***Programme of the***



**to be held between 1-7 June, 2015**

**Organizational setup**

The second international course and field seminar *Characterization and Engineering of Karst Aquifers* will take place in Trebinje, Bosnia & Herzegovina, between 1-7 June, 2015. The programme of the academic course “*Characterization and Engineering of Karst Aquifers*” is developed primarily for graduate students and students in senior years of undergraduate studies in geology, environmental sciences, and engineering that are interested in the research of karst environments and in the development and engineering of karst water resources. The professionals and decision makers involved in engineering and management of karst waters or environments will also benefit from the course by improving their understanding of karst processes and sensitivity. Therefore, wide range of participants from students to staff of water utilities or water managers at the local, regional and international levels may attend this course organized under framework of DIKTAS project (Dinaric Karst Transboundary Aquifer System) and sponsorship of UNESCO.

The course consists of intensive lectures, followed by the field work, two field trips, and the final exam. The goal of the course is to enhance knowledge of basic hydrogeology in fractured rock and karst aquifers, introduce applicable investigation methods, and provide framework for monitoring, engineering and management of water in karst. Design and execution of field investigations, design and optimization of groundwater extraction, aquifer protection and restoration, artificial groundwater control, and prevention of leakage from reservoirs constructed in karst are some of the specific topics that attendants will study and perform field work on.

The course is certified by the University of Belgrade as one of the regular courses of the MS Program of the Department of Hydrogeology. Its value is 6 ECTS (European Credit Transfer and Accumulation System). All attendants who pass the final exam will receive certificate of attendance, credits and the final grade.

The sessions will be held at the halls of the HET (Hydro-Electro System Trebisnjica River) in Trebinje, Obala Luke Vukalovica 2. During the course a half-day and a full-day field trips will take place.

All participants will receive printed lecture notes and other course materials upon arrival, as well as a DVD with additional presentations upon completion of the course.

The class will meet daily from 8:30 A.M. to 12:45A.M. and from 2:00 P.M. to 5:30 P.M. Short breaks are at 11:00 A.M. and 3:30 P.M. Due to the extensive amount of material, additional early evening session would be held in the second day.

Enrollment will be limited and applications will be accepted in the order they are received. It is expected that around 20 participants will attend the course in 2015. Up to date, 9 applications were already arrived to the Organizer.

Due to provided DIKTAS / UNESCO sponsorship and financial supportthere would be no course fee for university students, and they will receive small incentives for covering parts of their accommodation and travel. Working professionals will also not be charged for the course fee. The lecturers accepted to work *pro bono*.

**Lecturers (preliminary list):**

Dr Zoran Stevanović, Prof. University of Belgrade, Serbia

Dr Neven Kresic, Hydrogeol. Practice Leader, Amec Foster Wheeler, VA, USA

Dr Petar Milanović, Ret. Assoc. Prof., Univ. of Mostar, B&H

Dr Ognjen Bonacci, Prof. Emer. University of Split, Croatia

Geary Schindel, Chief TO, Edwards Aquifer Authority, San Antonio, TX, USA

Dr Neno Kukurić, Head UN-IGRAC, Delft, the Netherlands

Dr Petar Malik, Geological Survey of Slovakia, Bratislava, Slovakia

Dr Dragan Milovanović, Ret. Prof. University of Belgrade, Serbia

Dr Vesna Ristić Vakanjac, Assoc. Prof. University of Belgrade, Serbia

Dr Saša Milanović, Sci. Res. University of Belgrade, Serbia

**Tentative program:**

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| **Day** | **Time (h)** | **Topic/Activity** | **Lecturer** |
| **31 May** | **10 AM -** | Arrival, Registration |  |
| **7 PM -** | Welcoming reception |
| **1 June** | **9 – 9.30 AM -** | Opening ceremony |
| **9.30 – 11 AM** | Introductory note about course; Historical development of karstology and karst hydrogeology; Importance of karst and karst distribution worldwide; Geo-heritage sites; Dinaric karst | Z.Stevanović |
| **11.15 AM – 12.45** | Carbonate and non-carbonate rocks: mineralogy, depositional environments, classifications | D.Milovanović |
| **2 – 2.45 PM** | Chemical factors of karstification; Role of tectonics | D.Milovanović |
| **2.45 – 3.45 PM** | Porosity and permeability of karstic rocks; Karstification process and its features: Surface and subsurface karst landforms | Z.Stevanović |
| **4 – 5.30 PM** | Groundwater circulation in karst: recharge, flow types and directions, discharge | Z.Stevanović |
| **2 June** | **9 – 10.15 AM** | Methods in karst hydrogeology – an overview; Geology, field reconnaissance and mapping, , water occurrences inventory, remote sensing, geophysics, tracing tests | Z.Stevanović |
| **10.15 – 11.30 AM** | Methods in karst hydrogeology – climate, hydrology, water chemistry, statistics | V. Ristić Vakanjac |
| **11.45 AM – 12.45** | Methods in karst hydrogeology – geomorphology, speleology, hydrogeology maps, GIS and database, exploratory drilling | S. Milanović |
| **2 – 4.15 PM** | Methods in karst hydrogeology – groundwater tapping, hydrogeological properties and hydrodynamics of karst aquifers, field tests &  Characterization of karst aquifers; Groundwater budget and catchment delineation; Specific regime of karstic groundwater (quantity, quality) | Z.Stevanović |
| **4.15 – 5.15 PM** | Transboundary aquifers in karst: problems, solutions and experiences | N. Kukurić |
| **5.15-6.15 PM** | Leakage from reservoirs and remedial measures, case studies | S. Milanović |
| **3 June** | **9-10.45 AM** | Problems related to construction of dams, reservoirs and other structures and buildings in karst;  Investigation, design, corrective measures, case studies. | P. Milanović |
| **10.45-3.15 PM** | Half-day field trip to Grančarevo and Gorica dams, and intake for water supply of Trebinje (“Oko” spring) | guided by P. Milanović  and other  lecturers |
| **4.15-5.30 PM** | Presentation on the HE system Trebišnjica; DVD movie “Trebišnjica” waters. Other case studies, Discussion |  |
| **4 June** |  | One-day field trip and seminar (classical karst features, phenomena, engineering structures): Popovo polje – Vjetrenica cave – Vrelo Bune (the largest karst spring in Dinaric karst) – spring Vrelo Bregave – Dabarsko polje (water engineering structures) – Fatničko polje (estavelle Obod) – Bilećko Lake (submerged source of Trebišnjica River) – Trebinje | guided by P. Milanović  and other  lecturers |
| **5 June** | **9.00 – 10.45 AM** | Water resources cycle in karst; Surface-groundwater interaction; Feasibility studies and engineering design; Environmental impact assessment; Case studies | O. Bonacci |
| **11.00 - 12.30** | Karst springs as indicator of aquifer behaviour: measurements, assessment methods, spring hydrographs, case studies | P. Malik |
| **2- 3.30 PM** | Management of karst aquifers; Legislation, control, monitoring, over-extraction consequences; Hazardous material in urban karst; case studies | G. Schindel |
| **3.45 – 5 PM** | Water extraction in karst; Safe yield and sustainability; Aquifer control in discharge zones and drainage areas | Z.Stevanović |
| **6 June** | **9.00 – 11 AM** | Modeling of karst aquifers – conceptualization for numeric models, software, EPM, CFP, case studies | N. Krešić |
| **11.15 – 12.30** | Modeling of karst aquifer – Springs hydrograph analysis and stochastic models | V. Ristić Vakanjac |
| **2 – 3.30 PM** | Karst aquifer vulnerability: assessment methods, visualization, sanitary protection zones, case studies | Z. Stevanović |
| **3 – 4 PM** | Karst aquifer sustainability; Aquifer restoration (groundwater remediation); case studies | N. Krešić |
| **4.15 – 5 PM** | Protecting the nature: Endemic species in karst | S. Milanović |
| **5 – 5.30 PM** | Concluding remarks | Z.Stevanović |
| **7 June** | **9.30 – 12.30 AM** | Exam: Written test and verbal discussion | Z.Stevanović, V. Ristić Vakanjac, S. Milanović |
| **5.30 PM** | Results of the exam, Certificates, Closing ceremony |  |
| **6.00 PM -** | Farewell party: Local winery; Dinner in national restaurant |