLAN (2007-2009). Bilateral project of the Serbian Academy of Sciences and Arts and the Bulgarian Academy of Sciences.

Climate changes and Impacts on Water Supply CCWaterS, SEE Program, financed by the EU Delegation for Serbia from the IPA funds (2009-2012)



*Učesnici na radionici u okviru projekta CCWaterS u
Veloj Luci – Hrvatska
Participants in CCWaterS Project Workshop in Vela Luka
(Croatia)*

UN FAO project SWALIM - Part of a project to investigate the groundwater and water supply needs of northern Somalia. SWALIM, OSRO/SOM/103/CHS, UN FAO (2010-2011 i 2016)

Rehabilitation and modernization of irrigation of Shida Kartli region, Georgia, UN FAO (2009)

Preliminary hydrogeological assessment of selected areas in Samtse Dzongkhag, Bhutan FAO NRL Rome in cooperation with Ministry of Agriculture Royal Government of Bhutan (2011)

DIKTAS – Dinaric karst transboundary aquifer management, UNESCO & GEF (2011-2014)

WOKAM – World karst map, UNESCO, KIT – University of Karlsruhe, Germany and BRG – Geological Survey of Germany (2012-2017)

COST projektu CA19120: WATSON – Water isotopes in the critical zone: from groundwater recharge to plant transpiration

Naučno-tehnička saradnja

Jedan od fokusa rada CHK od formiranja je bio i ostvarivanje i uspostavljanje naučno-tehničke saradnje sa relevantnim svetskim institucijama iz oblasti istraživanja karsta. S tim u vezi, neophodno je istaći uspostavljenju saradnju sa dve renomirane institucije: Međunarodni Istraživački Centar za Karst (International Research Center on Karst – IRCK) iz Guilina, Kina i Institut za nuklearna istraživanja (Institute for Nuclear Research – Atomki) iz Debrecina u Mađarskoj.

Dana 5. decembra 2011. godine, potpisan je Memorandum o razumevanju za naučnu saradnju između Međunarodnog istraživačkog centra za karst pod pokroviteljstvom UNESCO-a iz Guilina, Kina i Centra za hidrogeologiju karsta, Univerziteta u Beogradu. Članovi CHK organizovali su ekskurziju za delegaciju IRCK: iz Trebinja preko Gatačkog polja, Višegrada (brane), ulazak u Srbiju kod Mećavnika - Mokra gora, te preko Zlatibora i Čačka do Beograda. Direktor IRCK-a, Jiang Luchi i dr Cao Jianhua boravili su u Beogradu od 15. do 18. juna, kao gosti CHK-a. Tokom njihovog boravka organizovan je prijem od strane Dekana RGF-a i sastanak tokom kojeg su članovi IRCK-a i CHK-a izlagali svoje aktivnosti i aktuelne projekte i razmatrali mogućnost saradnje na novim, zajedničkim projektima.



Prijem članova IRCK-a na RGF
Reception of the IRCK members at the FMG

Dr Cao je predstavio terensku opremu i uređaje koje je neophodno instalirati na karstnim terenima u Srbiji, radi posmatranja i analize dinamike ciklusa kruženja ugljenika u prirodi i njegovog uticaja na karstni proces. Po ovoj tematici je organizovan terenski obilazak istočne Srbije, terena izabranog za postavljanje ove monitoring opreme. Gosti su imali prilike da obiđu neke od najlepših karstnih izvora istočne Srbije (Mlava, Belosavac, Krupaja, Veliko vrelo), kao i jednu od najvećih uređenih pećina ovog dela Srbije – Resavsku pećinu. Demonstracija i postavljanje

Scientific and technical cooperation

Special focus, since the formation of CHK, has been the achievement and establishment of scientific and technical cooperation with relevant world institutions in the field of karst research. In this regard, it is necessary to emphasize the signed collaborations with two renowned institutions: The International Research Center on Karst (IRCK) from Guilin, China and the Institute for Nuclear Research (ATOMKI) from Debrecen, Hungary.

On December 5, 2011, a Memorandum of Understanding for scientific cooperation was signed between the UNESCO-sponsored International Karst Research Center in Guilin, China and the Centre for Karst Hydrogeology, University of Belgrade. The IRCK director Jiang Yuchi and Dr. Cao Jianhua stayed in Belgrade from June 15 to 18, as guests of CKH. CKH members organized an excursion for the IRCK delegation, leaving Trebinje (B&H) via Gatačko Polje and Višegrad (dam site), entering Serbia near Mećavnik - Mokra Gora, and proceeding via Mt. Zlatibor and the city of Čačak to Belgrade. During their stay, it was organized reception by the Dean of the FMG as well as a meeting, during which members of the IRCK and CKH presented their activities and current projects and discussed the possibility of cooperation on new joint projects.



Terenski obilazak i postavljanje karbonatnih tableta na terenu za analizu dinamike ciklusa kruženja ugljenika u prirodi i njegovog uticaja na karstni proces
Field trip and setting up of carbonate tablets in the ground to analyse the dynamics of the carbon cycle in nature and its impact on the karst process

Dr. Cao presented field equipment and devices that should be installed on karst terrains in Serbia, to observe and analyse the dynamics of the carbon cycle in nature and its impact on the karst process. According to this topic, a field trip of eastern Serbia was organized, the terrain chosen for the installation of this monitoring equipment. Guests had the opportunity to visit some of the most beautiful karst springs in eastern Serbia (Mlava Spring, Belosavac

karbonatnih tableta izvršeno je u srcu planine Beljanice na lokaciji uvale Busovate.



*Zajedničko druženje IRCK i CHK tokom boravka u Srbiji
IRCK and CKH members joint gathering during stay in Serbia*

Iste godine, članovi CHK (S. Milanović i Lj. Vasić), posetili su IRCK tokom i nakon realizacije 6-og međunarodnog kursa. Članovi CHK su imali priliku da obidu laboratorije IRCK-a i budu upoznati sa radom uređaja na utvrđivanju kvalitativnih parametara voda u karstu, kao i sa uređajima za definisanje sadržaja izotopa u vodi i steni. U terenskim obilascima, zajedno sa dr Caom, imali su priliku da obidu IRCK-ove karstne poligone za analiziranje dinamike ciklusa kruženja ugljenika u prirodi. Na osnovu saradnje IRCK-CHK, u laboratorijama IRCK-a urađeno je preko 140 izotopskih analiza ($^2\text{H}/^1\text{H}$, $^{18}\text{O}/^{16}\text{O}$ i $^{13}\text{C}/^{12}\text{C}$) i analiza jonskog sastava u vodama Beljanice, kao i 28 analiza izotopskog sastava matične stene za potrebe disertacije Lj. Vasić.

Tokom 2015. godine je uspostavljena i naučno-tehnička saradnja sa Institutom za nuklearna istraživanja – ATOMKI. Članovi Instituta Atomki boravili su u Srbiji i bili gosti CHK u dva navrata. Prvi terenski obilazak i uzorkovanje velikog broja uzoraka za datiranje i analizu geneze podzemnih voda u karstu izvršeno je tokom 2015. godine, za potrebe izrade doktorske disertacije Lj. Vasić. Tom prilikom uzeto je preko 50 uzoraka ponorskih i izvorskih voda za analizu sadržaja izotopa T, ^{14}C , T+ ^3He i plemenitih gasova. Tokom izrade disertacije, Lj. Vasić je zajedno sa B. Petrovićem i S. Milanovićem imala priliku dva puta da boravi u Institutu ATOMKI, i da se tom prilikom upozna sa tehnikama pripreme uzoraka i uređajima za izradu izotopskih analiza. Saradnja je nastavljena i narednih godina, a u julu 2021. godine, eksperti ATOMKI instituta su posetili Srbiju, odnosno karstne terene istočne Srbije, sa ciljem da izvrše uzorkovanje karstnih voda za njihovo datiranje metodom ^{39}Ar .

Spring, Krupaja Spring, Veliko Vrelo Spring), as well as one of the arranged caves in this part of Serbia - the Resava Cave. The demonstration and installation of carbonate tablets has been performed in the heart of the Beljanica Mountain at the location of the Busovata Ravine.

During the same year, members of CKH (S. Milanovic and Lj. Vasic) visited IRCK during and after the implementation of the 6th international course. CKH members had the opportunity to visit the laboratories of IRCK and get acquainted with the work of devices for determining the qualitative parameters of water in karst and devices for defining the content of isotopes in water and host rock. During the field trips, together with Dr. Cao, they had the opportunity to visit IRCK's karst polygons for analysing the dynamics of the carbon cycle in nature. According to IRCK-CKH cooperation, more than 140 isotopic ($^2\text{H}/^1\text{H}$, $^{18}\text{O}/^{16}\text{O}$ and $^{13}\text{C}/^{12}\text{C}$) and ionic analysis of the Beljanica karst groundwater were performed in the IRCK laboratories, as well as 28 analysis of the host rock isotopic composition for the purposes of the Lj. Vasić dissertation.



*Poseta laboratoriji u IRCK-u 2014 god.(Guilin, Kina)
Visiting laboratory in IRCK 2014 year (Guilin, China)*

During 2015, the scientific and technical cooperation was established with the Institute for Nuclear Research - ATOMKI. Members of the ATOMKI Institute stayed in Serbia and were guests of CKH for two times. The first field visit and sampling of many samples from karst water was carried out in 2015 for the purposes of Lj. Vasic doctoral dissertation. On that occasion, over 50 samples of sinkhole and spring water were taken for analysis of the isotope content of T, ^{14}C , T+ ^3He and noble gases. During the writing of the doctoral dissertation, Lj. Vasic, together with B. Petrovic and S. Milanovic, had the opportunity to stay at the Institute of ATOMKI twice, and got introduced with techniques of sample preparation and devices for making isotopic analyses. The cooperation continued in the following years, and during July 2021, experts from the ATOMKI Institute visited Serbia, that is, the karst terrains of eastern Serbia, with the aim of sampling karst waters for groundwater ageing by the ^{39}Ar isotopic method.



Članovi Instituta ATOMKI i CHK sa uređajem za ekstrakciju argona iz vode (jul, 2021)

Members of the Institute ATOMKI and CKH with a device for extracting argon from water (July 2021)

Upravo Laboratorija - Instituta ATOMKI je jedna od retkih u svetu koja se bavi analizom ovog izotopa, a konstrukcijom specijalnog prenosnog uređaja za ekstrakciju potrebne količine argona iz podzemnih voda, omogućeno je i uzorkovanje uzoraka iz izvora u Srbiji i njihov transport do laboratorije. Upravo ovakav vid uzorkovanja je specifičan i jedinstven u svetu, s toga se sa ponosom može reći da će u okviru ove saradnje Srbija, i CHK, biti jedna od prvih zemalja koja će dobiti dragocene podatke starosti podzemnih voda u karstu u rasponu 60-1000 godina, period koji pokriva upravo izotop ^{39}Ar .



Terenski obilazak Kučajsko-beljaničkog masiva 2015. godine radi uzorkovanja vode za izradu izotopskih analiza i datiranje podzemnih voda

Field trip on the Kučaj-Beljanica Massif in 2015 (water sampling for isotopic analyses and groundwater dating)

Laboratory of the ATOMKI Institute is one of the few in the world that can perform the analysis of this isotope. The construction of a special portable device for extracting the required amount of argon from groundwater, enables the sampling of samples from springs in Serbia and their transport to the laboratory. This type of sampling is specific and unique in the world, so it can be proudly said that within this cooperation, Serbia and CKH will be one of the first countries that will receive valuable data on the groundwater age in karst in the range of 60-1000 years, the period covered by the isotope ^{39}Ar .



Organizovanje i učešće na naučnim skupovima, konferencijama, simpozijumima, kursevima, radionicama, ekskurzijama

Kao i druge slične institucije i centri, a u skladu sa svojim nadležnostima i zadacima, Centar za hidrogeologiju karsta Rudarsko-geološkog fakulteta Univerziteta u Beogradu organizovao je naučne i stručne skupove u svojim prostorijama, kao i u okviru prostorija partnera i ko-organizatora. U okviru svojih zadataka, misija i ciljeva, CHK razvija i podstiče naučni pristup karstu/hidrogeologiji, organizuje i promovise fundamentalna i primenjena naučna istraživanja karsta, stimuliše i promovise istraživače koji rade u karstnim oblastima sveta. Jedan od rezultata ovog načina pristupa je kreiranje i održavanje kursa „Karakterizacija i inženjering karstnih izdani“, koji traje već 10 godina, a više o toj temi može se pročitati u jednom od narednih poglavlja.

Tokom 15 godina postojanja CHK je bio organizator ili ko-organizator više međunarodnih i domaćih naučnih i stručnih skupova.

Stručna ekskurzija u istočnom delu Karpatskog orogenog pojasa

Ekskurziju po istočnoj Srbiji organizovali su članovi Komisije za karst Srpskog geološkog društva (KK SGD) i CHK u periodu od 10. do 11. juna 2013. godine.



Učesnici ekskurzije ispred Velike prerasti na reci Vratna
Participants in front of the Big natural stone bridge at the Vratna River

Međunarodna konferencija „Karst bez granica“

Međunarodna konferencija i terenski seminar „Karst bez granica“ okupio je 155 međunarodnih karstologa, u srcu dinarskog karsta od 11. do 15. juna 2014. godine. Jedan od značajnih rezultata konferencije je monografija pod nazivom „Karst bez granica“ (“Karst without Boundaries”), koju su uredili dr Zoran Stevanović, dr Neven Krešić i dr Neno Kukurić.

Organizing and participating in scientific gatherings, conferences, symposia, courses, workshops, excursions

Like other similar institutions and centres and in keeping with its responsibilities and tasks, the Centre for Karst Hydrogeology (CKH) of the Faculty of Mining & Geology at the University of Belgrade (FMG-UB), has been organizing scientific gatherings and expert meetings on its premises as well as in partners' exhibition and meeting halls. Within the scope of its tasks, mission, and objectives, it develops and stimulates a scientific approach to karst/hydrogeology, organizes and promotes fundamental and applied scientific research of karst, and motivates and encourages researchers who work in the karstic areas of the world. One of the outcomes of this effort is the course “Characterization and Engineering of Karst Aquifers”. More on that subject can be found in following chapters.

Throughout the 15 years of its existence, CKH has been the organizer or co-organizer of several international and national scientific gatherings and expert meetings.

Professional excursion in the eastern part of the Carpathian orogenic belt

A field trip to eastern Serbia was organized by members of the Karst Commission of the Serbian Geological Society (KC SGS) and CKH on June 10 and 11, 2013.



Učesnici ekskurzije iznad klisure reke Zamna
Participants above the Zamna River gorge

The International Conference “Karst Without Boundaries”

The International Conference and Field Seminar “Karst Without Boundaries” gathered 155 international karst scientists, in the heart of the Dinaric karst from June 11 to 15, 2014. One of the important outcomes of the conference is a monograph

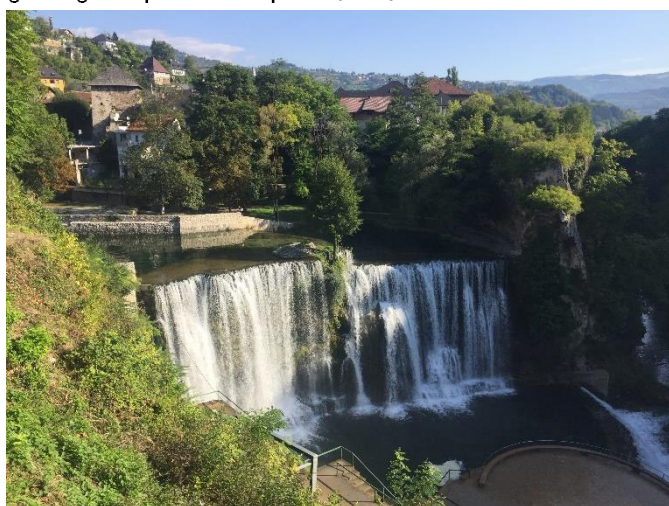


Konferencija „Karst bez granica“
The conference “Karst Without Boundaries”

Stručna ekskurzija u jugoistočnom delu Karpatskog orogenog pojasa

Ekskurziju po jugoistočnoj Srbiji organizovali su članovi Komisije za karst Srpskog Geološkog Društva i CHK u periodu od 15. do 17. maja 2015. godine. Ekskurzija je obuhvatila terene Suve planine, Svrljiških planina, Belave i Stare planine.

Stručna ekskurzija po severozapadnim delovima Bosne i Hercegovine, karstnim terenima u slivu Save
Ekskurzija na području severozapadnih delova BiH i karstnih terena u slivu Save organizovana je u periodu od 14. do 17. septembra 2017. godine. Ekskurziju su organizovali članovi KK SGD, CHK i Udruženja geologa Republike Srpske (BiH).



Vodopad reke Plive, u mestu Jajce
Waterfall on the Pliva River at Jajce

Simpozijum KARST 2018 "Očekujte neočekivano"

Simpozijum Karst 2018 „Očekujte neočekivano“ organizovan je u čast 80. rođendana prof. Dr Petra T. Milanovića, od 06. do 09. juna 2018. godine. Simpozijum je održan u Trebinju i široj okolini. Simpozijumu je prisustvovalo oko 100 učesnika iz 16 zemalja (SAD, Kanada, Rusija, Kina, Turska, Albanija,

entitled “Karst without Boundaries”, the monograph has been edited by Dr. Zoran Stevanović, Dr. Neven Krešić, and Dr. Neno Kukurić.



Učesnici konferencije „Karst bez granica“ ispred pećine Vjetrenica
Participants of the conference “Karst without Boundaries” in front of Vjetrenica Cave

Professional excursion in the southeastern part of the Carpathian orogenic belt

The excursion in south-eastern Serbia was organized by members of the Karst Commission of Serbian Geological Society and CKH from May 15 to 17, 2015. It included touring of the terrains of Mt. Suva Planina, the Svrljig Mountain Range, Mt. Belava, and Mt. Stara Planina



Učesnici ekskurzije ispred vodopada Tupavica
Participants in front of Tupavica waterfall

Professional excursion in NW parts of Bosnia & Herzegovina, karst terrains in the Sava River Basin

A field trip to NW parts of B&H and karst terrains in the Sava River Basin took place from September 14 to 17, 2017. It was organized by members of KC SGS, CKH, and the Association of Geologists of Republika Srpska (B&H).

Mađarska, Austrija, Rumunija, Bugarska, Makedonija, Crna Gora, Hrvatska, Slovenija, Italija, Bosna i Hercegovina i Srbija) i prezentovano je ukupno 47 radova (od strane 150 autora i koautora iz 21 zemlje). Odabrani radovi objavljeni su u Tematskom broju naučnog časopisa Environmental Earth Science - Topical Collection "Sustainable Management of Karst Natural Resources").



Nagrađeni pojedinci i institucije povodom desetogodišnjice CHK
Awarded individuals and institutions on the occasion of the 10th anniversary of CKH

Konferencija "Ka održivom upravljanju resursima podzemnih voda"

Konferenciju Centralnoevropske grupe IAH (CEG) i Geo trip u okviru Karpatskog karsta Srbije i Rumunije pod nazivom „Ka održivom upravljanju resursima podzemnih voda“ organizovali su Međunarodno udruženje hidrogeologa – Nacionalno odeljenje Srbije, SGD i CHK od 14. do 20. juna 2019. godine.



Učesnici konferencije u rudniku soli Ocele Mari
Participants in the salt mine Ocele Mari

Nedelja sa karstom

Konferenciju „Nedelja sa karstom“, kao jednu od brojnih aktivnosti u okviru obeležavanja „Međunarodne godine pećina i karsta“, organizovao je

KARST 2018 "Expect the Unexpected"

The Symposium Karst 2018: "Expect the unexpected" was organized to honor the 80th birthday of Prof. Dr Petar T. Milanović. It took place from June 6 to 9, 2018 in Trebinje and its extended environs. The Symposium was attended by approximately 100 participants from 16 countries (USA, Canada, Russia, China, Turkey, Albania, Hungary, Austria, Romania, Bulgaria, Macedonia, Montenegro, Croatia, Slovenia, Italy, Bosnia & Herzegovina, and Serbia) and 47 papers were presented (150 authors and co-authors from 21 countries). Selected papers have been published in the Topical Collection "Sustainable Management of Karst Natural Resources" of the Environmental Earth Science journal.



Učesnici konferencije na brani Klinje
Participants of the conference at Klinje dam

Conference "Towards Sustainable Management of Groundwater Resources"

A conference of the Central European Group of IAH (CEG) and a geo trip to the Carpathian karst of Serbia and Romania titled "Towards Sustainable Management of Groundwater Resources" was organized by the International Association of Hydrogeologists/National Chapter of Serbia, SGS, and CKH. It took place from June 14 to 20, 2019.

A week with karst

"A week with Karst", one of numerous activities to celebrate the International Year of Caves and Karst, was organized by CKH from June 1 to 7, 2021, with three separate events:

- CEKA 2021, from June 1 to 4, 2021, which took place on the Zoom platform (more on this event can be found in Chapter dedicated to this course).
- A special thematic session "Lecturing by Distinguished Guests" took place on June 5, 2021. The karst experts who presented are Abraham Springer, Attila Kovács, Augusto Auler, Bartolomé Andreo Navaro, Chris Groves, Francesco Fiorillo, Hervé Jourde, Jianhua Cao, John Gunn, Nico Goldscheider and Peter Malik. This thematic session was dedicated

CHK od 1. do 7. juna 2021. godine, kroz tri odvojena događaja, putem Zoom platforme:

a. CEKA 2021, od 1. do 4. juna 2021. godine (više o ovom događaju napisano je u poglavlju o međunarodnom kursu).

b. Posebna tematska sesija "Lecturing by Distinguished Guests" održana je 5. juna 2021. godine, a 11 pozvanih eminentnih stručnjaka za karst održalo je prezentacije: Abraham Springer, Attila Kovács, Augusto Auler, Bartolomé Andreo Navaro, Chris Groves, Francesco Fiorillo, Hervé Jourde, Jianhua Cao, John Gunn, Nico Goldscheider i Peter Malik. Ova tematska sesija bila je posvećena 40 godina rada prof. dr Zorana Stevanovića u hidrogeologiji karsta

c. Virtuelna multidisciplinarna konferencija za istraživače i profesionalce karsta „Karst: Od vrha do dna“ održana 6. juna 2021. godine. Konferenciji je putem on line platforme prisustvovalo 64 učesnika iz celog sveta.

to 40 years of Prof. Dr. Zoran Stevanović's work in the field of karst hydrogeology.

c. Virtual multidisciplinary conference for karst researchers and professionals "Karst: From Top to Bottom", took place online on June 6, 2021. The conference was attended by 64 participants from across the world.



Učesnici virtuelne konferencije „Karst: Od vrha do dna“
Participants of the virtual conference "Karst: From Top to Bottom"

Stručna ekskurzija u dinarskom karstnom području severozapadne Crne Gore

Stručna ekskurzija je održana u čast penzionisanja prof. dr Zorana Stevanovića sa Univerziteta u Beogradu. Ekskurziju su organizovali članovi KK SGD i CHK u periodu od 20. do 22. juna 2021. godine i obuhvatila je sliv reke Tare i Pive i planinu Durmitor.



Učesnici ekskurzije pre raftinga na reci Tari
Participants before rafting on the Tara River

Professional excursion in the Dinaric karst of northwestern Montenegro

This excursion was dedicated to Prof. Dr. Zoran Stevanović and his retirement from the University of Belgrade. The trip was organized by members of KC SGS and CKH and took place from June 20 to 22, 2021. It covered the Tara River and Piva River basins and Mt. Durmitor.



Učesnici kod spomenika posvećenom Jovanu Cvijiću
Participants at monument dedicated to Jovan Cvijić

Međunarodni naučni skup „Čovek i karst“

Međunarodni naučni skup „Čovek i karst“ organizovan je na Siciliji od 12. do 17. septembra 2022. Glavni organizatori bili su C.I.R.S. - Hiblean centar za speleo-hidrogeološka istraživanja, Ragusa i Opština Custonaci, Sicilija, Italija i između ostalih organizacija koje su podržale i učestvovala u ovom događaju je CHK.

International Conference "Man and Karst"

The International Scientific Conference "Man and Karst" was organized in Sicily from September 12 to 17, 2022. The main organizers were C.I.R.S. - Hyblean Center of Speleo-Hydrogeological Research, Ragusa, and the Municipality of Custonaci, Sicily, Italy. CKH was among the other organizations that supported and participated in this event.

Multidisciplinarna konferencija „KARST 2022: Značaj, stanje tehnike i perspektiva korišćenja i zaštite resursa u karstu“

Multidisciplinarna konferencija „Karst 2022: Značaj, stanje i perspektiva korišćenja i zaštite resursa u karstu“ posvećena je Međunarodnoj godini pećina i karsta (IYCK 2021), a održana je 21-22. oktobra 2022. godine. Organizatori su bili Srpska akademija nauka i umetnosti (SANU) - Odbor za kras i speleologiju, Centar za hidrogeologiju karsta Rudarsko-geološkog fakulteta, Geografski fakultet Univerziteta u Beogradu, Geografski institut „Jovan Cvijić“ - SANU i Komisija za karst Srpskog geološkog društva.



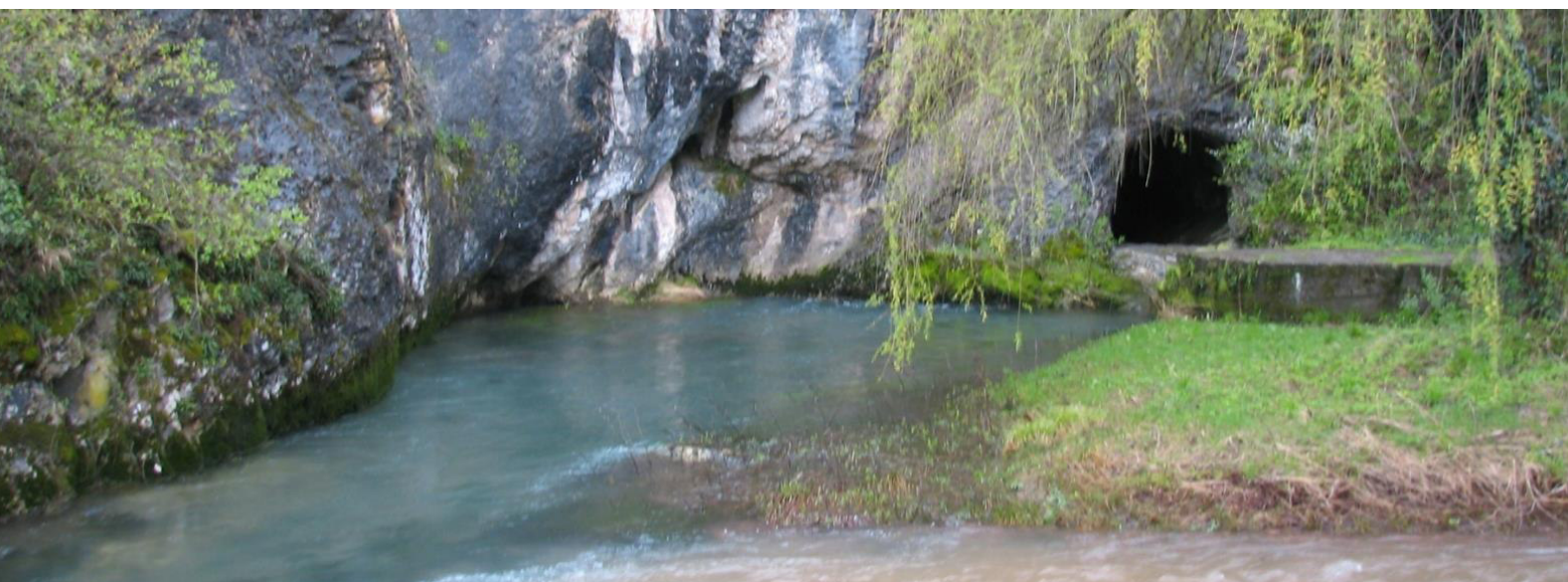
Otvaranje konferencije „KARST 2022: Značaj, stanje tehnike i perspektiva korišćenja i zaštite resursa u karstu“
The opening ceremony of the conference “KARST 2022: Importance, State of the Art, and Prospective of Utilization and Protection of Resources in Karst”

Multidisciplinary conference “KARST 2022: Importance, State of the Art, and Prospective of Utilization and Protection of Resources in Karst”

The multidisciplinary conference „Karst 2022: Importance, State of the Art, and Prospective of Utilisation and Protection of Resources in Karst” was dedicated to IYCK UIS as well and it was held October 21 to 22, 2022. The organizers of the event were the Serbian Academy of Sciences and Arts (SASA) - Board for Karst and Speleology, the Centre for Karst Hydrogeology of the Faculty of Mining and Geology and the Faculty of Geography of the University of Belgrade, Geographical Institute “Jovan Cvijić” of SASA, and the Karst Commission of the Serbian Geological Society.



Učesnici konferencije ispred vodopada Lisine
Participants in front of the Lisine waterfall



Nastavna delatnost Centra za hidrogeologiju karsta

Trenutno su u okviru Centra za hidrogeologiju karsta zaposlena tri profesora koja aktivno učestvuju u održavanju nastave na osnovnim, master i doktorskim studijama. Međutim, pored održavanja nastave na Departmanu za hidrogeologiju, Rudarsko-geološkog fakulteta, Univerziteta u Beogradu, svi članovi CKH aktivno učestvuju i na održavanju predavanja u okviru tradicionalnog kursa o karstu koji se održava u Trebinju, a takođe su i predavači po pozivu na drugim univerzitetima i institutima širom sveta.

Predmet na master studijama "Karakterizacija i inženjering karstnih izdani"

Predmet „Karakterizacija i inženjering karstnih izdani“ uveden je na master studije u okviru akreditacionog ciklusa 2013. godine. Cilj predmeta bio je upoznavanje sa tradicijom istraživanja karstnih terena i prepoznavanja uloge Jovana Cvijića, kao začetnika karstologije. Pohađanjem kursa, studenti treba da ovladaju znanjima iz oblasti istraživanja i korišćenja vode u karstu, da se upoznaju sa praktičnom primenom na karakterizaciji i konceptualnom definisanju karstne izdani radi veštačkog regulisanja režima karstnih podzemnih voda i stvaranja preduslova za njihovo stabilno i pouzdano korišćenje u svrhu snabdevanja vodom stanovništva i industrije.

Sadržaj predmeta obuhvata sledeće oblasti:

- Istorijski razvoj karstologije, uloga Jovana Cvijića.
- Distribucija karstnih terena u svetu i fenomenologija karsta (proces karstifikacije, pojave).
- Metode istraživanja vode u karstu.
- Karakterizacija i konceptualno definisanje cirkulacije vode u karstu, odnos sa drugim izdanima i površinskim vodama.
- Bilansiranje voda u karstu, problem određivanja slivova.
- Specifičnosti režima kvantiteta i kvaliteta karstnih izdanih voda, vodozahvati i objekti regulacije izdani u karstu (izvorišne zone i sliv).
- Uslovi izgradnje i problemi eksploatacije površinskih akumulacija i dr. veštačkih objekata u karstu.
- Osetljivost karstnih izdani na zagađivanje, karte ugroženosti. Mere zaštite voda u karstu i njihova remedijacija.
- Monitoring podzemnih voda – organizacija, obrada podataka i prognoze.
- Optimalni režim korišćenja izdanih voda, problemi nadeksploatacije. Podloge za održivo korišćenje voda u karstu, rizici i konflikt menadžment na lokalnom i/ili međunarodnom nivou.
- Regulacija u aridnim oblastima.

Teaching activities of the Centre for Karst Hydrogeology

The Center for Karst Hydrogeology (CKH) currently employs three professors who actively participate in lecturing of undergraduate, master's and doctoral students. However, in addition to holding classes at the Department of Hydrogeology (DHG), Faculty of Mining and Geology at the University of Belgrade (FMG-UB), all CKH members take active part in teaching as part of a traditional course on karst held in Trebinje, Bosnia and Herzegovina. They are also invited lecturers at other universities and institutes around the world.

Master's course "Characterization and Engineering of Karst Aquifers"

The subject Characterization and Engineering of Karst Aquifers was introduced in the master's study program in 2013, as part of the accreditation cycle. The aim of the course was to familiarize students with the tradition of karst research and recognize the role of Jovan Cvijić, the originator of karstology. By attending the course, students acquire knowledge in the field of investigation and use of water in karst and become familiar with the characterization and conceptual definition of karst aquifers in order to artificially regulate the regime of karst groundwater and create the preconditions for its stable and reliable use for industrial and domestic water supply.

- Evolution of karstology, the role of Jovan Cvijić.
- Distribution of karst terrains in the world and karst phenomenology (karstification process, features).
- Methods of water research in karst.
- Characterization and conceptual definition of water circulation in karst, connection with other aquifers and surface waters.
- Water balancing in karst, the problem of delineating watersheds.
- Specifics of the quantity and quality dynamics of karst spring water, water intakes and regulation structures in karst (spring zones and watersheds).
- Construction conditions and problems associated with the use of surface water reservoirs and other artificial structures in karst.
- Vulnerability of karst aquifers to pollution, vulnerability maps. Water protection measures in karst and remediation.
- Monitoring of groundwater - organization, data processing and forecasts.
- Optimum mode for spring water use, problems of over-exploitation. Fundamentals of sustainable use

- Praktični primeri i svetska iskustva.

Izvođenje teorijske i praktične nastave od samog uvođenja predmeta na master studije studijskog programa Hidrogeologija, RGF-a, sprovodi se kroz realizaciju kursa „Karakterizacija i inženjering karstnih izdani“, o čemu će posebno biti reči u poglavlju o kursu CEKA. Nastava iz ovog kursa je otvorena i za studente drugih fakulteta i inostrane učesnike, u kom se slučaju može sprovoditi paralelno na engleskom i srpskom jeziku. Uspešno izvršene obaveze svih studenata se sertifikuju ESP bodovima. Učesnici u izvođenju dela nastave ili praktičnog rada mogu biti po pozivu i eminentni domaći i inostrani profesori ili stručnjaci.

Učešće članova Centra za hidrogeologiju karsta u komisijama doktorskih disertacija

Od nastanka Centra za hidrogeologiju karsta, na Departmanu za hidrogeologiju, Rudarsko-geološkog fakulteta, Univerziteta u Beogradu, pod mentorstvom prof. dr Zorana Stevanovića (8 disertacija i dva komentorstva) i dr Saše Milanovića (1 komentorstvo), odbranjeno je ukupno 10 doktorskih disertacija na DHG-RGF-u.

- MSc Salahalddin Saeed Ali (2008) Geologija i hidrogeologija Šarazur - Piramagrun basena u oblasti Sulejmanije
- MSc Igor Jemcov (2009) Bilans karstnih izdanih voda i optimizacija rešenja njihovih zahvata na primerima iz Srbije
- MSc Saša Milanović (2010) Formiranje fizičkog modela karstne izdani na primeru Beljanice (istočna Srbija)
- Milan Radulović (2012) Višeparameterska analiza prihranjivanja karstne izdani na primjerima iz sliva Skadarskog jezera
- Brankica Majkić (2013) Starenje bunara u aluvijalnim sredinama različitih stepena oksidnosti
- MSc Bojan Hajdin (2014) Upravljanje resursima podzemnih voda severne Bačke
- Ljiljana Vasić (2017) Geneza i uslovi cirkulacije voda kompleksnih karstnih sistema Kučajsko-beljaničkog masiva
- MSc Momčilo Blagojević (2020) Održivo upravljanje međugraničnim podzemnim vodnim resursima u slivu Cijevne (Crna Gora - Albanija)
- Branislav Petrović (2020) Funkcionisanje i uticaj epikarsta na režim, bilans i kvalitet podzemnih voda istočnog dela karstnog sistema Suve planine
- MSc Veljko Marinović (2023) Regionalna karakterizacija karstnih podzemnih voda dela centralnog Balkana u funkciji njihovog održivog korišćenja i menadžmenta

Pored ovih, članovi Centra učestvovali su u brojnim komisijama na izradi doktorskih disertacija u inostranstvu. Takođe, aktuelno učestvuju kao mentori,

of water in karst, risks, and conflict management at local and/or international levels.

- Regulation in arid areas.
- Practical examples and global experiences.

Since this subject was introduced in the master's program in hydrogeology at FMG, theoretical and practical classes have been part of the course "Characterization and Engineering of Karst Aquifers", which will be discussed separately in detail in the chapter on the CEKA course. Lectures from this course are also open to students from other faculties and foreign participants, in which case it can be conducted in parallel in English and Serbian. Both domestic and international students who successfully complete the course and assignments are eligible for ECTS credits. Eminent national and international professors and experts are invited to take part in lecturing or practical field work.

Members of the Center for Karst Hydrogeology on doctoral dissertation committees

Since CKH of DHG (FMG-UB) was established, ten doctoral dissertations have been defended at DHG-FMG under the supervision of Prof. Dr. Zoran Stevanović (eight dissertation and two co-mentorships) and Dr. Saša Milanović (one co-mentorship).

- Salahalddin Saeed Ali, MSc. (2008): Geology and hydrogeology of the Sharazur - Piramagrun basin in the area of Suleimania
- Igor Jemcov, MSc. (2009): Balance of karst groundwater and optimization of solutions for their catchment using examples from Serbia
- Saša Milanović, MSc. (2010): Creation of a physical model on the example of Beljanica karst aquifer (eastern Serbia)
- Milan Radulović (2012): Multi-parameter analysis of karst aquifer recharge based on examples from the Skadar lake basin
- Brankica Majkic (2013): Water well ageing alluvial sediments of different oxic condition
- Bojan Hajdin, MSc. (2014): Management of groundwater resources in northern Bačka
- Ljiljana Vasić (2017): Genesis and circulation of groundwater of complex karst systems of the Kučaj-Beljanica Massif
- Momčilo Blagojević, MSc. (2020): Sustainable management of transboundary groundwater resources in the Cijevna basin (Montenegro - Albania)
- Branislav Petrović (2020): Functioning and impact of epikarst on the regime, balance and quality of groundwater in the eastern part of the Suva Planina karst system

komentori ili članovi komisije na izradi više doktorskih disertacija kandidata iz Srbije, BiH - Republike Srpske, Crne Gore, Poljske i Togo-a (Afrika).



Odbrana doktorske disertacije kandidata Lj. Vasić (jul 2017)
Defense of the doctoral dissertation of candidate Lj. Vasić (jul 2017)

Posete drugih univerziteta Centru za hidrogeologiju karsta

Od kako je formiran Centar za hidrogeologiju karsta, članovi Centra imali su tu čast da ugoste i budu domaćini velikom broju stručnjaka sa drugih univerziteta u svetu. Još i pre formalnog formiranja Centra u poseti Departmanu za hidrogeologiju RGF boravili su, i održavali predavanja eksperti za hidrogeologiju karsta, od kojih su većina i članovi Komisije za karst IAH. Među njima su Adrian Iurkiewicz i Iancu Oraseanu (Rumunija, 2005), Branka Trček i Metka Petrič (Slovenija, 2006), Yoram Eckstein (USA, 2007), Hans Zojer (Austrija, 2007), Francesco Fiorillo (Italija, 2011), Ognjen Bonacci (2011).

Gosti Centra u junu mesecu 2014. godine bili su predstavnici Međunarodnog Istraživačkog Centra za Karst (International Research Center on Karst – IRCK), Jiang Yuchi, Direktor IRCK-a and dr Cao Jianhua. Između CHK i IRCK je 2011. godine potpisana naučno-tehnička saradnja, stoga je više o ovoj poseti bilo reči u poglavlju Naučno-tehnička saradnja.

U junu 2016. godine, Centru za hidrogeologiju karsta i Rudarsko-geološkom fakultetu u poseti su boravili uvaženi gosti prof. dr Abraham Springer, iz Earth Sciences and Environmental Sustainability, Univerziteta severne Arizone, Flagstaff, i dr Hermann Stadler, viši naučni saradnik, Joanneum Research, Grac – Austrija.

Veliku čast i privilegiju imali su članovi CHK da od 12. do 14. juna 2018. godine budu domaćini svetski priznatim stručnjacima iz oblasti istraživanja karsta – dr Dereku Fordu i dr Petru Milanoviću. Članovi CHK su odlučili da ovom prilikom uvažene goste povedu u obilazak karstnog područja istočne Srbije, koje je poznato po svojim brojnim i atraktivnim površinskim i podzemnim karstnim pojavama, kao i po prelepom prirodi.

Krajem 2021. godine, CHK je posetila prof. dr Olga Meshcheriakova, Zamenik Dekana za vannastavne

- Veljko Marinović, MSc. (2023): Regional characterization of karst groundwater in the central Balkans as a function of their sustainable use and management

In addition, CKH members have served on numerous committees for the preparation and defense of doctoral dissertations around the world. They currently participate as mentors, supervisors or committee members for the preparation of several doctoral dissertations by candidates from Serbia, Bosnia & Herzegovina, Montenegro, Poland, and Togo (Africa).



Odbrana doktorske disertacije kandidata V. Marinovića (April 2023)
Defense of the doctoral dissertation of candidate V. Marinović (April 2023)

Visits of other universities to the Centre for Karst Hydrogeology

Since CKH was established, its members have had the honour of welcoming and hosting a large number of experts from other universities in the world. Even before the formal establishment of the Centre, experts in karst hydrogeology, most of whom are also members of the Commission for Karst IAH, visited the Department of Hydrogeology FMG BU and gave lectures. Among them are Adrian Iurkiewicz and Iancu Oraseanu (Romania, 2005), Branka Trček and Metka Petrič (Slovenia, 2006), Yoram Eckstein (USA, 2007), Hans Zojer (Austria, 2007), Francesco Fiorillo (Italy, 2011), Ognjen Bonacci (2011).

The special CKH guests in June 2014 were representatives of the International Research Centre on Karst - IRCK, Jiang Yuchi, Director of IRCK and Dr. Cao Jianhua. Scientific and technical cooperation was signed in 2011 between CKH and IRCK, so more about this visit was discussed in the chapter Scientific and technical cooperation.

In June 2016, the Centre for Karst Hydrogeology and the Faculty of Mining and Geology were visited by distinguished guests Prof. Dr. Abraham Springer, from the School of Earth Sciences and Environmental

aktivnosti, Geološkog fakulteta, Univerziteta u Permu. Prilikom posete CHK, potpisan je ugovor o saradnji Beogradskog Univerziteta i Univerziteta u Permu. Pored obilaska fakulteta, uvažena gošća je imala priliku da obiđe Beograd, kao i da poseti karstne predele istočne Srbije.



Dr Derek Ford i dr Petar Milanović sa dr Ljiljanom Vasić ispred Krupajskog vrela
Dr. Derek Ford and Dr. Petar Milanović with Dr. Ljiljana Vasić at Krupaja spring

Potpisan sporazum između RGF i Univerziteta u Permu tokom posete Dr Olga Meshcheriakova CHK-u
A cooperation agreement was signed between FMG and University of Perm while Dr Olga Meshcheriakova visiting CKH



Gost CHK u junu mesecu 2022. godine bila je Autumn Singer, Istraživač hidrolog i menadžer laboratorije u Crawford hidrološkoj laboratoriji, Western Kentucky University, SAD, koja je održala predavanje na Departmanu za hidrogeologiju, a potom sa članovima CHK obišla teren istočne Srbije.

Centar je imao priliku da ugosti i prof. dr Barbaru Čenčur Curk, sa Fakulteta za prirodne nauke i tehniku, Univerziteta u Ljubljani, Slovenija, u avgustu 2022. godine, koja je u posetu došla preko razmene u okviru CEPUS programa. Takođe, početkom 2023. godine, uvaženi gost CHK bio je i prof. dr Nikolay Maksimovich sa Državnog nacionalnog istraživačkog Univerziteta u Permu (Rusija).

Sustainability, Northern Arizona University, Flagstaff, and Dr. Hermann Stadler, Senior Research Fellow, from Joanneum Research - Institute for Water, Energy and Sustainability, Water Resources Management, Graz – Austria.

CHK also had the great honor and privilege to host world-renowned experts in the field of karst research, including Derek Ford and Petar Milanović from June 12 to 14, 2018. CHK took these distinguished guests on a tour of karst terrains of eastern Serbia, which is well known for its numerous attractive surface and underground karst features, as well as beautiful nature.

At the end of 2021, CKH was visited by Prof. Dr. Olga Meshcheriakova, Deputy Dean for Extracurricular Activities of the Faculty of Geology, University of Perm. During this visit, a cooperation agreement was signed between the University of Belgrade and the University of Perm. In addition to visiting FMG and the CKH Laboratory, the distinguished guest had an opportunity to tour Belgrade and the karst regions of eastern Serbia.

Autumn Singer, Research Hydrologist and Laboratory Manager at the Crawford Hydrological Laboratory, Western Kentucky University, USA was CKH's guest in June 2022. She gave a lecture at DHG and then visited the karst terrains of eastern Serbia with CKH members.

CHK had the opportunity to host Prof. Dr. Barbara Čenčur Curk from the Faculty of Natural Sciences and Technology, University of Ljubljana, Slovenia in August 2022. Her visit was arranged through an exchange under the CEPUS program. Prof. Dr. Nikolay Maksimovich from Perm State National Research University (Russia) was also a distinguished CKH guest at the beginning of 2023.

Dr Barbara Čenčur Curk na terenu sa članovima CHK pored vrela Belosavac
Dr Barbara Čenčur Curk in filed with CKH members at Belosavac karst spring



Posete članova Centra za hidrogeologiju karsta drugim univerzitetima u svetu

Tokom prethodnih 15 godina, članovi Centra su imali brojne prilike da posete i budu gosti i predavači na velikom broju različitih univerziteta u svetu. Tehnološki Univerzitet u Guilinu (Kina) posetili su S. Milanović i Lj. Vasić 2014. godine u okviru realizacije kursa koji tradicionalno organizuje Međunarodni istraživački centar za karst u Guilinu (International Research Centre on Karst in Guilin - IRCK), i tom prilikom su obišli univerzitetski prostor, sa posebnim osvrtom na univerzitetske laboratorije koje se bave kvalitetom površinskih i podzemnih voda. Pri poseti Univerziteta, dr S. Milanović je održao predavanje, a tokom ove posete Kini, imao je priliku da poseti još jedan Univerzitet u Chongqing-u (South west University), gde je održao studentima predavanje o specifičnim ispitivanjima podzemnih voda i pećinskih kanala u karstu. Mogućnost da posete Kinu i pohađaju kurs imali su i članovi CHK B. Petrović (2015, Naning) i V. Marinović (2016, Guilin), dok je P. Vojnović virtualno pohađao kurs 2022. godine. Prof. dr Z. Stevanović i dr S. Milanović, docent, redovno učestvuju u održavanju nastave na međunarodnom kursu IRCK-a, a za vreme pandemije korona virusa, predavanja su držali *online*. Neophodno je napomenuti da su prilikom pohađanja kursa i završnog ispita u vidu držanja prezentacija o karstu svoje zemlje, sva četiri člana CHK, polaznika kursa, bila nagrađena nagradom "najboljeg polaznika kursa" (excellent trainee).

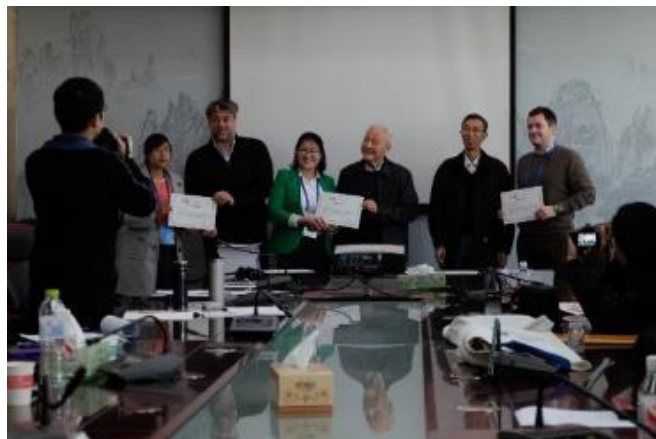


Članovi CHK, prilikom održavanja kursa IRCK 2015
Members of CKH during IRCK course 2015 (levo) and Lj.
Vasić "excellent trainee"

B. Petrović je, preko CEEPUS mreže, posetio Departman za geologiju (primenjena geologija, hidrogeologija), Univerziteta Etvoš Lorand (ELTE), Budimpešta, Mađarska, tokom februara 2016. godine. Bio je uključen u predavanja studentima osnovnih i master studija na predmetu „Hidrogeologija karsta“, kao i u određena terenska geofizička RMT istraživanja u okolini Budimpešte, speleološka istraživanja pećine

Visits by members of the Centre for Karst Hydrogeology to other universities in the world

During the past 15 years, CHK members have had numerous opportunities to visit and be guests and lecturers at a large number of universities around the world. The Technological University in Guilin (China) was visited by S. Milanović and Lj. Vasić in 2014 during the 6th training course traditionally organized by the International Research Centre on Karst in Guilin (IRCK), at which time they toured the university with a special focus on laboratories that deal with the quality of surface water and groundwater. During this visit, Dr. S. Milanović gave a lecture to the students and professors at this University, as well as at another university in Chongqing (South West University), where he lectured students about specific groundwater and cave conduit research in karst. CHK members B. Petrović (2015, Naning) and V. Marinović (2016, Guilin) also had an opportunity to visit China and attend the IRCK course in person, while P. Vojnović followed the course online in 2022. Prof. Dr. Z. Stevanović, and Dr. S. Milanović, assistant professor, regularly participate in classes at the IRCK international course. During the corona virus pandemic, lectures were held online. It is necessary to mention that when attending the course and the final exam in the form of giving presentations about the karst of their country, all four members of the CHK, who attended the course, were awarded the "excellent trainee" award.



Član CHK kao „najbolji polaznik kursa“ IRCK V. Marinović
2016. godine

Member of CKH as "excellent trainee" of IRCK course V.
Marinović 2016

Through the CEEPUS network, Branislav Petrović spent time at the Department of Geology (Applied Geology, Hydrogeology), Eötvös Loránd University (ELTE), Budapest, Hungary as a "short term student" in February 2016. He was involved in lecturing bachelor and master of science students for the subject "Karst Hydrogeology", as well as took part in some geophysical RMT field investigations,

Pavlove doline (Pál-völgyi-barlang) i hidrogeološka istraživanja izvora u pećini Gül Baba (Forrásbarlang).

U poseti Univerzitetu u Bulavaju (National University of Science and Technology – NUST) u Zimbabveu bili su dr S. Milanović i dr Lj. Vasić u julu 2017. godine. Tom prilikom su održali predavanja na Univerzitetu i obišli Viktorijine vodopade, kao i jedan od najinteresantnijih karstnih fenomena Zimbabvea i Afrike – Činoi karst, gde su imali prilike da vide specifičnosti karsta Zimbabeva.



Članovi CHK u poseti NUST-u, Zimbabveu
Members of CKH at NUST, Zimbabwe

Saradnju sa Univerzitetom u Krakovu (Poljska), Univerzitet nauke i tehnologije AGH uspostavila je prof. dr V. Ristić Vakanjac u novembru 2019. godine, kada je držala predavanja studentima osnovnih i master studija. Rezultat ove posete je uspostavljanje odlične saradnje u vidu razmene studenata na kursovima koje organizuju AGH i CHK. Saradnja je nastavljena kroz razmenu nastavnog osoblja, tako da su u novembru 2022. godine članovi CHK bili gosti AGH Univerziteta, gde su imali priliku da razmene iskustva i posete laboratorije Univerziteta. Prof. Ristić Vakanjac trenutno pomaže u izradi doktorske disertacije kandidata sa AGH, za koju je tokom 2022. godine zajedno sa kandidatom u više navrata obilazila teren zapadne Srbije, sa ciljem uzorkovanja podzemnih voda na terenu.

Pored ovih, naučno-stručnih poseta, treba naglasiti i da članovi CHK povremeno obilaze i decu osnovnih škola, koja su ujedno i povremeno bila gosti u CKH na Departmanu za hidrogeologiju, sa ciljem da geologiju i vodne resurse približe učenicima osnovnih razreda, zainteresujući ih time za prirodu koja nas okružuje i njenu zaštitu.

speleological research of the Cave of Paul Valley (Pál-völgyi-barlang), and hydrogeological investigation of the Gül Baba spring (Forrásbarlang).

Dr. S. Milanović and Dr. Lj. Vasić visited the University of Bulawayo (National University of Science and Technology - NUST) in Zimbabwe in July 2017. On that occasion, they gave lectures at the University and visited Victoria Falls, as well as one of the most interesting karst phenomena in Zimbabwe (and Africa), the Chinoy Karst.

Cooperation with the AGH University of Science and Technology from Krakow, Poland was established by Prof. Dr. V. Ristić Vakanjac in November 2019, when she gave lectures to undergraduate and master's students. This visit resulted in excellent collaboration in the form of student exchange on courses organized by AGH and CHK. Cooperation continued through an exchange of teaching staff, so that in November 2022 CHK members were guests of AGH University, where they had the opportunity to exchange experiences and visit the University's laboratories. Prof. Ristić Vakanjac is currently participating in the preparation of an AGH candidate's doctoral dissertation. In 2022, she and the candidate visited the terrains of western Serbia on several occasions with the aim of sampling groundwater in the field.



Članovi CHK tokom boravka u Krakovu, Poljska
Members of CKH in Krakow, Poland

In addition to these scientific and professional visits, it should be emphasized that CHK members occasionally visit children in elementary schools, who also visit CKH at DHG with the aim of bringing geology and water resources closer to elementary school pupils and thus getting them interested in the natural environment and its protection.

Publikacije Centra za hidrogeologiju karsta / Publications of Centre for Karst Hydrogeology

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Terenska oprema CHK

Istraživanja u bušotinama i bunarima

Najbitniji objekti u istraživanju karsta su svakako istražne bušotine i eksploatacioni bunari. Istraživanja koja CHK izvodi na ovim objektima pri terenskim istraživanjima su:

Merenje nivoa podzemnih voda

Centar za hidrogeologiju karsta je opremljen kako mehaničkim meračima nivoa podzemnih voda do dubina 50 m odnosno 100 m, tako i sa digitalnim meračima (diver), kompaktnim instrumentima za kontinuirano i autonomno (praćenje) merenje nivoa podzemnih voda i temperature u podzemnim, površinskim i industrijskim vodama: tipa Eijkelkamp TD-Diver sa opsegom od 100 m i tačnosti merenja od +/-0.05%, te Heron Instruments Inc. dipperLog 128+ (Series 54128) sa opsegom od 60 m i tačnosti merenja +/-0.05%.



dipperLog 128+ sa opsegom merenja do 60 m
dipperLog 128+ with a range of 60 m

Uzorkovanje, testiranje i definisanje karakteristika istražnih i eksploatacionih objekata

CHK je opremljen i najsavremenijim lakim terenskim pumpama za uzorkovanje podzemnih voda iz istražnih bušotina (Baster pumpe tipa „Gigant“). Pumpe su lagane, autonomne sa mogućnošću uzorkovanja voda do 60 m i to iz prečnika bušotina od svega 50 mm.

Pored ovih pumpi, centar poseduje i niz mehaničkih uzorkivača vode, koji služe za česta uzorkovanja iz istražnih bušotina ili bunara sa određenih dubina i to uglavnom za potrebe opita obeležavanja ili uzimanja uzorka vode, kada u isti nije instalirana pumpa.

Interni sistem snimanja bušotina

Današnji sistemi za snimanja u bunarima su napredovali tako da postoje sistemi internog video nadzora i snimanja (koji su razvijeni i u CHK-u) za snimanja do dubina od više stotina metara (pod vodom). Ovakvi sistemi za podvodna snimanja su

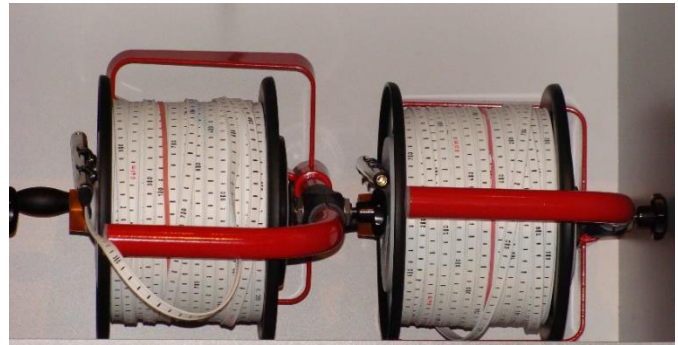
Field equipment

Research in boreholes and wells

The most important objects in karst research are investigation boreholes and exploitation wells. The research that CKH performs on these objects during field research are:

Measurement of groundwater level

The Center for Karst Hydrogeology is equipped with both mechanical groundwater level meters up to 50 m and 100 m deep, as well as digital data loggers (diver), compact groundwater monitoring instrument for the continuous and autonomous measuring of level and temperature in groundwater, surface water, and industrial waters: type Eijkelkamp TD-Diver with a range of 100 m and a measurement accuracy of +/-0.05%, and type Heron Instruments Inc. dipperLog 128+ with a range of 60 m and a measurement accuracy of +/-0.05%.



Nivomeri do 100 m
Water level meters – up to 100 m

Sampling, testing and defining the characteristics of investigative and exploitation objects

The CKH is also equipped with the most modern portable field pumps for sampling groundwater from exploratory wells: Booster pump "Gigant". These are light autonomous pumps with the ability to sample water up to 60 m from wells with a diameter of only 50 mm.

In addition to these pumps, the CKH also has several mechanical samplers that are used for frequent sampling from exploratory wells and from certain depths, mainly for the purposes of tracer tests or taking a water sample, when no pump is installed in it.

uglavnom projektovani za prečnike od 50 mm pa naviše i imaju, pri dobroj vidljivosti, osvetljenje i rezoluciju za snimanje oko 10 m u prečniku, a neki modeli i znatno više. Kompletan tok snimanja karstnog podzemlja se direktno posmatra na površini terena. Jedan od najnaprednijih modela koji poseduje CHK je model video-endoskopske kamere sa rotacionim objektivom.

CHK poseduje: kameru za snimanje istražnih bušotine malih prečnika do 50 mm do dubine od 300 m, 4 vertikalne kamere (prečnika 50-70 mm) visoke rezolucije za snimanje do dubina 300 i 500 m i kameru za rotaciono snimanje do dubine od 300 m.

CHK takođe, poseduje opremu koja je u potpunosti kreirana i izrađena od strane članova centra, a za potrebe uklanjanja prepreka iz bunara. U pitanju je pneumatsko-mehanička hvataljka za podvodne radove u bunarima, bušotinama, akumulacijama do dubina od 100-150 metara. Ovaj uređaj je konstruisan i prvi put uspešno iskorišćen 2014. godine. Pneumatska hvataljka je iskorišćena još nekoliko puta u bunarima prečnika od 140 mm do 300 mm, i do dubine od 100 metara.

Istraživanje i monitoring izdašnosti i proticaja (karstna vrela, izvori, vodotoci)

Pored istraživanja na hidrogeološkim objektima CHK vrši i sva istraživanja i monitoring karstnih vrela, izvora i površinskih vodotokova uopšte. Za potrebe ovih istraživanja CHK poseduje niz različite opreme, a vrši i namensku izradu opreme za potrebe određenih istraživanja (prelivi, letve, sistemi za digitalno osmatranje nivoa itd.).

Merenje izdašnosti vrši se profesionalnim hidrometrijskim krilom tipa SEBA (Seba Hydrometrie Z6) za količine od par desetina do više hiljada l/s. U poslednje vreme CHK praktikuje i ugradnju digitalnih merača protoka (merač protoka Stingray), kao pouzdan i veoma precizan postupak sa korakom merenja protoka od svega par sekundi pa do intervala od nekoliko sati ili dana.

Hidrometrijsko krilo – SEBA

Universal current meter - SEBA



Opit obeležavanja podzemnih voda

Jedna od važnih metoda u ispitivanju podzemnih voda u karstu i njihovih pravaca kretanja, brzina, a samim tim i razvića karstne izdani je obeležavanje ili trasiranje podzemnih tokova. Najčešći obeleživač koji upotrebljavaju stručnjaci CHK-a je Na-fluorescein. CHK poseduje opremu za izvođenje opita (boja,



Uzorkovanje pomoću baster pumpi
Sampling with booster pump

CCTV system for boreholes

Today's recording systems for wells have advanced so that there are internal video surveillance and recording systems (also developed at CKH) for recording at depths of several hundred meters (under water). These types of underwater recording systems are generally designed for diameters of 50 mm and above and have good visibility, lighting and resolution for recording around 10 m in diameter. The complete process is directly observed from the surface. One of the most advanced models that CKH owns is a model of underwater camera for wells with a rotating lens.

The CKH has: a camera for recording exploratory wells with a small diameter of up to 50 mm to a depth of 300 m, 4 vertical cameras (diameter 50-70 mm) with high resolution for recording to depths of 300 and 500 m and a camera with a rotating lens for recording to a depth of 300 m.

Kamera za snimanje istražnih bušotina prečnika od 50 mm do 70 mm, i dubine do 500 m

Camera for recording exploratory wells with diameters from 50 mm to 70 mm, depth to 500 m



CHK also has equipment that was completely designed and made by the members of the CKH, for the purpose of removing obstacles from wells. It is a pneumatic-mechanical gripper for underwater work in wells, boreholes, reservoirs up to a depth of 100-

fluolampa, zaštitna odela, etaloni i ostala prateća oprema).



Opit bojenja procurivanja ispod brane Višegrad (B&H)
Tracer test, Višegrad dam (B&H)

Ispitivanje kvaliteta vode in-situ

CHK je opremljen savremenim uređajima za ispitivanje fizičko-hemijskih parametara vode direktno na terenu. CHK ima prenosne uređaje za merenje: T (°C), pH, Mutnoća (NTU), Elektroprovodljivost ($\mu\text{S}/\text{cm}$), Oksido-Redukcioni potencijal - Eh (mV), Ukupnu tvrdoću (mg/l), Ukupan alkalitet (mg/l), Rastvoreni kiseonik O₂ (mg/l), Kalcijum (Ca²⁺), Hidrokarbonate (HCO₃⁻), Nitrate (NO₃⁻), Gvožđe (Fe), Mangan (Mn), Amonijak (NH₄), Nitrite (NO₂).



Uređaji za ispitivanje fizičko-hemijskih parametara vode na terenu

Devices for measurements of physico-chemical parameters of water in situ

Specijalna istraživanja koja izvodi CHK

Poseban segment CHK-a čine specijalna – speleološka istraživanja (jame i pećine). Drugi vid su podvodna istraživanja i radovi – speleoronilačka istraživanja karstnih vrela, kao i na sva ostala podvodna istraživanja koja su vezana za isticanje ili poniranje vode u karstu, odnosno za podvodna snimanja i pretraživanja u zonama brane ili u akumulacionim jezerima. Treći vid specijalnih istraživanja je korišćenje specijalne opreme za razne tipove istraživanja, kao što su podvodni roboti – ronilice (ROW), pneumatska hvataljka za čišćenje bušotina (o kojoj je bilo reči) itd. Sva topografska snimanja u speleološkom objektu izvode se primenom

150 meters. This device was constructed and successfully used for the first time in 2014. The gripper was used several more times in wells with a diameter from 140 mm to 300 mm, and up to a depth of 100 meters.

Research and monitoring of a spring discharge and flow (karst springs, springs, watercourses)

In addition to research on hydrogeological CKH also conducts all research and monitoring of karst springs, springs and surface watercourses in general. For the needs of these, the CKH owns a number of different equipment, and also carries out purpose-built equipment for the needs of certain research (weir, laths, digital level monitoring systems, etc.).

Measurement of discharge is performed with a professional universal current meter (hydrological impeller) for flow measurement type SEBA (Seba Hydrometrie Z6) for quantities from a few tens to several thousand l/s. Recently, the CKH has been practicing the installation of digital flow meters (the Stingray flow meter) as a reliable and very precise procedure with a step of flow measurement of just a few seconds up to an interval of several hours or days.

Groundwater dye tracing test

One of the important methods in the karst groundwater research and groundwater direction movement and speed, and therefore the development of the karst aquifer, is dye tracing tests of groundwater flow. The most common dye tracer used by CKH experts is Na-fluorescein. In the CKH, there are several kilograms of Na-fluorescein as well as equipment for performing dye tracing experiments (tracer, fluorescent lamp, protective suits, standards and other supporting equipment).

In-situ water quality monitoring

The CKH is equipped with modern devices for testing the physico-chemical parameters of water directly in the field. CKH has devices for measuring: T (°C), pH, Turbidity (NTU), Electrical conductivity ($\mu\text{S}/\text{cm}$), Redox potential Eh (mV), Total hardness (mg/l), Total alkalinity (mg/l), Dissolved oxygen O₂ (mg/l), Calcium (Ca²⁺), Hydrocarbons (HCO₃⁻), Nitrates (NO₃⁻), Iron (Fe), Manganese (Mn), Ammonia (NH₄), Nitrites (NO₂).

Special research conducted by CKH

A special segment of CKH consists of special research and works - speleological investigations (jamas and caves). The second type is underwater research and work - speleodiving, as well as all other underwater research related to the flowing or sinking of water in the karst, that is, to underwater surveys and research in the dam zones or in reservoirs. The third type of

merne trake i geološkog kompasa, a i pomoću elektronskih uređaja, kao što su laserski daljinomeri (npr. Leica DistoTM) (koje poseduje CHK) ili pak digitalnih kompasa i padomera. Koriste se i prenosivi uređaji za merenje sadržaja CO₂, CO, temperature i vlažnosti vazduha, kao i brzine protoka vazduha u zatvorenim prostorijama pomoću sonde.

Speleoronjenje je grana speleologije tj. istraživačka tehnika koja se bavi istraživanjem podzemnih morfoloških oblika u karstu ispunjenih vodom.

Pored speleoronilačkih istraživanja karstnih vreća, istraživači CHK-a se bave i podvodnim radovima u domenu istraživanja akumulacija, reka i jezera. Za potrebe ovakvih istraživanja opremljeni su: sonarima za ispitivanje sa površine, a za podvodna sistemima podvodnih kamera, specijalnih robota - ronilica, reflektora, kao i opremom za podvodna hidrometrijska merenje, uzorkovanja, sondiranja, bojenja itd. Osim toga, u CHK je dizajniran i napravljen podvodni robot-ronilica „ROW HELLENA 2009“, za daljinsko istraživanje karstnih vreća, akumulacija.

special research is the use of special equipment for various types of research, such as underwater robots – divers - ROW, pneumatic gripper for cleaning wells (which was discussed), etc. All topographic surveys in the speleological object are carried out the classical method, using a measuring tape and a geological compass as well as new electronic devices such as laser rangefinders (eg Leica DistoTM) or digital compasses and dip-meters. During cave exploration multifunctional portable device for measuring the content of CO₂, CO, air temperature and humidity, as well as the air flow rate in a closed room.

Speleodiving (cave diving) is a branch of speleology, i.s. a research technique that deals with the investigation of underground morphological forms in karst filled with water.

In addition to speleodiving research of karst springs, CHK researchers are also engaged in work in the field of underwater exploration in reservoirs, rivers and lakes. For such research, they are equipped with sonar for examination from surface and for underwater with underwater camera systems, special robot divers, reflectors, as well as equipment for underwater hydrometric measurements, sampling, sounding, tracing, etc. In addition, the underwater robot-diver "ROW HELLENA 2009" was designed and built at CHK, for remote research of karst springs, reservoirs.



Speleoronilac u karstnom kanalu
SpeleoDiver in karst channel

Članovi Centra za Hidrogeologiju Kasta - CHK

Centar za hidrogeologiju karsta čini nekoliko stalno zaposlenih profesora i honorarnih istraživača i jedan student doktorskih studija. Svi su izabrali karst kao glavnu temu u obrazovanju i istraživanju. Zadaci Centra su istraživanja u različitim oblastima hidrogeologije karsta uz promociju dobijenih rezultata, edukaciju, naučnu, komercijalnu i tehničku saradnju sa sličnim institucijama i organizacijama širom sveta.

Members of The Centre for Karst Hydrogeology - CKH

The Centre for karst hydrogeology consists of several permanent employee professors and part-time researchers and one PhD students. All of them have chosen the karst as their main topic in education and in research. The tasks of the Centre are research in various fields of karst hydrogeology along with promotion of obtained results, education, scientific, commercial and technical cooperation with similar institutions and organizations worldwide.

15 CKH
10 CEKA



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Profesor u penziji, osnivač i bivši rukovodilac Centra za hidrogeologiju karsta na Departmanu za hidrogeologiju Rudarsko-geološkog fakulteta Univerziteta u Beogradu. Bio je mentor dvanaest doktorskih disertacija i član ispitnih komisija za doktorske teze u Novom Sadu, Bukureštu, Frajbergu, Nojšatelu, Erbilu i Sulejmaniji (Irak). Predavač po pozivu na univerzitetima i institucijama u Sloveniji, Nemačkoj, SAD, Iranu, Mađarskoj, Italiji, Kini, Indiji. Konsultant je organizacija UN FAO i UNESCO sa velikim međunarodnim iskustvom u implementaciji projekata hidrogeoloških istraživanja, korišćenja i zaštite podzemnih voda (Severna i Istočna Afrika, Bliski istok, zemlje Balkana). Objavio je 400 radova uključujući 45 u SCI časopisima. Napisao i uredio 19 monografija i četiri udžbenika. Autor i koautor 36 poglavlja u međunarodnim monografijama. U više od 50 svojih radova učestvovali su autori iz 30 različitih zemalja. Broj citata u aprilu 2023. prema Google Scholar-u je 2668 (h-indeks 22), a prema Research Gate-a 1675 (h-indeks 20). Monografije renomiranih izdavača su: Groundwater Hydrology of Springs: Engineering, Theory, Management and Sustainability (Elsevier, 2010), Karst Aquifer Characterization and Engineering (Springer, 2015) and Karst without Boundaries (CRC Press/Balkema, Taylor & Francis, 2016). Bio je predsednik Komisije za karst IAH (2017-2019). Potpredsednik je Odbora za kras i speleologiju Srpske akademije nauka i umetnosti. Bivši predsednik Srpskog geološkog društva (2012-2016). Član je Naučnog društva Srbije i dopisni član Akademije inženjerskih nauka Srbije. Počasni član Mađarskog geološkog društva i član Bugarskog geološkog društva. Dobitnik je Nagrade Srpskog geološkog društva 1991. i 2021. godine. Nagradu „Branislav Milovanović“ dobio je 2004. godine, a Društva „Milutin Milanković“ 2021. godine. Dobio je i nekoliko diploma zahvalnosti stranih univerziteta i istraživačkih centara. (Italija 2009, Kina 2013, SAD 2007, 2015). Godine 2022. dobio je specijalnu nagradu EUROKARST2022 u Malagi, Španija.

Retired Professor, founder and former Head of the Centre for Karst Hydrogeology at the Department of Hydrogeology of the University of Belgrade - Faculty of Mining & Geology, Serbia. He was mentor of twelve doctoral dissertations, and member of examination panels for doctoral theses in Novi Sad, Bucharest, Freiberg, Neuchatel, Erbil and Sulaimani (Iraq). Invited lecturer at the universities and institutions in Slovenia, Germany, USA, Iran, Hungary, Italy, China, India. He is Consultant of the UN organizations FAO and UNESCO with extensive international experience in implementation of projects of hydrogeological exploration, management and protection of groundwater (North and East Africa, Middle East, the Balkans countries). He published 400 papers including 45 in SCI journals. Wrote and edited 19 monographs and four textbooks. Author and co-author of 36 chapters in international monographs. In more than 50 of his papers contributed authors from 30 different countries. The number of citations in April 2023 according to Google Scholar is 2668 (h-index 22), and after Research Gate 1675 (h-index 20). The monographs of renowned publishers are Groundwater Hydrology of Springs: Engineering, Theory, Management and Sustainability (Elsevier, 2010), Karst Aquifer Characterization and Engineering (Springer, 2015) and Karst without Boundaries (CRC Press/Balkema, Taylor & Francis, 2016). He served as Chair of the IAH Karst Commission and is the Co-Chair of the Board on Karst and Speleology of the Serbian Academy of Science and Arts. The Past President of the Serbian Geological Society (2012-2016). He is Member of the Scientific Society of Serbia and Corresponding member of the Academy of Engineering Sciences of Serbia. Honorary member of the Hungarian Geological Society and member of the Bulgarian Geological Society. He was granted by the Award of the Serbian Geological Society in 1991 and in 2021. He received Award "Branislav Milovanović" in 2004, and of the Society "Milutin Milanković" in 2021. He also received a few gratitude diplomas from foreign universities and research centres (Italy 2009, China 2013, USA 2007, 2015). In 2022 received a Special Award EUROKARST2022 in Malaga, Spain.



**Asst. Prof. Saša P. MILANOVIĆ, PhD,
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Saša Milanović ima više od 24 godine inženjersko-geološkog i hidrogeološkog iskustva u projektovanju i realizaciji istraživačkih projekata i studija, pre svega iz oblasti: projektovanja kaptaza, bušotina i bunara; zaštite karstnih PV; istraživanju karstnih izdani; rudničke hidrogeologije karsta; speleoloških i speleoronačkih istraživanja; radova na problematici izgradnje i sanacije brana i akumulacija; 3D modeliranja karstnih izdani, monitoringa i izrade baza podataka podzemnih voda; održivog i ekološki bezbednog korišćenje podzemnih karstnih voda, procene uticaja na životnu sredinu itd. Kao geolog, konsultant i član stručnih odbora učestvovao je u različitim fazama istraživanja, projektovanja i izgradnji brana, akumulacija i tunela i objekata za zahvatanje podzemnih voda u različitim karstnim regionima (Srbija, Bosna i Hercegovina, Hrvatska, Crna Gora, Iran, Turska, Alžir, Somalija, Peru itd.), kao i na više od 120 projekata hidrogeoloških istraživanja, injektiranja, vodosnabdevanja, navodnjavanja i kontrole zagađenja podzemnih voda. U svojoj naučnoj karijeri, do sada je objavio preko 130 naučnih i stručni radovi kako u časopisima sa SCI liste tako i na međunarodnim i domaćim konferencijama. Na brojnim međunarodnim konferencijama je učestvovao kao predavač po pozivu i plenarni predavač. Takođe je član Komisije za karst IAH (Međunarodnog udruženja hidrogeologa) kao i član Odbora za karst i speleologiju SANU (Srpske akademije nauka i umetnosti) i velikog broja stručnih i naučnih tela i organizacija u zemlji i inostranstvu. Kao ekspert UN-a služio je u Somaliji na projektu SWALIM u okviru FAO organizacije UN-a. Kao gostujući profesor i predavač, držao je predavanja i seminare o hidrogeologiji karsta, istraživanju karstnih izdani i inženjerskoj karstologiji na nekoliko univerziteta i vodoprivrednih institucija širom sveta.

Saša Milanović has more than 24 years of karst engineering and hydrogeological experience in designing and implementation of research projects and studies, primarily in the field of: design of tapping structures, boreholes and wells; GW protection; Investigation of karst aquifers; mining hydrogeology; speleological and cave diving investigations; remediation works for reservoirs and dams; supervising of borehole and well drilling, pumping test execution, tracer tests organization; 3D modeling of karst conduits, monitoring and database of ground water; sustainable development of GW sources and environmentally safe groundwater extraction; environmental impact assessment. As geologist, consultant and member of boards of expert participated in various stages of investigation, design and construction of dams, reservoirs and tunnels and tapping structures in different karst regions (Serbia, Bosnia and Herzegovina, Croatia, Montenegro, Iran, Turkey, Algeria, Somalia, Peru etc.), as well as on more than 120 projects of underground excavation, grouting, water supply, irrigation and ground water pollution control, hydrogeology for mining purpose etc. In his scientific career, he has so far published over 130 scientific and professional papers both in journals from the SCI list and at international and domestic conferences. At a number of international conferences served as the invited or key speaker. Also is a member of the Commission for Karst of the IAH (International Association of Hydrogeologists) as well as the member of Board for Karst and Speleology of SASA (Serbian Academy of Sciences and Arts) and many professional bodies and organizations in the country and abroad. As Expert of UN served in Somalia on SWALIM Project under FAO organization of UN. As visiting professor and distinguished lecturer, delivered lectures and seminars on karst hydrogeology, monitoring of karst aquifer and engineering karstology at several universities and water management institutions worldwide.



**Prof. Vesna RISTIĆ Vakanjac, PhD,
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Vesna Ristić Vakanjac ima 35 godina profesionalnog iskustva u oblasti hidrogeologije i hidrologije, hidroloških analiza hidrometeoroloških vremenskih serija, analiza, proračuna, simulacija i prognoza izdašnosti karstnih vrela, primene hidroloških modela u karstu, statističkih metoda u hidrogeologiji, regresije i korelacione analize u hidrogeologiji karsta, analize režima izdašnosti vrela i bilansa podzemnih voda u karstnim terenima. Takođe, oblast interesovanja se odnosi na istraživanja karaktera podzemnih voda u oblastima potencijalnim za eksploataciju urana, kao i primena GIS-a u hidrogeologiji. U okviru svog angažmana na Fakultetu, profesorka Ristić Vakanjac predaje predmete Opšta hidrologija, Primenjena hidrologija sa osnovama vodoprivrede, Terenska nastava iz hidrogeologije, Meliorativna hidrogeologija i Primenjena statistika i verovatnoća u hidrogeologiji. Učestvovala je u mnogim projektima u Srbiji koji se odnose na monitoring voda, vodosnabdevanje i procenu i karakterizaciju resursa podzemnih voda. Takođe od 2006. do 2009. provela je 4 godine u Mongoliji radeći kao ekspert u okviru projekata istraživanja urana. Kao hidrogeolog, upoznata je sa domaćim i međunarodnim standardima i propisima iz oblasti vodne politike i zaštite životne sredine. U svojoj naučnoj karijeri do sada je objavila preko 230 naučnih i stručnih radova kako u časopisima sa SCI liste tako i na međunarodnim i domaćim konferencijama. Takođe je urednik, autor ili koautor više od 10 knjiga i monografija. Član je Međunarodnog udruženja hidrogeologa (IAH), Evropske geološke unije (EGU), Karpato-Balkanske geološke asocijacije (CBGA) kao član nacionalnog komiteta od 2016. godine, Bugarskog geološkog društva (BGS), Srpskog geološkog društva (predsednik Hidrogeološka sekcija od 2012).

Vesna Ristić Vakanjac has 35 years of professional experience in the field of hydrogeology and hydrology, hydrological analyzes of hydrometeorological time series, analyses, calculations, simulations and predictions of karst spring flow, application of hydrological models in karst, statistical methods in hydrogeology, regression and correlation analyses in karst hydrogeology, analyses of karst spring flow regime and balance of groundwater in karst terrains. Also, the area of interest is related to investigations of the character of groundwater in areas potential for uranium mining, as well as applications of GIS in hydrogeology. As a part of her engagement at the Faculty, professor Ristić Vakanjac teaches courses in General Hydrology, Applied hydrology with basics of water management, Field Work in Hydrogeology, Hydrogeology of Irrigation and Applied statistics and probability in hydrogeology. She has been involved in many projects in Serbia related to water monitoring, water supply and estimation and characterization of groundwater resources. Also, from 2006 until 2009 she spent 4 years in Mongolia working as expert in Uranium exploration projects. As a hydrogeologist, she is familiar with local and international standards and regulations in the field of water policy and environmental protection. In her scientific career, she has so far published over 230 scientific and professional papers both in journals from the SCI list and at international and domestic conferences. She is also the editor, author or co-author of more than 10 books and monographs. She is member of International Association of Hydrogeologists (IAH), European geological union (EGU), Carpatto-Balkan Geological Association (CBGA), member of the national committee since 2016, Bulgarian Geological Society (BGS), Serbian Geological Society (President of the Hydrogeology Section since 2012).



**Asst. Prof. Ljiljana M. VASIĆ, PhD,
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Ljiljana Vasić je docent na Departmanu za hidrogeologiju, Rudarsko-geološkog fakulteta, Univerziteta u Beogradu. Šef je Laboratorije Centra za hidrogeološka istraživanja i monitoring podzemnih voda. Tokom svoje 16 godina duge naučno-istraživačke karijere, svoja interesovanja i istraživanja pretežno je usmerila u oblasti hidrohemije, izotopske hidrogeologije, upravljanja vodnim resursima, klimatskih promena i zaštite podzemnih voda. Dugogodišnje iskustvo ima u monitoringu podzemnih voda, kao i u definisanju: geneze, porekla i mehanizama prihranjivanja podzemnih voda; srednjeg vremena zadržavanja vode unutar sistema i starosti podzemnih voda; međupovezanosti površinskih i podzemnih voda i mešanja vode iz različitih vodonosnih slojeva korišćenjem izotopskih i hidrohemijskih obeležja vode. Svoje naučno-stručno usavršavanje ostvarila je učesćem na brojnim međunarodnim kursevima i radionicama (Austrija, Grčka, Hrvatska, B&H, Kina). Kao ekspert za kvalitet podzemnih voda, učestvovala je na velikom međunarodnom projektu Climate change and impact on water supply (CCWaterS), a takođe je i član Management Committee-ja za Rudarsko-geološki fakultet u COST projektu CA19120 pod nazivom: *WATSON – Water isotopes in the critical zone: from groundwater recharge to plant transpiration*. Autor je i koautor je preko 70 radova, od čega je 11 u časopisima sa SCI liste, a takođe je i autor i koautor pet poglavlja objavljenih u istaknutim monografijama domaćeg i međunarodnog značaja. Učestvovala je na velikom broju domaćih i stranih skupova, gde je bila i predavač po pozivu i plenarni predavač. Član je Međunarodne asocijacije hidrogeologa (IAH) i Srpskog geološkog društva.

Ljiljana Vasić is an assistant professor at the Department of Hydrogeology, Faculty of Mining and Geology, University of Belgrade. She is the Head of the Laboratory of the Centre for Karst Hydrogeology and the Head of the Center for Hydrogeological Research and Groundwater Monitoring. During her 16-year long scientific research career, she mainly focused her interests and research in the fields of hydrochemistry, isotopic hydrogeology, water resources management, climate change and groundwater protection. She has many years of experience in groundwater monitoring, as well as in defining: the genesis, origin and mechanisms of groundwater recharge; groundwater mean residence time and groundwater age; interconnections between surface and groundwater and mixture of water from different aquifers using isotopic and hydrochemical characteristics of water. She achieved her scientific and professional skills by participating in numerous international courses and workshops (Austria, Greece, Croatia, B&H, China). As an expert on groundwater quality, she participated in the large international project Climate change and impact on water supply (CCWaterS), and is also a member of the Management Committee for the Faculty of Mining and Geology in the COST project CA19120 entitled: *WATSON – Water isotopes in the critical zone: from groundwater recharge to plant transpiration*. She is the author and co-author of over 70 papers, 11 of which are in journals from SCI list, and also the author and co-author of five chapters published in prominent monographs of national and international importance. She participated in a large number of domestic and foreign conferences, where she was also an invited lecturer and a plenary lecturer. She is a member of the International Association of Hydrogeologists (IAH) and the Serbian Geological Society.



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Dr Branislav Petrović rođen je 27. marta 1981. godine u Kragujevcu. Osnovne akademske studije završava oktobra 2005. godine. Doktorske akademske studije okončava 2020. godine odbranom doktorske disertacije pod nazivom „Funkcionisanje i uticaj epikarsta na režim, bilans i kvalitet podzemnih voda istočnog dela karstnog sistema Suve planine“. Branislav Petrović ima skoro 20 godina inženjersko-geološkog i hidrogeološkog iskustva u projektovanju i realizaciji istraživačkih projekata i studija, pre svega iz oblasti: projektovanja vodozahvatnih objekata; istraživanja karstnih i drugih tipova izdani; zaštite karstnih podzemnih voda; funkcionisanja i uticaja epikarsta na karstnu izdan; organizovanja monitoring mreže podzemnih voda i izrada baza podataka podzemnih voda; procene uticaja na životnu sredinu; održivog i ekološki bezbednog korišćenje podzemnih (karstnih) voda; speleoloških istraživanja; radova na problematici sanacije brana i akumulacija itd. Kao hidrogeolog, konsultant i član projektantskih timova učestvovao je u različitim fazama istraživanja, projektovanja i izrade objekata za zahvatanje podzemnih voda u različitim karstnim regionima (Srbija, Bosna i Hercegovina, Crna Gora), ali i drugih tipova izdani, na više od 20 projekata hidrogeoloških istraživanja, vodosnabdevanja, navodnjavanja, injektiranja i kontrole zagađenja podzemnih voda. U svojoj naučnoj karijeri, do sada je kao autor i koautor objavio 60 naučnih i stručni radovi kako u časopisima sa SCI liste i međunarodnim monografijama (ukupno 9 radova i poglavlja) tako i na međunarodnim i domaćim konferencijama. Član je Srpskog geološkog društva (SGD), kao i Komisije za karst SGD-a, član je IAH (Međunarodnog udruženja hidrogeologa) i „prijatelj“ Komisije za karst IAH. Kao gostujući predavač održao je nekoliko predavanja o hidrogeologiji karsta, istraživanju karstnih izdani i inženjerskoj karstologiji na Univerzitetu „Etvoš Lorand“, Budimpešta, Mađarska (Department of Physical and Applied Geology, Eötvös Loránd University) studentima osnovnih i master studija. Učestvovao je u organizaciji nekoliko međunarodnih naučnih/stručnih skupova, kao član tima i tehnički sekretar.

Dr. Branislav Petrović was born on March 27, 1981 in Kragujevac. He completed his BS/MS studies in October 2005. He completed his doctoral academic studies in 2020 defending doctoral dissertation entitled "The Functioning and Impact of Epikarst on the Regime, Balance and Groundwater Quality of the Eastern Part of the Suva Planina Mountain Karst System". Branislav Petrović has almost 20 years of engineering and hydrogeological experience in the design and implementation of research projects and studies, primarily in the areas of: design of water tapping objects; research of karst and other type of aquifers; protection of karst groundwater; the functioning and influence of the epikarst on the karst aquifer; organization of groundwater monitoring network and creation of groundwater databases; environmental impact assessments; sustainable and ecologically safe use of (karst) groundwater; speleological research; remediation works for reservoirs and dams, etc. As a hydrogeologist, consultant and member of design teams, he participated in various phases of research, design and construction of water tapping objects for groundwater in different karst regions (Serbia, Bosnia and Herzegovina, Montenegro), but also of other types of aquifers, on more than 20 hydrogeological projects for research, water supply, irrigation, injection and groundwater pollution control. In his scientific career, he has so far published 60 scientific and professional papers as an author and co-author, both in journals from the SCI list and international monographs (a total of 9 papers and chapters) and at international and domestic conferences. He is a member of the Serbian Geological Society (SGS), as well as the Commission for Karst of the SGS, a member of the IAH (International Association of Hydrogeologists) and a "friend" of the Karst Commission of the IAH. As a guest lecturer, he gave several lectures on karst hydrogeology, karst research and engineering karstology at the Department of Physical and Applied Geology, Eötvös Loránd University, Budapest, Hungary to undergraduate and master's students. He participated in the organization of several international scientific/expert meetings and conferences, as a team member and technical secretary

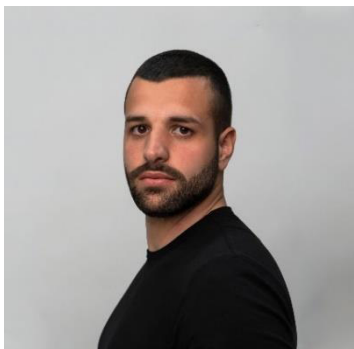


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Dr Veljko Marinović rođen je 29. juna 1990. godine u Beogradu. Osnovne akademske studije završava septembra 2013. godine, a master akademske studije septembra 2014. Doktorske akademske studije okončava 2023. godine odbranom doktorske disertacije pod nazivom „Regionalna karakterizacija karstnih podzemnih voda dela centralnog Balkana u funkciji njihovog održivog korišćenja i menadžmenta“. Dr Veljko Marinović radni odnos započinje 2015. godine u Centru za hidrogeologiju karsta DHG RGF, gde stiče profesionalno iskustvo u istraživačkim projektima i studijama u kojima se najviše bavi istraživanjem podzemnih vodnih resursa karstnih terena Srbije, Crne Gore i Bosne i Hercegovine, menadžmentom podzemnih vodnih resursa, GIS analizama hidrogeoloških podataka, stohastičkim modeliranjem i analizama vremenskih serija isticanja i kvaliteta karstnih voda, zaštitom podzemnih voda, ocenom prirodne ranjivosti, hazarda i rizika podzemnih voda, procenom uticaja klimatskih promena na podzemne vode, ocenom bilansa podzemnih karstnih voda i implementacijom Okvirne direktive o vodama Evropske unije u Srbiji, Crnoj Gori i Bosni i Hercegovini. Dr Veljko Marinović aktivno učestvuje u održavanju nastave na OAS (Metode hidrogeoloških istraživanja, Vodosnabdevanje podzemnim vodama) i MAS (Metodologija naučnog rada, Menadžment podzemnih vodnih resursa i Karakterizacija i inženjering karstnih izdani) Objavio je 59 radova u domaćim i stranim časopisima i monografijama, od čega 6 radova u časopisima sa SCI liste, uz citiranost 36 puta, h-indeks 3, i i10-indeks 1. Učestvovao je na brojnim konferencijama i radionicama u Kini, Španiji, Francuskoj, Austriji, Bugarskoj, Rumuniji, Hrvatskoj, Bosni i Hercegovini. Nagrađivan je nekoliko puta u zemlji i inostranstvu.

Dr. Veljko Marinović was born on June 29, 1990 in Belgrade. He completed his BS studies in September 2013, and his MS studies in September 2014. He completed his doctoral academic studies in 2023 defending doctoral dissertation entitled "Regional Characterization of Karst Groundwater of the Central Balkan Parts in the Function of Their Sustainable Use and Management". Dr. Veljko Marinović started his employment in 2015 at the Center for Karst Hydrogeology DHG FMG, where he gained professional experience in research projects and studies in which he mainly deals with the research of groundwater resources of the karst terrains of Serbia, Montenegro and Bosnia and Herzegovina, management of groundwater resources, GIS analyzes of hydrogeological data, stochastic modeling and time series analyzes of karst water discharge and quality, groundwater protection, assessment of natural vulnerability, hazards and risks of groundwater, assessment of the impact of climate change on groundwater, karst groundwater budget assessment and the implementation of the Framework Directive on waters resources of the European Union in Serbia, Montenegro and Bosnia and Herzegovina. Dr. Veljko Marinović actively participates in teaching at BS (Methods of Hydrogeological Research, Groundwater Utilization in Water Supply) and MS studies (Methodology of Scientific Work, Management of Groundwater Resources and Characterization and Engineering of Karst Aquifers). He has published 59 papers in domestic and international journals and monographs, of which 6 papers in journals from the SCI list, with citations 36 times, h-index 3, and i10-index 1. He participated in numerous conferences and workshops in China, Spain, France, Austria, Bulgaria, Romania, Croatia, Bosnia and Herzegovina. He has been awarded several times in the country and abroad.



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Petar Vojnović rođen je 21. juna 1997. godine u Trebinju, Bosna i Hercegovina. Osnovne akademske studije završava septembra 2020. godine, a master akademske studije septembra 2021. godine, stičući tako titulu master inženjera geologije, iz oblasti hidrogeologije. Doktorske akademske studije upisuje u oktobru 2021. godine. Radni odnos započinje 2022. godine u Centru za hidrogeologiju karsta (CHK), Departmana za hidrogeologiju Rudarsko-geološkog fakulteta, gde trenutno ima zvanje istraživača pripravnika. Posebno polje interesovanja pokazuje prema istraživanju podzemnih vodnih resursa karstnih terena Istočne Hercegovine i Srbije. Bavi se i menadžmentom podzemnih vodnih resursa, GIS analizama hidrogeoloških podataka, kvalitetom karstnih voda, zaštitom podzemnih voda, ocenom prirodne ranjivosti, hazarda i rizika podzemnih voda, ocenom bilansa podzemnih karstnih voda, kao i projektovanjem istražnih bušotina i eksploatacionih bunara. Petar aktivno učestvuje u održavanju nastave na OAS (Istražno bušenje u hidrogeologiji, Izrada bunara) i MAS (Metodologija naučnog rada, Menadžment podzemnih vodnih resursa i Karakterizacija i inženjering karstnih izdani). Do sada je objavio 5 radova u različitim časopisima i zbornicima. Učestvovao je na nekoliko domaćih i stranih konferencija i radionica. Nagrađivan je nekoliko puta u zemlji i inostranstvu.

Petar Vojnović was born on June 21, 1997, in Trebinje, Bosnia and Herzegovina. He completed his BS studies in September 2020, and his MS studies in September 2021., thus gaining the title master's degrees in Hydrogeological Engineering. He enrolled his PhD studies in October 2021. Petar started his employment in 2022 at the Centre for Karst Hydrogeology (CKH), Department of Hydrogeology, Faculty of Mining and Geology, University of Belgrade. His special field of research interest are karst groundwater resources of Eastern Herzegovina and Serbia. He also works in the field of management of groundwater resources, GIS analyses of hydrogeological data, karst water quality, groundwater protection, assessment of natural vulnerability, hazards and risks of groundwater, karst groundwater budget assessment and the designing boreholes and exploitation wells. Petar actively participates in teaching at BS (Hydrogeological Drilling, Well Designing) and MS studies (Methodology of Scientific Work, Management of Groundwater Resources and Characterization and Engineering of Karst Aquifers). He has published 5 papers in various journals and proceedings. He participated in several domestic and international conferences and workshops. He has been awarded several times in the country and abroad.

LABORATORIJA CENTRA ZA HIDROGEOLOGIJU KARSTA

Osnivanje laboratorije

Laboratorija Centra za hidrogeologiju karsta (LCHK) formirana je 2020. godine. Međutim, razvoj Laboratorije kroz nabavku opreme, započeo je zajedno sa osnivanjem samog Centra, 2008. godine. Početna laboratorijska oprema dobijena je kroz realizaciju projekata SUDEHSTRA (Sustainable Development of Hungarian – Serbian Transboundary Aquifer – INTERREG 2007/2008) i CCWaterS (Climate Changes and impact on Water Supply -2009/2012 SEE Programme ERDF & IPA) u kojima su učestvovali članovi CKH, kada su nabavljeni prvi terenski prenosivi uređaji, pomoću kojih je bilo moguće meriti, ne samo osnovne fizičko-hemijske parametre na terenu, već i parametre kao što su nitrati, nitriti, amonijum jon i sadržaj gvožđa i mangana u vodama. Porast broja uređaja i opreme za rad u laboratorijskim i terenskim uslovima rezultirao je potrebom za formiranjem laboratorijskog prostora. Rad i funkcija Laboratorije primarno je vezana za naučna i stručna istraživanja u okviru međunarodne saradnje i domaćih i međunarodnih projekata članova CKH. Pored ovih, laboratorijski prostor i uređaji dostupni su za sprovođenje nastave osnovnih i master studija, vezano za hidrogeološka istraživanja, posebno za kvalitet voda, definisanje specifičnih komponenti u karstnim podzemnim vodama, pripremu i analizu različitih uzoraka vode, stene i zemljišta, kao i pripremu uzoraka za određene izotopske analize. Takođe, prostorija Laboratorije namenjena je i naučno-istraživačkom radu studenata doktorskih studija, kao i naučnih radnika ne samo RGF-a već i ostalih istraživačkih organizacija. Osnivači Laboratorije su Ljiljana Vasić, šef Laboratorije, Saša Milanović i Zoran Stevanović, a pored njih u radu laboratorije aktivno učestvuju Branislav Petrović, Veljko Marinović i Petar Vojnović, članovi CHK-a.

Uređenje laboratorijske prostorije

Formiranje Laboratorije sa značajnim fondom nove i savremene opreme za cilj je imao podizanje kvaliteta rada na stručnim i naučnim projektima, kao i podizanje kvaliteta rada na različitim studijskim programima, kroz upoznavanje i rad studenata na savremenoj opremi. Takođe, omogućilo je i usavršavanje naučnog kadra, kako na doktorskim studijama, tako i naučnika u daljem naučnom radu. Pored očiglednog podizanja obrazovnog i naučnog kapaciteta ove visoko obrazovne ustanove, ovakva Laboratorija je omogućila konkurisanje i saradnju na brojnim domaćim i međunarodnim naučnim projektima.

LABORATORY OF CENTRE FOR KARST HYDROGEOLOGY

Establishment of the Laboratory

The Laboratory of the Center for Karst Hydrogeology (LCKH) was founded in 2020. However, the procurement of equipment began together with the establishment of the Center itself in 2008. Initial laboratory equipment was obtained through the implementation of the international projects SUDEHSTRA (Sustainable Development of Hungarian-Serbian Transboundary Aquifer - INTERREG 2007/2008) and CCWaterS (Climate Change and Impact on Water Supply - 2009/2012 SEE Program ERDF & IPA). CKH members participated in these projects. The first field-portable equipment, CKH acquired, were capable of measuring not only the basic physicochemical parameters in the field, but also concentrations in water of parameters such as nitrates, nitrites, the ammonium ion, iron, and manganese. The increase in the number of devices and equipment for laboratory and field work resulted in the necessity to create laboratory space. The purpose of the Laboratory is primarily associated with scientific and professional research related to international cooperation and domestic and international projects of CKH members. In addition, the Laboratory and the equipment are available for teaching undergraduate and master studies in the area of hydrogeological research, especially concerning water quality, defining of specific components of karst groundwater, preparation and analysis of water from various types of rocks, sampling and analysis of rocks and soil, as well as sample preparation for certain isotopic analyses. Moreover, the Laboratory is intended for scientific and research work of doctoral students, as well as scientific personnel not only of the Faculty of Mining and Geology, but from other research organizations as well. The founders of the Laboratory were Ljiljana Vasić (Head of the Laboratory), Saša Milanović and Zoran Stevanović, along with Branislav Petrović, Veljko Marinović and Petar Vojnović, CKH members that actively participate in the work of the Laboratory.

Arrangement of the Laboratory premises

The Laboratory, with a significant supply of new and modern equipment, was set up with the purpose to raise the quality of work on professional and scientific projects, as well as on various study programs, through the introduction of students to modern equipment and training in its use. It also advanced the expertise of scientific staff, in both doctoral study programs and further scientific work. In addition to the obvious increase in the educational and scientific capacity of the higher education institution, this kind

Formiranje laboratorijskog prostora počelo je adaptacijom kancelarijske prostorije 239, Departmana za hidrogeologiju, Rudarsko-geološkog fakulteta, u laboratorijski prostor. Uređenje ovog prostora sprovedeno je u skladu sa svim zakonskim propisima izgradnje laboratorija, što je podrazumevalo izradu pregradnog zida i oblaganje prostorije materijalom u skladu sa merama zaštite od požara, postavljanje protiv požarnog sistema, kao i opremanje prostorije savremenim laboratorijskim nameštajem, izrađenim po važećim standardima. Rad na adaptaciji prostorije trajao je dve godine, da bi konačno 2020. godine Laboratorija CHK bila puštena u rad.

Donacije Laboratoriji CHK

Od osnivanja CHK, članovi su uspeali na osnovu uspešne naučno-tehničke saradnje da obezbede i donaciju dva veoma važna uređaja za ispitivanje kvaliteta podzemnih voda. Jedan od uređaja je SHIMADZU, TOC 5000A, za određivanje sadržaja organskog ugljenika, dobijen kao donacija Nemačkog TZW-a (Technologiezentrum Wasser), odnosno tehnološkog centra Nemačke. Od strane ovog Centra dobijen je i određeni broj magnetnih i električnih mešaća.

Posebno je značajna i ističe se donacija vodovoda u Hajdelbergu, koji je Centru za hidrogeologiju karsta donirao uređaj Vista-PRO CCD Simultaneous ICP-OES inductively coupled plasma optical emission spectrometry, koji vrlo precizno definiše sadržaj mikroelemenata u podzemnim i površinskim vodama.



Vista-PRO CCD Simultaneous ICP-OES, donacija vodovoda u Hajdelbergu, Nemačka
Vista-PRO CCD Simultaneous ICP-OES, donated by Heidelberg Waterworks, Germany

Pored ovih donacija, veliki značaj za formiranje laboratorije imao je doprinos Ministarstva prosvete, nauke i tehnološkog razvoja, Sektor za učnički i studentski standard i investicije, koje je Centru za hidrogeologiju karsta odobrilo sredstva za finansiranje kompletnog laboratorijskog nameštaja, koji je uključivao stolove, ormane, stolice, sudoperu od posebnog materijala, sef za odlaganje argonske boce,

of Laboratory made it possible to apply for and collaborate on numerous domestic and international scientific projects.

Work on the Laboratory premises began with remodeling of office 239 of the FMG-DHG to suit that purpose. The Laboratory was set up in accordance with all pertinent regulations, which included building of a partition wall, covering the room with fire-resistant material, installing a fire protection system, and outfitting with modern laboratory furniture, made according to applicable standards. Remodeling lasted for two years and the CKH Laboratory was finally commissioned in 2020.

Donations to the CKH Laboratory

Since the establishment of CKH, based on successful scientific and technical cooperation, its members have managed to secure the donation of two very important groundwater quality analyzers. One was Shimadzu TOC 5000A, for determining the content of total organic carbon, donated by the German TZW (Technologiezentrum Wasser), which is the technology center of Germany. A certain number of magnetic and electric stirrers were also obtained from that center.

A very important addition came from Heidelberg Waterworks, which donated to the Center and Laboratory a Vista-PRO CCD Simultaneous ICP-OES (inductively coupled plasma optical emission spectrometer), which very precisely determines the concentrations of trace elements in surface water and groundwater.

In addition to these donations, extremely important for the establishment of the Laboratory was a contribution by the Serbian Ministry of Education, Science and Technological Development/Department for Pupil and Student Standards and Investments, which granted funds to CKH to procure all the laboratory furniture, which included tables, cabinets, chairs, a sink made of special material, a safety locker for argon bottle storage, a laboratory refrigerator, and a special table for setting up a high-precision analytical balance.



SHIMADZU, TOC 5000A, donacija tehnološkog centra Nemačke TZW
Shimadzu TOC 5000A donated by the German Technology Center TZW

laboratorijski frižider i specijalni sto za postavljanje precizne analitičke vage.

Upravo sredstva Ministarstva prosvete, nauke i tehnološkog razvoja, kao i donacije stranih institucija, omogućila su savremeni izgled i moderne tehnologije za rad Laboratorije Centra za hidrogeologiju karsta.



Savremeni izgled i moderna tehnologija za rad Laboratorije Centra za hidrogeologiju karsta
Modern looking and modern technologies for the work of the Laboratory of the Center for Karst Hydrogeology

Oprema Laboratorije Centra za hidrogeologiju karsta

Kao što je navedeno, broj raspoloživih instrumenata i uređaja za utvrđivanje parametara kvaliteta površinskih i podzemnih voda vremenom je rastao. Trenutno Laboratorija raspolaže velikim brojem uređaja za merenje kvalitativnih parametara (fizičko-hemijski parametri, osnovni jonski sastav, TOC, mikroelementi), ali takođe i terenski prenosivim uređajima, kojim direktno na terenu može da se uradi skraćena hemijska analiza, koja pored fizičko-hemijskih parametara, podrazumeva i veliki broj drugih kvalitativnih parametara vode (alkalitet, tvrdoća, Ca^{2+} i HCO_3^- , amonijum jon, hlor, gvožđe, mangan, nitrati, nitriti, sulfati, sulfidi).

Instrumenti i oprema za hemijske analize:

Vista-PRO CCD Simultaneous ICP-OES inductively coupled plasma optical emission spectrometry

Varian Vista-PRO Simultaneous ICP-OES je plazmeni spektrometar za utvrđivanje sadržaja mikroelemenata u vodi i čvrstom uzorku. Uređaj se odlikuje velikim brzinama očitavanja, pomoću kojeg se mogu definisati sadržaji 73 elementa za manje od 35 sekundi po uzorku. Poznavanje sadržaja mikroelemenata od velikog je značaja za definisanje geneze podzemnih voda i geohemijskih procesa koji su uticali na hemijski sastav vode. U sklopu uređaja je i zaštitni orman za skladištenje boce sa argonom za rad uređaja i sistem za ventilaciju.

The funds of the Ministry of Education, Science and Technological Development, as well as the donations from foreign institutions, made it possible for Laboratory of CKH to have a modern appearance and use contemporary technologies.



Savremeni izgled i moderna tehnologija za rad Laboratorije Centra za hidrogeologiju karsta
Modern looking and modern technologies for the work of the Laboratory of the Center for Karst Hydrogeology

Equipment of the Laboratory of the Center for Karst Hydrogeology

The number of available instruments and devices for determining surface water and groundwater quality parameters has grown over time. Currently, the Laboratory has a large number of instruments for measuring qualitative parameters (physicochemical parameters, basic ionic composition, TOC, trace elements), but also field-portable equipment that can be used to shorten chemical analyses directly in the field, which, in addition to physicochemical parameters, also include a large number of other qualitative water parameters (alkalinity, hardness, Ca^{2+} and HCO_3^- , ammonium ion, chlorine, iron, manganese, nitrates, nitrites, sulfates, sulfides).

Instrument and equipment for chemical analyses:

Vista-PRO CCD Simultaneous ICP-OES inductively coupled plasma optical emission spectrometry

The Varian Vista-PRO Simultaneous ICP-OES is a plasma spectrometer for determining the content of trace elements in water and solid samples. The analyzer is characterized by high reading speeds, where the content of 73 elements can be determined in less than 35 seconds per sample. Knowledge of microelement concentrations is of great importance for defining the genesis of groundwater and the geochemical processes that influenced the chemical composition of water in general. This analyzer includes a safety locker for the argon bottle needed for its operation, as well as a ventilation system.

SHIMADZU, TOC 5000A

Laboratorijski uređaj za merenje sadržaja ukupnog organskog ugljenika (TOC) u površinskim i podzemnim vodama. Voda, osim u slučaju da je ultračista, prirodno sadrži neka organska jedinjenja. Organski zagađivači (prirodne organske supstance, insekticidi, herbicidi i druge poljoprivredne hemikalije) često mogu dospeti u površinske vodene tokove tokom kišnog oticanja, samim tim i u podzemne vode. Utvrđivanje sadržaja TOC-a pruža brz i prigodan način određivanja stepena organske kontaminacije.

WTW Oxi 340i / set – kompaktni, precizni i vodonepropusni terenski prenosivi uređaj za brzo i pouzdano merenje sadržaja rastvorenog kiseonika O_2 u vodi (mg/l), sa integrisanim senzorom za merenje temperature ($^{\circ}C$).

WTW Cond 340i / set – kompaktni, precizni i vodonepropusni terenski prenosivi uređaj za brzo i pouzdano merenje električne provodljivosti vode ($\mu S/cm$), sa integrisanim senzorom za merenje temperature ($^{\circ}C$).

WTW pH 340i / set – kompaktni, precizni i vodonepropusni terenski prenosivi uređaj za brzo i pouzdano merenje pH vrednosti vode i redoks potencijala (mV) (opciona sonda), sa integrisanim senzorom za merenje temperature ($^{\circ}C$).

WTW TURB 355ir – kompaktni, precizni i vodonepropusni terenski prenosivi uređaj za brzo i pouzdano merenje mutnoće vode sa infracrvenim LED za nefelometrijska merenja.

AQUA LYTIC NO_3 – laboratorijski/terensko-prenosivi fotometar za merenje sadržaja nitrita u vodi.

AQUA LYTIC Fe – laboratorijski/terensko-prenosivi fotometar za merenje sadržaja gvožđa u vodi.

AQUA LYTIC NH_4 – laboratorijski/terensko-prenosivi fotometar za merenje sadržaja amonijum jona u vodi.

HANNA instruments multiparameter waterproof meter HI98194, pH/EC/DO – kompaktni, vodonepropusni terenski prenosivi uređaj za brzo i pouzdano merenje temperature vode, pH vrednosti i oksido-redukcionog potencijala, električne provodljivosti vode, sadržaja rastvorenog kiseonika.

TESTO 535 CO_2 measuring equipment – kompaktni, prenosivi uređaj za merenje sadržaja CO_2 u zatvorenim prostorijama pomoću sonde.

TESTO 435 measuring equipment – kompaktni, multifunkcionalni prenosivi uređaj za merenje sadržaja CO_2 , CO, temperature i vlažnosti vazduha, kao i brzine protoka vazduha u zatvorenoj prostoriji.

Exact Micro 7+ i 20+ advanced photometer system – laboratorijski/terenski prenosivi fotometri za *in situ* merenja sledećih fizičko-hemijskih

SHIMADZU, TOC 5000A

This laboratory instrument measures the content of total organic carbon (TOC) in surface water and groundwater. Water, unless it is ultrapure, naturally contains some organic compounds. Organic pollutants (natural organic substances, insecticides, herbicides, and other agricultural chemicals) often reach surface water with rainfall runoff, and thus groundwater as well. The determination of the TOC content provides a quick and convenient way of establishing the degree of organic contamination.

WTW Oxi 340i / set – compact, precise, and waterproof field-portable instrument for fast and reliable measurement of the dissolved oxygen content (O_2) in water (mg/l), with an integrated sensor for measuring temperature ($^{\circ}C$).

WTW Cond 340i / set – compact, precise, and waterproof field-portable instrument for fast and reliable measurement of the electrical conductivity of water ($\mu S/cm$), with an integrated sensor for measuring temperature ($^{\circ}C$).

WTW pH 340i / set – compact, precise, and waterproof field-portable instrument for fast and reliable measurement of water pH and redox potential (mV) (optional probe), with an integrated sensor for measuring temperature ($^{\circ}C$).

WTW TURB 355ir – compact, precise, and waterproof field-portable instrument for fast and reliable water turbidity determination with infrared LED for nephelometric measurements.

AQUA LYTIC NO_3 – laboratory/field-portable photometer for measuring nitrite content in water.

AQUA LYTIC Fe – laboratory/field-portable photometer for measuring iron content in water.

AQUA LYTIC NH_4 – laboratory/field-portable photometer for measuring ammonium ion content in water.

HANNA instruments multiparameter waterproof meter HI98194, pH/EC/DO – compact and waterproof field-portable device for rapid measurement of water temperature, pH, redox potential, electrical conductivity, and dissolved oxygen content.

TESTO 535 CO_2 measuring equipment – compact, portable device for measuring CO_2 content in closed rooms using a probe.

TESTO 435 measuring equipment – compact, multifunctional portable device for measuring the content of CO_2 , CO, air temperature and humidity, as well as the air flow rate in a closed room.

Exact Micro 7+ i 20+ advanced photometer system – laboratory/field portable photometers for *in-situ* measurements of the following physical and chemical parameters of water: pH level, alkalinity (Al), total hardness (Th), aluminum, ammonium ion,

parametara u vodi: pH vrednost, alkalitet (Al), ukupna tvrdoća (Th), aluminijum, amonijum jon, hlor, hrom, bakar, fluor, gvožđe, mangan, nitrati, nitriti, sulfati, sulfidi.

Merck Ca^{2+} - Calcium Test za definisanje sadržaja titracijom - laboratorijski/terensko-prenosivi komplet za definisanje sadržaja Ca^{2+} titracijom

Merck HCO_3^- - Alkalinity test acid capacity to pH 8,2 and pH 4,3 - laboratorijski/terensko-prenosivi komplet za definisanje sadržaja HCO_3^- titracijom.

Prateća laboratorijska oprema i oprema za pripremu hemijskih i izotopskih uzoraka

Laboratorijski frižider

Sigurnosni sef za argonsku bocu

Vakuumpumpa

Mikrometarski kvareni filter sa posudom za vakuumsko filtriranje

Laboratorijski sterilizator

Analitička vaga - RADWAG AS 220.R2

Uređaj za uzimanje/pripremu uzoraka plemenitih gasova

Slike terenske opreme prikazane su u poglavlju koje je posvećeno terenskoj opremi CHK.

chlorine, chromium, copper, fluorine, iron, manganese, nitrates, nitrites, sulfates, and sulfides.

Merck Ca^{2+} - Calcium Test Method titrimetric with titration pipette - laboratory/field-portable kit for defining Ca^{2+} content by titration.

Merck HCO_3^- - Alkalinity test acid capacity to pH 8,2 and pH 4,3 - laboratory/field-portable kit for defining HCO_3^- content by titration.

Accompanying Laboratory equipment and equipment for the preparation of chemical and isotopic samples

Laboratory refrigerator

Safety locker for storing the argon bottle

Vacuum pump

Micrometer quartz filter with vacuum filter bowl

Laboratory sterilizer

Analytical balance - RADWAG AS 220.R2

Device for sampling/preparing samples for noble gases detection

Photos of field laboratory equipment are shown in the chapter about CKH field equipment.

Međunarodni kurs „Karakterizacija i inženjering karstnih izdani“

Reč inicijatora CEKA kursa

Od samog formiranja Centra edukacija i širenje znanja o karstu i njegovim vodama stavljeni su visoko na listu prioriteta, kao što je već i analizirano u uvodnom, i poglavlju o Nastavnoj delatnosti CHK.

Ideja o međunarodnom kursu koji bi se bavio hidrogeologijom karsta je nastavak ideja koje su razmatrane još u vreme formiranja CKH i prve akreditacije nastavnog plana Departmana za hidrogeologiju po Bolonjskom konceptu 2008. godine. Još tada se razmatralo da pojedini kursevi na master studijama budu na engleskom, ili predavani dvojezično, ali se zbog propisanog limita opterećenja nastavnika, od ovoga moralo odustati. Uvođenje kursa *Karakterizacija i inženjering karstnih izdani* sa drugom akreditacijom DHG je bio novi korak u ovom pravcu, i to u situaciji kada se ostvaruju i povoljne predispozicije u smislu mogućeg finansiranja zbog paralelne realizacije velikog projekta *Dinaric Karst Transboundary Aquifer System* (DIKTAS). Ovaj projekat, u kome je kao konsultant učestvovao i autor ovog priloga, finansiran je od strane Global Environmental Facility (GEF) sa implementacionim agencijama UNESCO i UNDP. Koordinator projekta bio je Neno Kukurić (rođeni Trebinjac), ujedno i šef UN-IGRAC, a jedan od članova stručnog saveta i Neven Krešić. Upravo je Neven sa svojim kolegom Alexom Mikszewskim održao u Trebinju od 5-8. juna 2013. workshop na temu *Problems and Solutions in Numeric Modeling of Karst Aquifers* sa učešćem 19 stručnjaka, doktoranata ili MS studenata iz država bivše Jugoslavije.



Učesnici workshop-a 2013. godine
Participants of workshop 2013

Ova uspešno realizovana "generalna proba" dala je novi podstrek ideji da se uspostavi stalni međunarodni kurs na engleskom jeziku, čija okosnica treba da bude kurs MS studija na RGF. U pripremi i razradi ove ideje učestvovali su pored autora priloga i Neven Krešić i

International course "Characterization and Engineering of Karst Aquifers"

A word from the initiator of the CEKA course

From the formation of the Centre and its first steps, education and dissemination of knowledge about karst and its waters have been placed high on the list of priorities, as already noticed in the introduction, as well as in the chapter Teaching activities of CKH.

The idea of an international course dealing with karst hydrogeology is a continuation of ideas that were considered at the time of the formation of CKH and the first accreditation of the curriculum of the Department of Hydrogeology according to the Bologna concept in 2008. Back then, it was considered that certain courses at the master's studies would be in English, or taught bilingually, but due to the prescribed limit on the professor's workload, this had to be abandoned. The introduction of the course *Characterization and engineering of karst* with the second DHG accreditation was a new step in this direction, in a situation where favourable predispositions had been created for possible financing due to the parallel implementation of the large project *Dinaric Karst Transboundary Aquifer System* (DIKTAS). This project, in which the author of this contribution participated as a consultant, was financed by the Global Environmental Facility (GEF) with the implementing agencies UNESCO and UNDP. The coordinator of the project was Neno Kukurić (born in Trebinje), also the head of UN-IGRAC, while one of the members of the project Advisory Board was Neven Krešić. By support of DIKTAS it was Neven with his colleague Alex Mikszewski who held workshop on the topic *Problems and Solutions in Numerical Modelling of Karst Aquifers* in Trebinje from 5-8. June 2013. The workshop was attended by 19 experts, PhD students or MS students from the countries of the former Yugoslavia.



Predavanja na workshop-u 2013. godine
Lectures at workshop 2013

Neno Kukurić, a podršku su naravno pružili i svi tadašnji članovi Centra. Tako je 2014. rođena CEKA – *Characterization and Engineering of Karst Aquifers*, koristeći novi pogodan moment, koji je predstavljao okončanje DIKTAS projekta i tim povodom organizovan veliki naučni skup u Trebinju “*Karst without Boundaries*”. Uz podršku Nena Kukurića obezbeđena je finansijska podrška i sponzorstvo UNESCO, kojim su pokriveni troškovi putovanja i smeštaja predavača i učesnika, uključujući i sve studente sa RGF. Ovo se sponzorstvo nastavilo i u narednim godinama. Uz RGF, kao koorganizator CEKA, se od prvog kursa javlja i Geološki zavod Republike Srpske (BiH), a domaćinstvo skupu je u svakom smislu pružila organizacija Hidroelektrane Trebišnjice (HET). Spisak drugih partnera se menjao u narednim godinama, ali je najveća podrška dobijena od strane Regionalnog vodovoda Crnogorskog primorja, na čijem je izvoristu u narednim godinama održano i nekoliko sesija i terenskih eksperimenata. Uz UNESCO, pokroviteljstva se prihvatila i Komisija za karst IAH, kao i UN-IGRAC, a veliku podršku pružili su University of Northern Arizona, Flagstaff; University of Western Kentucky, Bowling Green; Edwards Aquifer Authority, San Antonio, zatim Geološki zavod Crne Gore, Institut za vodoprivredu “Jaroslav Černi”. Zahvaljujući partnerima uspešno je realizovana ideja da se kurs, i naš transfer znanja učini potpuno besplatnim.

Kao predavači još od prvog kursa su, uz autora priloga angažovana i dva vodeća člana Centra Saša Milanović i Vesna Ristić Vakanjac.

Petar Milanović, koji je praktično i formiran kao svetski ekspert radeći na projektima regulacije Trebišnjice i izgradnje HE Grančarevo i HE Gorica, nije propustio nijedan do sada organizovan kurs, a da nije nesebično delio sa učesnicima svoja bogata inženjerska iskustva. Ognjen Bonacci, profesor Univerziteta u Splitu je, takođe, aktivno i redovno učestvovao, sve do poslednjih nekoliko godina.

Na prvom kursu 2014. uz njih je učesnicima svoja znanja i iskustva prenosila odlična ekipa predavača u kojoj su bili Neven Krešić, Neno Kukurić, Francesco Fiorillo, Bartolomeo Andreo, kao i Dragan Milovanović. Te prve godine bilo je, dakle, 10 predavača iz 7 država, dok je broj učesnika bio 21 iz 11 zemalja sveta. Redovna rotacija dela predavača i broj učesnika u narednim godinama predmet su daljeg teksta.

Kurs ne bi bio moguć bez ekipe Centra, i njihovog entuzijazma i posvećenosti, i proteklih 10 godina učinilo je da od uloge organizatora (Ljiljana, Branislav) ili prvih učesnika (Veljko), mlađi stručnjaci CHK postanu i predavači ovog kursa. Prvih godina značajnu pomoć u organizaciji kursa pružala je i Marina Čokorilo Ilić.

This successfully realized “general rehearsal” gave new impulse to the idea of establishing a permanent international course in English, the backbone of which should be the course of MS studies at RGF. In addition to the author of the article, Neven Krešić and Neno Kukurić also participated in the preparation and development of this idea, and of course all the members of the Centre at the time also provided support. Thus, CEKA – *Characterization and Engineering of Karst Aquifers* was born in late 2013 and announced for June 2014, using a new convenient moment, which represented the end of the DIKTAS project, and on that occasion a large conference organized in Trebinje “*Karst without Boundaries*”. With the support of Neno Kukurić, financial support and sponsorship from UNESCO was provided, which covered the travel and accommodation costs of lecturers and participants, including all students from FMG. UNESCO sponsorship continued in the next following years. Along with the FMG, the Geological Survey of the Republic of Srpska (B&H) has been participating as a co-organizer of CEKA since the first course, while the course was hosted by the Hidroelektrana Trebišnjice (HET) in every sense. The list of other partners changed in the following years, but the biggest support was received from the Regional Waterworks of the Montenegrin Coast, at whose source Bolje Sestre several sessions and field experiments were held in the following years. Along with UNESCO’s, the IAH Karst Commission, as well as UN-IGRAC, also accepted patronage, and great support was provided by the University of Northern Arizona, Flagstaff; University of Western Kentucky, Bowling Green; Edwards Aquifer Authority, San Antonio, Geological Survey of Montenegro, Institute for Water Management “Jaroslav Černi”. Thanks to these partners, the idea of making the course and our knowledge transfer completely free of charge was successfully realized.

Two leading members of the Center, Saša Milanović and Vesna Ristić Vakanjac, have been engaged as lecturers since the first course, along with the author of this contribution.

Petar Milanović, who was practically formed as a world expert by working on projects for the regulation of Trebišnjica River and the construction of HPP Grančarevo and HPP Gorica, has not missed a single course organized so far without selflessly sharing his rich engineering experience with the participants. Ognjen Bonacci, a professor at the University of Split, also actively and regularly participated to CEKA until the last few years.

Along with professors from CKH, at the first course in 2014, excellent team of lecturers, including Neven Krešić, Neno Kukurić, Francesco Fiorillo, Bartolomeo Andreo, and Dragan Milovanović, shared their knowledge and experience with 21 participants from 11 countries. That first year, there were 10 lecturers from 7 countries. The regular rotation of lecturers and the number of participants in the following years are the subject of further contributions of this publication.

Course and Workshop Lecturers

Lectures, laboratory and field demonstrations, and tutorials will be conducted by university professors and leading experts from the industry and research organizations from around the World. These include the University of Belgrade and the Geological Survey of the Republic of Srpska, Zvornik, B&H, the University of Texas at Austin (UT), UNESCO centres, HET – HydroElectro Trebinje. The participation in the programme has been confirmed by Dr. Neven Kresic (AMEC, USA), Dr. Petar Milanovic (ret. Univ. of Mostar), Dr. Ognjen Bonacci (Univ. of Split), and Dr. Neno Kukuic (UNESCO-IGRAC). They all started their distinguished international careers working in the Dinaric region. Professors from the UT are John M. Sharp, Marcus Cery and Suzanne Pierce. Other international experts from the Karst Commission of IAH and international university centers of excellence will be invited to take part in the course during the following years as well.

About the Course Partners

Organizers:

- Department of Hydrogeology and Centre for Karst Hydrogeology of the University of Belgrade - The Faculty of Mining & Geology (<http://www.karst.edu.rs>)
- The Geological Survey of the Republic of Srpska, Zvornik (Bosnia & Herzegovina) (<http://www.geozavodrs.com>)

in cooperation with:

- Department of Geological Sciences, The University of Texas at Austin, USA (<http://www.geotexas.edu>)
- HET (Hydro-Electro System on Trebisnjica River), Trebinje, Bosnia & Herzegovina (<http://www.het.ba>)
- Karst Commission of the IAH (International Association of Hydrogeologists) (<http://www.iah.org/karst/>)
- The Geological Survey of Montenegro, Podgorica, Montenegro (www.geozavod.me)
- The Jaroslav Černi Institute for the Development of Water Resources (JCI) and its UNESCO's Category 2 Centre, Serbia (<http://www.icemi.org>)
- IGRAC (International Groundwater Resources Assessment Centre), Delft, The Netherlands (<http://www.un-igrac.org>)
- Edwards Aquifer Authority, San Antonio, Texas, USA (www.edwardsaquifer.org)
- Speleological club "Zelena brda" (Green Fields), Trebinje, Bosnia & Herzegovina (<http://www.24casa.com/zelenabrdra/contact.php>)

Course Fee

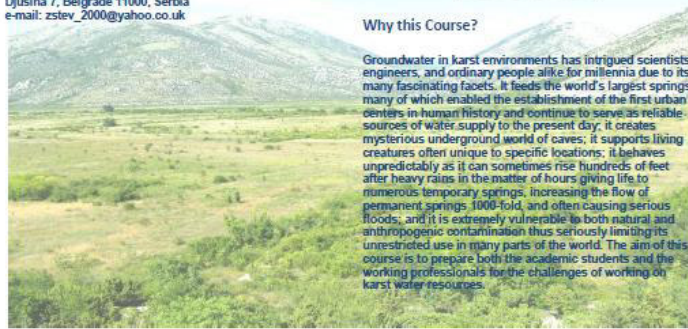
The attendants are responsible for covering travel and accommodation cost which is very affordable in comparison with nearby tourist centers (accommodation and food costs in Trebinje are on the order of 40-50 USD/day). Although the course is not commercially based for university students, the participants will be charged to cover operating cost (field trips, refreshments, tutorials preparation and copying, and similar). Working professionals will be charged a modest fee in addition.



Additional information:

Prof. Dr Zoran Stevanović, accredited full professor responsible for the course implementation and Head of the Centre for Karst Hydrogeology

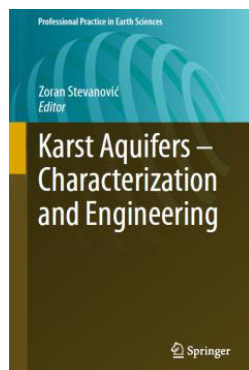
University of Belgrade
School of Mining and Geology
Djulsina 7, Belgrade 11000, Serbia
e-mail: zstev_2000@yahoo.co.uk



Why this Course?

Groundwater in karst environments has intrigued scientists, engineers, and ordinary people alike for millennia due to its many fascinating facets. It feeds the world's largest springs, many of which enabled the establishment of the first urban centers in human history and continue to serve as reliable sources of water supply to the present day; it creates mysterious underground world of caves; it supports living creatures often unique to specific locations; it behaves unpredictably as it can sometimes rise hundreds of feet after heavy rains in the matter of hours giving life to numerous temporary springs, increasing the flow of permanent springs 1000-fold, and often causing serious floods; and it is extremely vulnerable to both natural and anthropogenic contamination thus seriously limiting its unrestricted use in many parts of the world. The aim of this course is to prepare both the academic students and the working professionals for the challenges of working on karst water resources.

Liflet kursa sa listom partnera i obrazloženjem
Course leaflet with list of partners and explanation



Tutorial pripremljen od strane CHK i knjiga Karst Aquifers – Characterization and Engineering u izdanju Springer
Tutorial prepared by the CKH and the book Karst Aquifers – Characterization and Engineering, published by Springer

Osnovnu literaturu pružile su *power point* prezentacije koje su deljene učesnicima, zatim *Tutorial* koji je takođe pripremljen od strane članova Centra, a koji je najvećim delom bio baziran na poglavljima knjige *Karst Aquifers – Characterization and Engineering* u izdanju Springer, a koja su velikim delom pisali upravo članovi Centra.

Z. Stevanović

The course would not have been possible without the CKH team, and their enthusiasm and commitment, and over the past 10 years, the role of organizers (Ljiljana, Branislav) or the first participants (Veljko) has turned the CKH younger experts into permanent lecturers of this course. In the first years, Marina Čokorilo Ilić helped significantly in the organization of the course. Basic literature was provided by the power point presentations that were regularly distributed to the participants, then the Tutorial, which was also prepared by the members of the Centre, and which was mostly based on the chapters of the book *Karst Aquifers - Characterization and Engineering*, published by Springer, and which were largely written by members of the Centre.

Z. Stevanović

CEKA

„Karakterizacija i inženjering karstnih izdani“

Međunarodni kurs „Karakterizacija i inženjering karstnih izdani“ jubilarno se, po 10. održava u Trebinju, Bosni i Hercegovini. A ideja o međunarodnom kursu rodila se pre više od 15 godina, a njeni inicijatori prof. dr Zoran Stevanović, dr Neven Krešić i dr Saša Milanović za lokaciju održavanja kursa odabrali su Trebinje, grad u istočnoj Hercegovini, koji pripada Dinarskom karstu, *locus typicus*-u karstnih terena na čitavoj planeti, o čemu je već bilo reči u prethodnom poglavlju inicijatora kursa.

Ovaj međunarodni kurs je koncipiran tako da, pored teorijskih predavanja osnovnih koncepata hidrogeologije karsta po principu *ex cathedra*, uključuje i niz praktičnih pokaznih primera i terenskih ekurzija na prostoru Hercegovine i Crne Gore. Tako, učesnici su tokom prethodnih godina postojanja kursa imali prilike da posete karstne fenomene istočne Hercegovine i Crne Gore, koji obuhvataju karstna vrela Oko, Vrelo Bune, Vrelo Bregave, Tučevac i Ušac u Hercegovini, odnosno Glavu Zete, vrela Ljuta, Sopot, Spila Risanska i vrulju Bolje Sestre u Crnoj Gori. Pored vrela, studenti su posećivali i karstna polja istočne Hercegovine (Popovo, Fatničko, Dabarsko) i Crne Gore (Grahovsko), pećinu Vjetrenica, kao i hidrotehničke objekte izgrađene u karstu, kao što su brane Grančarevo i Gorica u sklopu hidrosistema na Trebišnjici, akumulacije Krupac i Slano u blizini Nikšića i HE „Peručica“ u Crnoj Gori, odnosno posetili su i izgradnju tunela u sklopu Hidroelektrane Dabar, u blizini Nevesinja. Stoga, može se slobodno reći da ovaj kurs predstavlja jedinstven primer u svetu koji u svega nekoliko dana obuhvata i teorijski i praktični aspekt hidrogeologije karsta.

Prvi međunarodni CEKA kurs organizovan je od 3. do 10. juna 2014. godine u Trebinju, u organizaciji Centra za hidrogeologiju karsta i Geološkog zavoda Republike Srpske, uz podršku Hidroelektrana na Trebišnjici i UNESCO fonda. Među predavačima na prvom CEKA kursu bili su **prof. dr Zoran Stevanović, dr Neven Krešić, dr Petar Milanović, prof. em. dr Ognjen Bonacci, prof. dr Francesco Fiorillo, prof. dr Bartolomeo Andreo Navarro, prof. dr Dragan Milovanović, dr Neno Kukurić, dr Saša Milanović i prof. dr Vesna Ristić Vakanjac**. Prvi CEKA kurs je ukupno pohađalo 21 učesnik iz 11 zemalja: Slovenija, Slovačka, Mađarska, Čile, Nemačka, Crna Gora, Bosna i Hercegovina, Srbija, Ujedinjeno Kraljevstvo, Švajcarska i Estonija.

CEKA

"Characterization and Engineering of Karst Aquifers"

On its 10th anniversary, the international course "Characterization and Engineering of Karst Aquifers" is being held again in Trebinje, Bosnia and Herzegovina. The idea of an international course was born more than 15 years ago, which initiators, Prof. Dr. Zoran Stevanović, Dr. Neven Krešić, and Dr. Saša Milanović, chose Trebinje, a city in eastern Herzegovina situated in the Dinaric Karst, the *locus typicus* of karst terrains on the entire planet, as the venue for the course, which was already discussed in the previous chapter by the course initiator.

This international course is designed in such a way that, in addition to theoretical lectures on the basic concepts of karst hydrogeology according to the *ex cathedra* principle, it includes a number of practical demonstrations and field trips within the territories of Herzegovina and Montenegro. In the past years of the course's existence, participants had an opportunity to tour the karst phenomena of eastern Herzegovina and Montenegro, which include the following karst springs: Oko, Vrelo Bune, Vrelo Bregave, Tučevac and Ušac in Herzegovina, and Glava Zeta, Ljuta, Sopot, Spila Risanska and the sublacustrine spring Bolje Sestre in Montenegro. In addition, students also visited the karst poljes of eastern Herzegovina (Popovo Polje, Fatničko Polje, Dabarsko Polje) and Montenegro (Grahovsko Polje), the Vjetrenica cave, as well as hydrotechnical facilities built in karst, such as the Grančarevo and Gorica dams, as part of the Trebišnjica Hydrosystem, Krupac and Slano reservoirs near Nikšić, and Perućica HPP in Montenegro. They also got to see the construction of a tunnel of the Dabar Hydroelectric Power Plant near Nevesinje. As such, this course certainly represents a unique example in the world as it covers both theoretical and practical aspects of karst hydrogeology in just a few days.

The first international CEKA course was held from June 3 to 10, 2014 in Trebinje, by the Center for Karst Hydrogeology and Geological Survey of Republika Srpska, supported by HET and UNESCO. The lecturers at the first CEKA course were **Prof. Dr. Zoran Stevanović, Dr. Neven Krešić, Prof. Dr. Petar Milanović, Prof. Emer. Dr. Ognjen Bonacci, Prof. Dr. Francesco Fiorillo, Prof. Dr. Bartolomeo Andreo Navarro, Prof. Dr. Dragan Milovanović, Dr. Neno Kukurić, Dr. Saša Milanović, and Prof. Dr. Vesna Ristić Vakanjac**. The first CEKA course was attended by 21 participants from 11 countries: Slovenia, Slovakia, Hungary, Chile, Germany, Montenegro, Bosnia and Herzegovina, Serbia, United Kingdom, Switzerland, and Estonia.



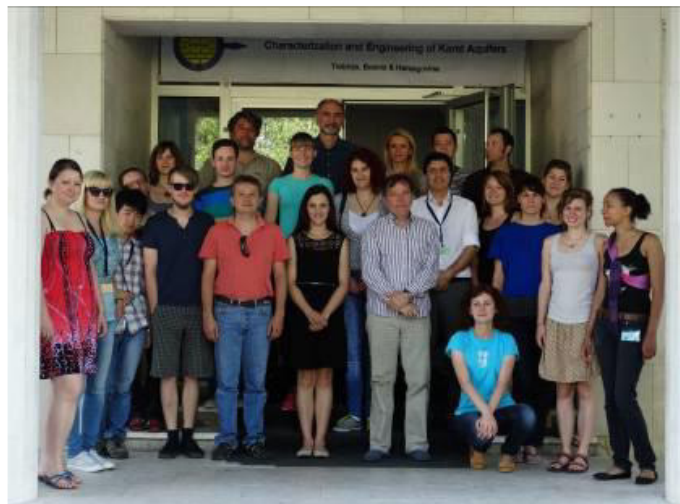
Praktična nastava i terenska ekskurzija CEKA 2014. godine
Practical demonstrations and field trip CEKA 2014

Nakon uspešnog prvog kursa, drugi kurs je organizovan od 1. do 7. juna 2015. godine, u istom gradu. Kurs je pohađao 21 učesnik iz 8 zemalja: Bosna i Hercegovina, Hrvatska, Iran, Italija, Francuska, Srbija, Ukrajina i SAD. Kao predavači, na kursu su učestvovali: **Prof. Dr Zoran Stevanović; Dr Neven Krešić; Prof. Dr Petar Milanović; Prof. Emer. Dr Ognjen Bonacci; Geary Schindel; Dr Petar Malik; Prof. Dr Dragan Milovanović; Dr Neno Kukurić; Dr Saša Milanović; Prof. Dr Vesna Ristić Vakanjac.**



Predavanja CEKA 2015. godine
Lectures CEKA 2015

Treći po redu kurs, održan je između 30. maja i 6. juna 2016. godine u Trebinju. Među predavačima bili su **Prof. Dr Zoran Stevanović; Dr Neven Krešić, Prof. Dr Petar Milanović, Prof. Emer. Dr Ognjen Bonacci; Prof. Dr Abraham Springer; Dr Mario Parise; Prof. Dr Dragan Milovanović; Dr Hermann Stadler; Dr Neno Kukurić; Prof. Dr Vesna Ristić Vakanjac.** Ukupno je 16 učesnika pohađalo kurs 2016. godine iz 5 zemalja: Bosna i Hercegovina, Crna Gora, Hrvatska, Slovenija i Srbija.



Učesnici kursa CEKA 2014. godine
Participants of CEKA 2014

After the successful first CEKA course, the second was held from June 1 to 7, 2015 in the same city. The course was attended by 21 participants from eight countries: Bosnia and Herzegovina, Croatia, Iran, Italy, France, Serbia, Ukraine, and the USA. The following lecturers participated in the course: **Prof. Dr. Zoran Stevanović, Dr. Neven Krešić, Prof. Dr. Petar Milanović, Prof. Emer. Dr. Ognjen Bonacci, Geary Schindel, Dr. Petar Malik, Prof. Dr. Dragan Milovanović, Dr. Neno Kukurić, Dr. Saša Milanović, and Prof. Dr. Vesna Ristić Vakanjac.**



Učesnici i predavači na kursu CEKA 2015. godine ispred pećine Vjetrenica
Participants and lecturers of CEKA 2014 in front of Vjetrenica Cave

The third CEKA course was held from May 30 to June 6, 2016, in Trebinje. Among the lecturers were **Prof. Dr. Zoran Stevanović, Dr. Neven Krešić, Prof. Dr. Petar Milanović, Prof. Emer. Dr. Ognjen Bonacci, Prof. Dr. Abraham Springer, Dr. Mario Parise, Prof. Dr. Dragan Milovanović, Dr. Hermann Stadler, Dr. Neno Kukurić, and Prof. Dr. Vesna Ristić Vakanjac.** The course was attended by 16 participants from five countries: Bosnia and Herzegovina, Montenegro, Croatia, Slovenia, and Serbia.



Praktična nastava i terenska ekskurzija CEKA 2016. godine
Practical demonstrations and field trip CEKA 2016



Učesnici i predavači na kursu CEKA 2016. godine ispred
Arslanagića mosta u Trebinju
*Participants and lecturers of CEKA 2014 in front of Arslanagić
bridge in Trebinje*

CEKA kurs 2017. godine je održan između 1. i 8. juna, u Trebinju. Pored već tradicionalnih organizatora i prijatelja kursa, podršku je pružio i Grad Trebinje, kao i Univerzitet Severne Arizone iz Flagstafa, SAD, budući da su njihovi studenti i profesori bili učesnici i gosti. Kurs je otpočeo 29. maja 2017. godine kraćom ekskurzijom koja je organizovana za američke studente i profesore, tokom koje su posećeni hidrogeološki objekti i pojave u Crnoj Gori: Nikšićko karstno polje sa akumulacijama Slano i Krupac, Hidroelektrana „Perućica“, Regionalni vodovodni sistem „Bolje Sestre“ sa koga se snabdeva Crnogorsko primorje, Skadarsko jezero, Budva, Kotor, vrela Ljuta, Sopot, Spila Risanska, Kameno more i Grahovsko karstno polje. Nakon povratka u Trebinje, zvanično je 1. juna otpočeo kursa CEKA 2017.

The CEKA 2017 course was held from June 1 to 8 in Trebinje. In addition to the already traditional organizers and friends of the course, support was provided by the City of Trebinje, as well as the Northern Arizona University from Flagstaff, USA, since their students and professors were participants and guests. The course began on May 29, 2017, with a short excursion organized for the US students and professors, during which hydrogeological features and phenomena in Montenegro were visited, including the Nikšić karst polje with Slano and Krupac reservoirs, Perućica HPP, the Bolje Sestre Regional Water System, which services the Montenegrin coast, Lake Skadar, Budva, Kotor, the springs of Ljuta, Sopot and Spila Risanska, Kameno more (the Stone Sea) and the Grahovsko karst polje. After the return to Trebinje, the CEKA 2017 course officially started on June 1.



Učesnici iz SAD-a i predavači na kursu CEKA 2017. godine
ispred akumulacije Krupac, Nikšićko polje
*Participants from USA and lecturers of CEKA 2017 in front of
Krupac reservoir in the Nikšić karst polje*



Učesnici iz SAD-a i predavači na kursu CEKA 2017. godine
ispred vruće Bolje Sestre
*Participants from USA and lecturers of CEKA 2017 in front of
sublacustrine spring Bolje Sestre*

Predavači na kursu 2017. godine bili su **Prof. Dr Zoran Stevanović; Prof. Dr Petar Milanović, Prof. Emer. Dr Ognjen Bonacci; Prof. Dr Abraham Springer; Prof. Dr Dragan Milovanović; Dr Saša Milanović; Prof. Dr Vesna Ristić Vakanjac**. Tokom kursa 2017. godine, po prvi put su svoja predavanja održali i Ljiljana Vasić, Branislav Petrović i Veljko Marinović u sklopu predavanja mladih eksperata, dok je takođe po prvi put dvoje učesnika kursa pozvano da održi kraće predavanje – Čarisl Čak Graf iz SAD i Ramanathan Baskar iz Indije. Kurs je pohađao 21 učesnik iz 11 zemalja: SAD, Bosna i Hercegovina, Honduras, Nemačka, Indija, Italija, Severna Makedonija, Meksiko, Crna Gora, Slovenija i Srbija.

The CEKA 2017 lecturers were **Prof. Dr. Zoran Stevanović, Prof. Dr. Petar Milanović, Prof. Emer. Dr. Ognjen Bonacci, Prof. Dr. Abraham Springer, Prof. Dr. Dragan Milovanović, Dr. Saša Milanović, and Prof. Dr. Vesna Ristić Vakanjac**. During the course, Ljiljana Vasić, Branislav Petrović and Veljko Marinović gave their first lectures within the thematic session "Lectures of Young Experts". Also for the first time, two course participants, Charles Chuck Graf from the USA and Ramanathan Bhaskar from India, were invited to give



Praktična nastava i terenska ekskurzija CEKA 2017. godine, brana Grančarevo
Practical demonstrations and field trip CEKA 2017, Grančarevo dam

Nakon održavanja kursa 2017. godine, organizovana je još jedna terenska praksa za američke studente i profesore, koja je obuhvatala brojne karstne fenomene istočne i zapadne Hercegovine, kao i dalmatinske (jadranske) obale u Hrvatskoj: estavela Tučevac u Popovom polju kod Trebinja, Vrelo Bune, Mostar, vodopadi Kravice na reci Trebižat, Imotski (Modro i Crveno jezero) u Hrvatskoj, Split, vrelo Jadro, delta Neretve, vrelo Mali Zaton-Robinzon, Vrelo Ombla i Dubrovnik. Pored hidrogeoloških pojava, posećeni su i nalazište stećaka Radimlja u Stocu, kao i Fakultet građevinarstva, geodezije i arhitekture Univerziteta u Splitu.



Učesnici iz SAD-a i predavači na kursu CEKA 2017. godine u estaveli Tučevac
Participants from USA and lecturers of CEKA 2017 in Tučevac estavelle

Peti po redu CEKA kurs održan je između 27. maja i 5. juna 2018. godine i to po prvi put u dve zemlje: Bosni i Hercegovini (Trebinje) i Crnoj Gori (Virpazar). Organizaciju su, pored Centra za hidrogeologiju karsta i Geološkog zavoda Republike Srpske, preuzeli i Regionalni vodovodni sistem „Bolje Sestre“ iz Podgorice, Geološki zavod Crne Gore, kao i Opština Trebinje. Kurs je bio koncipiran tako da obuhvata i pokazne vežbe, te je tokom kursa u okviru izvorišta „Bolje Sestre“ izveden i kraći opit trasiranja podzemnih voda korišćenjem kuhinjske soli. CEKA 2018 kurs je započeo kraćim predavanjima u Trebinju, da bi se svi učesnici preselili u Crnu Goru gde su, pored pomenutog izvorišta „Bolje Sestre“ i posećeni i sledeći karstni

short lectures. The course was attended by 21 participants from 11 countries: USA, Bosnia and Herzegovina, Honduras, Germany, India, Italy, North Macedonia, Mexico, Montenegro, Slovenia, and Serbia.



Svi učesnici kursa CEKA 2017. godine
All participants of CEKA 2017

After the CEKA 2017 course, another field trip was organized for the US students and professors, which included numerous karst phenomena of eastern and western Herzegovina, as well as the Dalmatian (Adriatic) coast in Croatia: Tučevac estavelle in Popovo Polje near Trebinje, Buna Spring, Mostar, Kravice waterfalls on the Trebižat River, Imotski (Blue and Red lakes) in Croatia, Split, the Jadro Spring, the Neretva delta, the Mali Zaton-Robinson Spring, the Ombla Spring, and Dubrovnik. In addition to the hydrogeological features, they also visited the Radimlja Stećak site in Stolac and the Faculty of Civil Engineering, Geodesy and Architecture of the University of Split.



Učesnici iz SAD-a i predavači na kursu CEKA 2017. godine ispred vrela Bune, Blagaj kod Mostara
Participants from USA and lecturers of CEKA 2017 at Buna karst spring, Blagaj near Mostar

The fifth CEKA course was held from May 27 to June 5, 2018, for the first time in two countries: Bosnia and Herzegovina (Trebinje) and Montenegro (Virpazar). Besides the Center for Karst Hydrogeology and the Geological Survey of Republika Srpska, the Bolje Sestre RWS from Podgorica, the Geological Survey of Montenegro, and the Municipality of Trebinje also took part in the organization. The course was designed to include practical exercises and a short experiment was conducted at the Bolje Sestre sublacustrine spring, using salt. The CEKA 2018 course started with short

fenomeni: Nikšićko polje i akumulacije, Podgorica, Virpazar, Skadarsko jezero, Boka Kotorska i Grahovsko polje. Povratkom u Trebinje, nastavljeno je sa daljnim aktivnostima kursa u vidu teorijskih predavanja, odnosno terenskim ekskurzijama i posetama branama Grančarevo i Gorica, karstnim poljima, vrelima i pećinama istočne Hercegovine. Ukupno je 14 učesnika iz 5 zemalja (SAD, Srbija, Bosna i Hercegovina, Kina, Crna Gora) pohađalo kurs, na kome su sledeći profesori održali svoja predavanja: **Prof. Dr Zoran Stevanović; Prof. Dr Petar Milanović; Prof. Dr Derek Ford, Prof. Dr Richard Parizek, Prof. Emer. Dr Ognjen Bonacci; Prof. Dr Dragan Milovanović; Dr Saša Milanović.** Nastavljena je i praksa iz prethodne godine, da učesnici po pozivu održe kraće predavanje iz svog domena. Tokom kursa 2018. godine to su bile kolegice iz SAD Lee Anne Bledsoe i Lisa Ryan, odnosno prof. dr Junbing Pu iz Kine. Takođe, u sklopu predavanja grupe mladih eksperata, svoja predavanja imali su i dr Ljiljana Vasić, Branislav Petrović i Veljko Marinović.



Praktična nastava i terenska ekskurzija CEKA 2018. godine, Regionalni vodovod Crnogorsko primorje
Practical demonstrations and field trip CEKA 2018, Regional Waterworks Montenegrin Coast

Šesti po redu kurs CEKA održan je 2019. godine u periodu od 27. do 31. maja 2019. godine. Usled finansijskih i administrativnih razloga sa kojima su se sponzori i partneri suočili te godine, Organizacioni odbor kursa CEKA 2019 se odlučio za promenu lokacije održavanja kursa, tako da su predavanja održana na Rudarsko-geološkom fakultetu od 27. do 29. maja, a terenska praksa na prostoru karstnih terena Karpato - Balkanida istočne Srbije 30-31. maja, tokom koje je su posećeni karstni fenomeni Karpatskog karsta na prostoru Kučajsko-beljaničkog masiva: Regionalni vodovodni sistem Bogovina, Bogovinska pećina, *Felix Romuliana*, Zlotsko vrelo i Lazareva pećina i Lazarev kanjon, Brestovačka banja, vrelo Mlave i Krupaje, termalni izvor i bušotina pored Krupajskog vrela i banja Ždrelo. Ovim je uspešno zadržan kontinuitet u održavanju kursa, a domaći i strani studenti su imali jedinstvenu priliku da posete karstne fenomene istočne Srbije. Kurs je pohađalo 15 učesnika iz 5 zemalja (Bosna i Hercegovina, Indija, Iran, Srbija i Švedska), dok su predavanja održali mahom profesori Departmana za hidrogeologiju: **Prof. Dr Zoran Stevanović; Prof. Dr Petar Milanović; Prof. Dr Dragan Milovanović; Prof.**

lectures in Trebinje, after which all participants moved to Montenegro, where they additionally visited the following karst features: the Nikšić karst polje and reservoirs, Podgorica, Virpazar, Lake Skadar, the Bay of Kotor, and Grahovsko Polje. Returning to Trebinje, the group continued its course activities in the form of lectures and field trips to the Grančarevo and Gorica dams, karst poljes, and springs and caves of eastern Herzegovina. Fourteen participants from five countries (USA, Serbia, Bosnia and Herzegovina, China, Montenegro) attended the course. The lecturers were **Prof. Dr. Zoran Stevanović, Prof. Dr. Petar Milanović, Prof. Dr. Derek Ford, Prof. Dr. Richard Parizek, Prof. Emer. Dr. Ognjen Bonacci, Prof. Dr. Dragan Milovanović, and Dr. Saša Milanović.** As in the previous year, participants were invited to give short lectures in their respective fields. During the CEKA 2018 course, these lecturers included Lee Anne Bledsoe and Lisa Ryan from the USA and Prof. Dr. Junbing Pu from China. In addition, lectures were given by Dr. Ljiljana Vasić, Branislav Petrović and Veljko Marinović from the group of young experts.



Učesnici i predavači na kursu CEKA 2018. godine ispred Popovog polja
Participants and lecturers of CEKA 2018 in front of the Popovo karst polje

The sixth CEKA 2019 course was held from May 27 to 31, 2019. Due to financial and administrative challenges faced that year by the sponsors and partners, the Organizing Committee of the CEKA 2019 course decided to change the venue of the course. The lectures were held at the Faculty of Mining and Geology from May 27 to 29, and field practice in Carpatho-Balkanides karst terrains of Eastern Serbia from May 30 to 31, during which the features of the Carpathian karst in the area of the Kučaj-Beljanića massif were visited, including the Bogovina Regional Water System, Bogovinska cave, *Felix Romuliana*, Zlotsko Vrelo (spring), Lazareva Cave, Lazarev Canyon, the spa town of Brestovac, the Mlava and Krupaja springs, a thermal spring and borehole next to the Krupaja Spring, and the spa village of Ždrelo. This effectively maintained the continuity of the course, and local and foreign students had a unique opportunity to tour the karst features of eastern Serbia. The course was attended by 15 participants from five countries (Bosnia and Herzegovina, India, Iran, Serbia, and Sweden). The lectures were given mainly by DHG professors: **Prof. Dr.**

Dr Vesna Ristić Vakanjac; Prof. Dr Igor Jemcov; Prof. Dr Saša Milanović; Prof. Dr Vladimir Živanović. Takođe, dr Ljiljana Vasić je održala predavanje iz domena primene izotopa u hidrogeologiji karsta, dok su Branislav Petrović i Veljko Marinović održali kraća predavanja iz oblasti u kojima rade svoje disertacije.



Praktična nastava i terenska ekurzija CEKA 2019. godine, Krupajsko vrelo

Practical demonstrations and field trip CEKA 2019, Krupaja karst spring

Tokom 2020. godine, predviđeno je da kurs CEKA bude podignut na još viši nivo, tako što bi se dodala još jedna lokacija održavanja kursa. Planirano je bilo da se kurs održi u period od 11. do 20. juna 2020. godine na tri lokacije u dve države: na prostoru Žabljaka i Virpazara u Crnoj Gori, i tradicionalno u Trebinju. U planu je bilo i održavanje predavanja i terenskih ekurzija po Durmitorskom karstu, poseta vrelima Bukovice i Šavničke glave, Nikšićkom polju, Glavi Zete i HE „Perućica“, odnosno Regionalnom izvorištu „Bolje Sestre“, Skadarskom jezeru i vrelima Bokokotorskog zaliva. Pored toga, tradicionalne ture po istočnoj Hercegovini su takođe bile planirane, kao i svake prethodne godine. U cilju realizacije takvog kursa, jedinstvenog u svetskoj praksi, prikupljena su značajna finansijska sredstva od naših partnera, ali i od strane Ministarstva poljoprivrede i ruralnog razvoja Crne Gore. Međutim, usled pandemije korona virusa koja je zahvatila čitav svet 2020. godine, organizacioni odbor CEKA kursa je odlučio da otkáže isti i pomeri ga za 2021. godinu. Ipak, studentima master studija Rudarsko-geološkog fakulteta održana je *online* nastava iz ovog kursa, budući da je takav vid predavanja jedino bio moguć. Na ovaj način, uspešno je održan kontinuitet u održavanju kursa, čak i u vremenu pandemije i globalnog zatvaranja svetske populacije.

Osmi po redu CEKA kurs održan je 2021. godine u sklopu jedinstvenog događaja „Nedelja sa karstom“, o čemu je već bilo reči u prethodnom tekstu. Tradicionalni osmi CEKA kurs održan je od 1. do 4. juna 2021. godine, a kurs je *online* pratilo ukupno 93 polaznika iz 24 zemlje širom sveta.

Zoran Stevanović, Prof. Dr. Petar Milanović, Prof. Dr. Dragan Milovanović, Prof. Dr. Vesna Ristić Vakanjac; Prof. Dr. Igor Jemcov; Prof. Dr. Saša Milanović, and Prof. Dr. Vladimir Zivanović. Also, Dr. Ljiljana Vasić gave a lecture in the field of isotope application in karst hydrogeology, while Branislav Petrović and Veljko Marinović gave short lectures on the topics they were addressing at the time in their dissertations.



Učesnici i predavači na kursu CEKA 2019. godine u Feliks Romuliani

Participants and lecturers of CEKA 2019 in Felix Romuliana

In 2020, plans called for the CEKA course to be raised to a higher level, by adding another location. The course was supposed to be held from June 11 to 20, 2020, at three venues in two countries: Žabljak and Virpazar in Montenegro, and traditionally in Trebinje. Plans also included lectures and field trips to the Durmitor Karst areas, visits to the Bukovica and Šavnička Glava springs, Nikšić Polje, Glava Zeta spring, Perućica HPP, Bolje Sestre RWS, Lake Skadar, and the springs of the Bay of Kotor. Traditional tours of eastern Herzegovina were also included, as in every previous year. To hold such a course, unique in the world, significant financial resources were collected from partners, as well as the Ministry of Agriculture and Rural Development of Montenegro. However, due to the corona virus pandemic that affected the entire world in 2020, the CEKA organizing committee decided to cancel the course and move it to 2021. Nevertheless, online classes from this course were offered to master's students of the Faculty of Mining and Geology since remote teaching was the only possible option. This effectively maintained the continuity of the course, even at a time of worldwide lockdowns and closures due to the pandemic.

The eighth CEKA course was held in 2021 as part of the unique event "A Week with Karst" which was already discussed in the previous text. The traditional eighth CEKA course was held from June 1 to 4, 2021, and the course was followed online by a total of 93 participants from 24 countries around the world.

The CEKA course returned to Trebinje in 2022, after a break of four years. Given that the conditions for

CEKA kurs se 2022. godine vratio u Trebinje, posle pauze od 4 godine. S obzirom na to da su se stekli uslovi za održavanje kursa uživo, organizacioni odbor je odlučio da kurs vrati u Trebinje, gde se održavao tradicionalno sve do pandemije korona virusa. CEKA 2022 je održana od 26. do 30. maja 2022. godine u prostorijama HET-a, koje su i 2022. godine tradicionalne bile naš domaćin. Organizatori kursa su veliku pomoć dobili i od Opštine i Grada Trebinja. Kurs je pohađalo ukupno 14 učesnika iz Bosne i Hercegovine, Crne Gore i Srbije, tako da je ovo prvi kurs koji je organizovan na srpskom jeziku. Ukupno je 7 predavača održalo teorijsku i praktičnu nastavu: **Prof. Dr Zoran Stevanović; Prof. Dr Petar Milanović; Prof. Dr Vesna Ristić Vakanjac, Prof. Dr Saša Milanović, Prof. Dr Ljiljana Vasić; Dr Josip Terzić, Dr Branislav Petrović i Veljko Marinović.** Na ovaj način, kurs je vraćen u Trebinje, nastavljen je kontinuitet održavanja i dolaska u Hercegovinu, čime su se stekli uslovi za održavanje narednih kurseva!









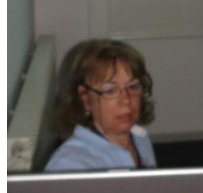

Praktična nastava i terenska ekskurzija CEKA 2022. godine
Practical demonstrations and field trip CEKA 2022






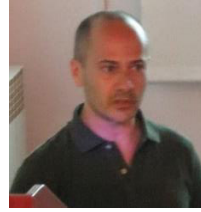


holding a live course had been met, the Organizing Committee decided to return the course to Trebinje, its traditional venue before the corona virus pandemic. CEKA 2022 was held from May 26 to 30, 2022 on the premises of HET, which was again our host in 2022. The organizers of the course received great help from the Municipality and City of Trebinje. The course was attended by 14 participants from Bosnia and Herzegovina, Montenegro, and Serbia, so it was the first course organized in the Serbian language. Seven lecturers held theoretical and practical classes, including **Prof. Dr. Zoran Stevanović, Prof. Dr. Petar Milanović, Prof. Dr. Vesna Ristić Vakanjac, Prof. Dr. Saša Milanović, Prof. Dr. Ljiljana Vasić, Dr. Josip Terzić, Dr. Branislav Petrović, and Veljko Marinović.** Thus, the course returned to Trebinje, the continuity of the venue in Herzegovina was maintained, and conditions were created for upcoming courses!



Učesnici i predavači na kursu CEKA 2022. godine
Participants and lecturers of CEKA 2022

Spisak svih predavača koji su držali predavanja na kursu CEKA od 2014. godine
List of all lecturers at CEKA since 2014

Predavač / Lecturer	Afilijacija / Affiliation	Godina predavanja / Year of participation	Država / State	Fotografija / Photo
Prof. Dr Zoran Stevanović	CHK / CKH	2014 -	Srbija / Serbia	
Prof. Dr Petar Milanović	Univerzitet u Mostaru / University of Mostar	2014 -	Srbija / Serbia	
Prof. Dr Ognjen Bonacci	Univerzitet u Splitu / University of Split	2014 - 2019	Hrvatska	
Dr Neven Krešić	Konsultant / Expert	2014 -	SAD	
Prof. Dr Saša Milanović	CHK / CKH	2014 -	Srbija / Serbia	
Prof. Dr Dragan Milovanović	Rudarsko-geološki fakultet, UB	2014-2021	Srbija / Serbia	
Prof. Dr Vesna Ristić Vakanjac	CHK / CKH	2014 -	Srbija / Serbia	
Prof. Dr Francesco Fiorillo	Univerzitet Sanio, Benevento / University of Sannio	2014, 2021	Italija / Italy	

Prof. Dr Bartolome Andreo Navarro	Univerzitet u Malagi / University of Malaga	2014, 2021	Španija / Spain	
Dr Neno Kukurić	IGRAC-UN	2014-	Holandija / The Netherlands	
Geary Schindel	Izvorište Edwards / Edwards Aquifer Authority	2015	SAD / USA	
Dr Petar Malik	Geološki zavod Slovačke / Geological Survey of Slovakia	2015, 2021	Slovačka / Slovakia	
Prof. Dr. Abraham Springer	Univerzitet Severne Arizone / Northern Arizona University	2016, 2017, 2021	SAD / USA	
Dr Mario Parise	Istraživački institut za hidrološku zaštitu / Institute of Research for Hydrological Protection	2016	Italija / Italy	
Dr Hermann Stadler	Joanneum Research Institute for Water, Energy and Sustainability Water Resources Management	2016	Austrija / Austria	
Prof. Dr Derek Ford	Univerzitet MekMaster / McMaster university	2018	Kanada / Canada	

Prof. Dr Richard Parizek	Pensilvanijski Univerzitet / Pennsylvania State University	2018	SAD	
Doc. Dr Ljiljana Vasić	CHK / CKH	2017 -	Srbija / Serbia	
Dr Branislav Petrović	CHK / CKH	2017 -	Srbija / Serbia	
Dr Veljko Marinović	CHK / CKH	2017 -	Srbija / Serbia	
Jeff Bennett	Nacionalni park Big Bend / Big Bend National Park	2017	SAD / USA	
Charles (Chuck) Graf	Departman za Kvalitet Životne Sredine Arizone / Arizona Department of Environmental Quality	2017	SAD	
Prof. Dr Ramanathan Baskar	Univerzitet za nauku i tehnologiju Guru Džambešvar / Guru Jambheshwar University of Science and Technology	2017	Indija	
Lee Anne Bledsoe	Hidrogeološka laboratorija Kraford / Crawford Hydrogeology Laboratory	2018	SAD	
Lisa Ryan	Geolog u penziji / retired professional geologist	2018	SAD	

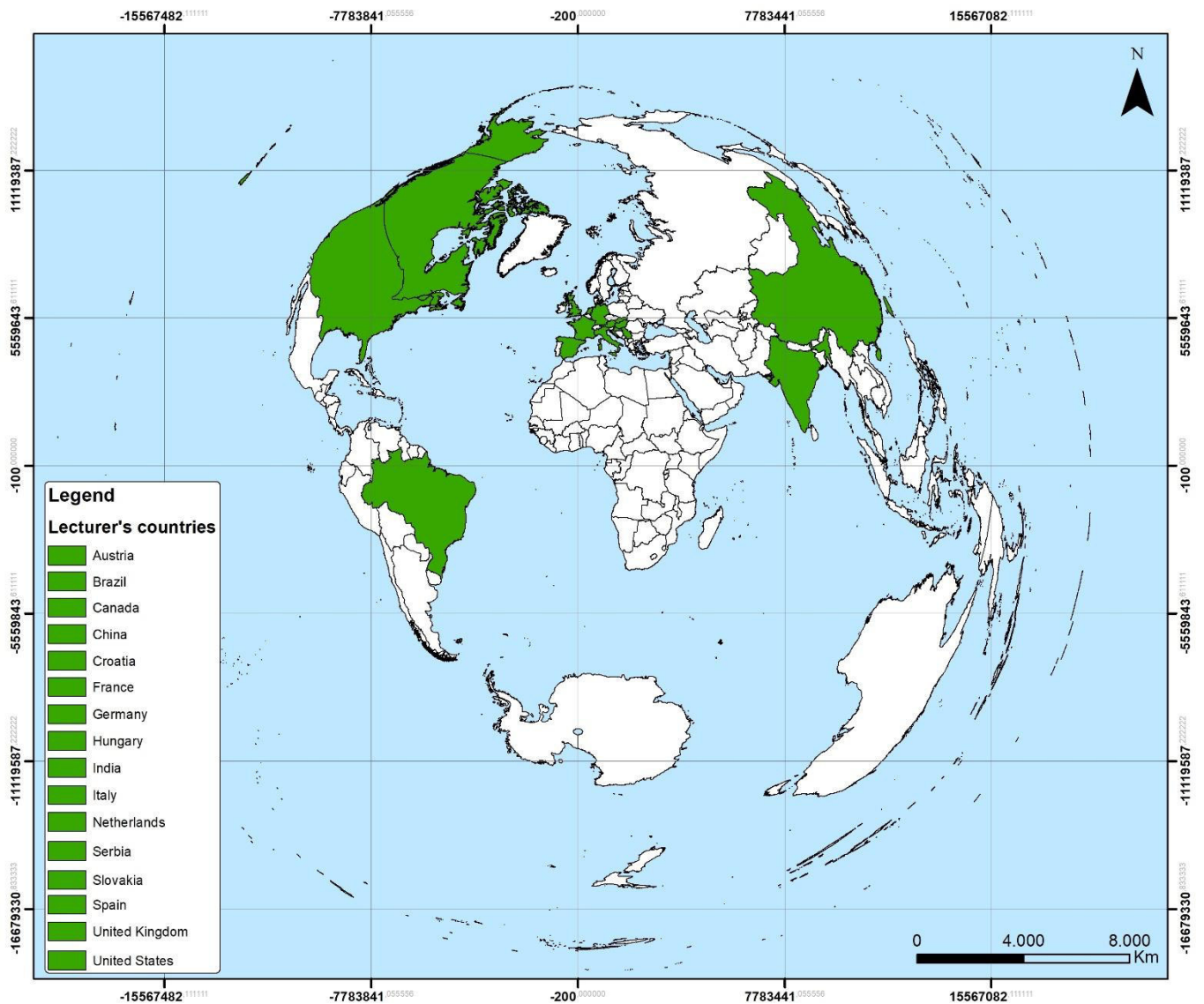
Prof. Dr Junbing Pu	Univerzitet u Čongqvinu / Chongqing Normal University	2018	Kina	
Prof. Dr Igor Jemcov	Rudarsko-geološki fakultet, UB	2019	Srbija / Serbia	
Prof. Dr Vladimir Živanović	Rudarsko-geološki fakultet, UB	2019	Srbija / Serbia	
Dr Augusto Auler	Institut za karst / Carste Ciência e Meio Ambiente	2021	Brazil / Brasil	
Prof. Dr Nico Goldscheider	Karlsruhe institut za tehnologiju / Karlsruhe Institut of Technology KIT	2021	Nemačka / Germany	
Prof. Dr Chris Groves	Univerzitet Zapadni Kentaki / Western Kentucky University	2021	SAD / USA	
Prof. Dr John Gunn	Univerzitet u Birmingemu / University of Birmingham	2021	UK	
Prof. Dr Hervé Jourde	Univerzitet u Monpeljeu / University of Montpellier	2021	Francuska / France	
Prof. Dr Attila Kovács	Univerzitet u Miškolcu / University of Miskolc	2021	Mađarska / Hungary	

Dr Josip Terzić

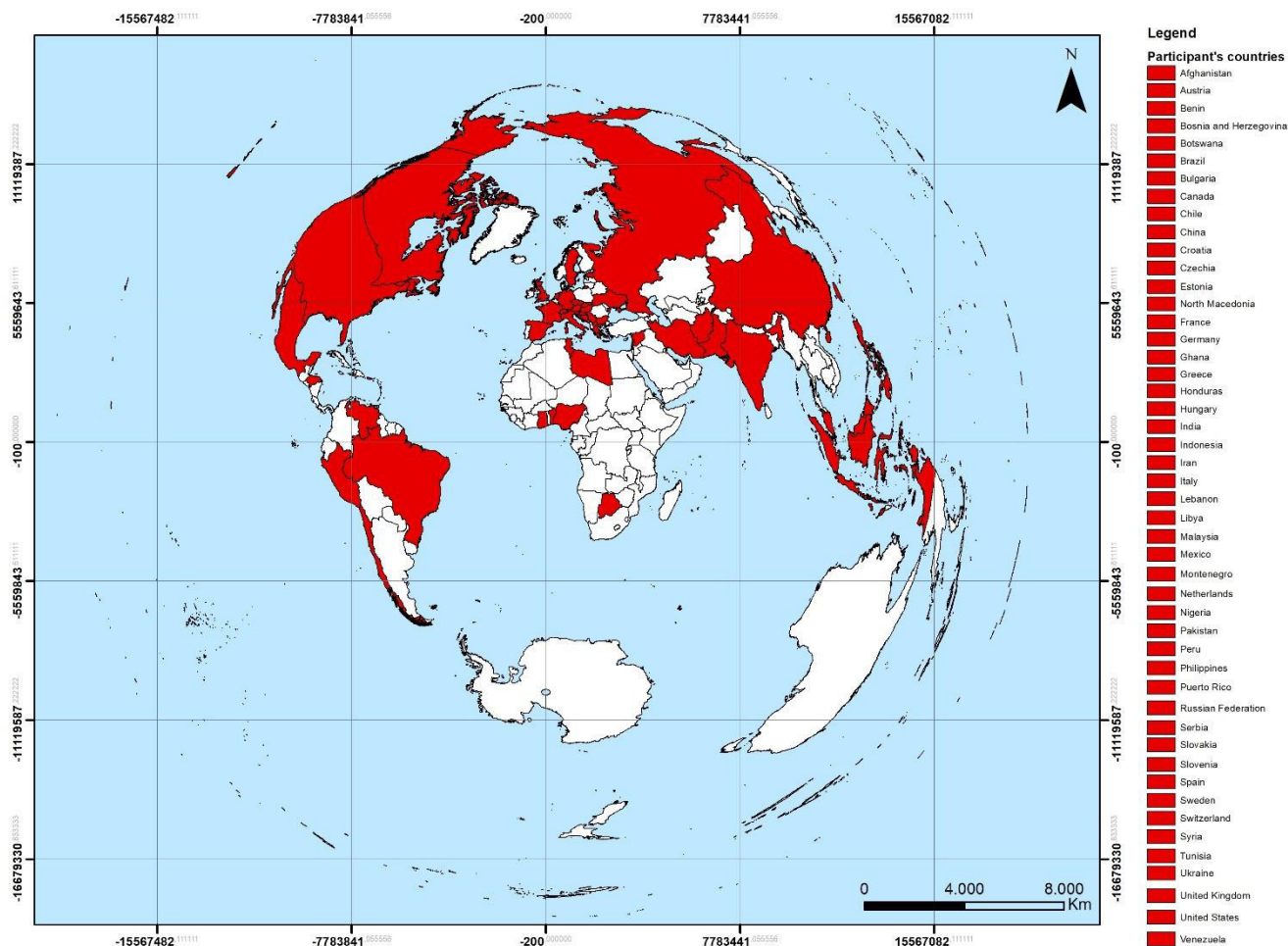
Hrvatski geološki
zavod / Croatian
Geological Survey

2022

Hrvatska /
Croatia



Karta zemalja odakle su dolazili predavači na kursu CEKA
Map of the countries where the lecturers of CEKA came from



Karta zemalja odakle su dolazili učesnici na kursu CEKA
 Map of the countries where the participants of CEKA came from



