

# **Abstracts of Scientific Talk Programs**

## **Root cause analysis of the 2018 Disaster at the Ituango Hydroelectric Project in Colombia, S-America**

**Ulrich Glawe**

Senior Consultant in Hydropower companies

The Ituango Project, under construction since 2011, is located at the river Cauca in central Colombia. The estimated capacity is 2,456 MW. The main structures constructed on the surface are 225 m high earth-fill clay core dam and a gated spillway with a capacity of 22.000 m<sup>3</sup>/s. While, the underground powerhouse complex includes the significant excavations of transformer cavern, the actual powerhouse and the downstream surge cavern as well as numbers of tunnels. Each eight-intake lead to eight penstocks that produce a nominal head of 197 m. The river Cauca with an annual mean flow of 1.000 m<sup>3</sup>/sec was initially diverted through two D-shaped, 14 m diameter tunnels. In addition, a 14 m diameter auxiliary diversion tunnel was constructed in 2016/17 and went into operation in late 2017 in support for the diversion closure.

Later, at the end of April 2018, the river was diverted only through the auxiliary diversion tunnel, while the other two main tunnels were not on an operation. Because of this, the supporting diversion tunnel collapsed and blocked. This collapse was associated with the development of 100 m wide sinkhole at the surface (approximately 120 m above the tunnel roof) and it produced a seismic event of magnitude  $m_L = 1.4$ . The incident leads to the rapid rise in the reservoir level; however, until this time, both the dam and spillway were still under construction phase. To avoid dam overtopping, it was essential to divert the uncontrolled river through the intakes and powerhouse complex (also under construction). During that time, the uncontrolled river spill  $> 1.000 \text{ m}^3/\text{sec}$ , resulted in the significant damage ( $> 1$  billion USD) in the powerhouse complex. A comprehensive geotechnical and hydraulic analysis was conducted to delineate the root cause of this disaster. All available geological data before and during construction were scrutinized along with the hydraulic dataset that helps to determine stream power at the tunnel walls. The study concludes that high stream power, which was undetected/neglected, unfavorable geological conditions, as well as design and construction-related errors, lead to erosion of the unlined tunnel invert. This was followed by the collapse of the tunnel sidewalls and upward failure progression in tightly jointed rock up to the boundary of highly weathered to completely weathered rock. The final collapse and blockage occurred in completely weathered rock and residual soil, creating the large surface crater.

## **Real-time health monitoring of tunnels**

**Ajay K. Jha**

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Dr. Jha, BioID GmbH, Germany, has developed ADA solutions for real-time monitoring of any civil structure using their patented Artificial intelligence-powered advanced data analytics code. "ADA system," which they have developed, uses a special type of fiber optic sensing cable, which is capable of measuring rock movement/strain and temperature inside any tunnel, road or rail embankment, dams, or any type of civil structure. The characteristics of a monitoring system are as follows:

- spatial resolution: 0.20 m i.e 20 cm
- accuracy of strain measurement =  $2 \mu$  (  $2/1000 \text{ mm}$  )
- accuracy of temperature measurement =  $0.1^\circ\text{C}$

One tool is capable of monitoring 25 km of any stretch on a real-time basis (24x7) with following three types of alarms when the strain or temperature exceeds the threshold set up by site manager

- mail notification
- text notification
- audio-Visual alarm

The user can fix the fiber optic sensing cable (different from telecom grade cable as these are designed explicitly for strain and temperature monitoring) using shortening in a new tunnel. For existing tunnels, it can use low-cost cement capsules or resin capsules for fixing, and it has a short setting time i.e., 4s. A user can choose any traverse of laying the cable on the structure i.e., along the roof, along pillar, horizontal, crisscross, zig-zag, or any type of traverse, as one deems fit. The tool supports the following types of data transmission.

- telnet
- API Library
- transmission over TCP/IP
- modbus over TCP/IP
- SNMP
- API Calls

## **Structure of the crust and upper mantle beneath the SE United States' continental margin from two applications of seismic interferometry**

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The Gulf of Mexico (GoM) passive margin is the site of our planet's second largest accumulation of sediments (following the Bay of Bengal). These sediments form deep blankets that, among other things, harbor vast reserves of hydrocarbons, create fertile soils, and produce flat terrains that millions of people call home. They also obscure the structure and composition of the crust and mantle beneath the sediments, so that, even now, their geological histories, compositions, and tectonic processes are poorly understood.

Previous studies suggest that Laurentia moved west-northwest during Proterozoic rifting, creating a passive continental margin that consisted of distinct north-northeast–striking rift segments and east-southeast–striking transform segments, and that the Gulf of Mexico opened through a net counter-clockwise rotation of the Yucatan block.

Until recently, few studies have investigated the margin's structure, partly because few seismic stations and very little data were available. However, EarthScope's USArray provides a great deal of new data with which to model crustal and lithospheric structure in the southern U.S. I will present two applications of seismic interferometry, coupled with tomography, to investigate the Gulf of Mexico passive margin. The first is comprised of body waves in a transect across the Texas-GoM; the second uses Rayleigh waves extracted from ambient noise to produce velocity maps, and ultimately shear wave velocity profiles, of the southeastern U.S.

In the first application we perform two-dimensional seismic tomography across the “dry land” portion of the Texas-Gulf of Mexico margin using Pg, Pn, SsPmp, and teleseismic P data from various sources. The resulting model (and additional studies) reveals several unexpected features. A high velocity body is observed in the crust below the Luling uplift, indicating possible magmatism during rifting. The crust thins from NW to SE, indicating that extension occurred mostly to the south of the Ouachita orogeny. The non-uniform extended crust suggests that the rift moved southward with time. Our model suggests a new role for the enigmatic Balcones Fault Zone.

In the second application we use continuous time series from more than 400 vertical-component broadband seismic stations for the period January 2010 to July 2017 to compute Green's functions for more than 80000 station pairs across the continental margin of the southeastern United States. Cross-correlations are computed on a daily basis, using a cross-coherence function and double beamforming techniques, and stacked to increase the signal-to-noise ratio of the coherent waves propagating along the great-circle path between each station pair. A preliminary tomographic model for the southeastern U.S. shows features that confirm those obtained from previous geological and geophysical studies but also several unexpected features.

## **Topics in risk and hazard seismology regarding Nepal**

**Max Wyss**

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The study emphasized the data type and software needed for the estimation of casualties due to earthquakes within minutes of the event. This information is crucial to enable first responders to make a quick decision on the rescue operation. The number of mortalities in past Himalayan earthquakes need to be calculated correctly (within a factor of 3) to allow scenario loss estimates for future ruptures. Line source models of historic Himalayan earthquakes further suggest that up to 1 million people will require medical attention during the re-occurrence of such ruptures.

In contrary to the current belief that urban centers should be in prime focus for the protection of a large number of population, the data shows that the fatalities during large earthquakes in rural areas is  $> 90\%$ . Despite few cities, long ruptures (300 km) affect thousands of villages and the urban deaths on earthquakes are short (50 km) and mostly centric to the industrial area. The earthquake closet structure, similar to a tornado shelter built inside a rural house is one of the solutions for protecting a family in strong earthquakes. The cost of such shelter is minimal while retrofitting the entire house will be much higher.

In case of earthquake hazard estimation made by extrapolating an expected large magnitude, the Gutenberg-Richter relationship of small and medium-sized earthquakes in an area, resulting in the observation of incorrect return time ( $1/\text{probability}$ ). In general, this happened because too few earthquakes occur along faults, leading to estimated recurrence times of 100,000 years (stunning examples are the San Andreas and the Alpine Faults), instead of about 250 years, the correct number. However, it has been demonstrated for about 200 mapped faults with recurrence times of large earthquakes known from paleoseismology.

## **Characterizing fault behavior for better assessing the seismic hazard: examples and challenges**

**Laurent Bollinger**

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Seismic hazard has long been evaluated on the sole basis of known seismicity. However, instrumental and historical seismicity along faults capable of generating strong earthquakes is often known for a duration corresponding to a small fraction of their seismic cycle. The seismicity considered as an input for the seismic hazard calculations is thus hardly representative of the whole seismogenic potential. To overcome this difficulty, we document past earthquakes ruptures and the seismic behavior of the fault systems.

## **Expansive mortar: A cracking Agent**

**Raman Kumar Jha**

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Conventional blasting where not possible, alternative practice is going on successfully by using non-explosive material, which is expansive mortar. This non-explosive blasting material is very effective and economical too. Expansive mortar is a soundless, safe and non-explosive demolition agent that provides the most technically suitable, environmental friendly and cost-effective alternative solution. This product is a new kind of static, chemical non-blasting agents with a max pressure of 15Mpa. This product is efficient, environment friendly and cost-effective, safe, easy to use and not any special permits or licenses required for operating and lastly noise and vibration free.

The expansive mortar is soft, like a malleable putty. More importantly, we can easily fit it into previously drilled holes with required intervals, and within few seconds of filling, it starts to work. Within a few hours, the mortar will create a build-up pressure within the rocks that results the cracks and split of big rock mass. This unique product is usable in almost anywhere that requires a mortar rather than a liquid. Since expansive mortar can be easily formed into 'sausages' and inserted into holes, it is efficient in hard to reach areas of horizontal rock too. Due to its safety feature, not requirement of any licenses and permits as well as extra security of protection, it is becoming interest of many industries in worldwide. The expansive mortar usages a premium grade natural material that only causes pressure to crack rock without dust, noise, vibration or dangerous fallout and less destruction on surrounding environment. This expansive mortar is easy to use, and only attention should be made that after mixing, it has pliable expansive cement rather than a liquid.

## **Checking the pulse and taking the temperature: how do karst springs respond to environmental stresses?**

**Alan Fryar**

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Karst terrains, which form on limestone and other soluble rocks, form approximately 7–10% of dry, ice-free land on Earth. These landscapes are marked by the integration of surface and subsurface drainage through features such as sinkholes, caves, and springs. Karst aquifers supply water for about 25% of the world's population. Because flow-path apertures are large and groundwater velocities are rapid, karst aquifers tend to respond quickly

to rainfall. As a result, water flow and quality are sensitive to environmental stresses such as land-use/land-cover changes, climate change, and pollution. To understand how karst aquifers respond to such stresses, field tests with hydrologic tracers and automated monitoring of water flow and quality are important. This talk highlights the use of these techniques in two studies: on variability in spring flow at different time scales (Middle Atlas region, Morocco) and on the occurrence and transport of bacteria to springs (Inner Bluegrass region, Kentucky).

## **Challenges of landslide disaster to development of Nepal and their mitigations**

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The landslides in Nepal are affecting directly to the settlements threatening to lives and properties of people, agricultural land, and infrastructures and are affecting to the national goal as poverty alleviation and the Gross Domestic Product (GDP) by 4%. The landslide disaster is one of the major disasters occurring in Nepal each year, which covers about more than 105 toll deaths, (22% of total casualties), and property losses cover more than 142million rupees in average according to the analysis of ten years data from 2009/10 to 2018/19 of Ministry of Home Affairs (MoHA.). This situation of landslide disaster is challenging to the development of Nepal. Those challenges can be addressed by mitigation of landslide disasters as application of appropriate structural mitigation technologies, which need the preparation of the basic data map like inventory map with degree of hazard, selected hot spot and community level hazard maps with risk zoning of landslide. Similarly, it can be mitigated by application of appropriate non-structural mitigation technologies as landslide early warning system, community awareness training, roving seminar and application of appropriate land use policy. The disaster focal institute, National Disaster Risk Reduction and Management Authority (NDRRMA) and Ministry of Home Affairs (MoHA) is focusing mainly in immediate response component of disaster management cycle in terms of rescue and relief works, study and policy making. It will be difficult to fulfill the remaining components of disaster management cycle as prevention, mitigation, capacity building and awareness as early warning systems by NDRRMA, MoHA alone. The NDRRMA is getting support of Department of Hydrology and Meteorology (DHM) for flood hazard management and flood EWS, Department of Health for health management area, local governments as municipalities for fire management sector and so on. So, it is obvious that establishment of a Landslide Disaster Management Institute (LDMI) with research and development unit will support to NDRRMA, provincial government and local government as a line agency which will fulfill the disaster management cycle with satisfying the Sendai Framework for Disaster Risk Reduction 2015–2030 and the recommendation made from the International SABO Symposium 2015 in Sendai focusing on Sediment Disaster Reduction (SDR) as well.

*Key words:* Landslide, Disaster, Management, Implementing institute, Development of Nepal.

# A Glimpse of Scientific Talk Program by Dr. Ulrich Glawe Nepal Geological Society

December 6, 2019 (Mangsir 20, 2076)



Dr. Ulrich Glawe presenting paper on Root Cause Analysis of the 2018 Disaster at the Ituango Hydroelectric Project in Colombia, S-America



Participants attending the talk program of Dr. Ulrich Glawe.

# A Glimpse of Scientific Talk Program by Dr. Ulrich Glawe Nepal Geological Society

December 6, 2019 (Mangsir 20, 2076)



Professor Dr. Tara Nidhi Bhattarai, introducing about Dr. Ulrich Glawe after offering Khada.



Mr. Ram Prasad Ghimire, President of the Society delivering the word of appreciation to the presenter Dr. Ulrich Glawe after handover of Token of Love.

# A Glimpse of Scientific Talk Program by Dr. Ajay K. Jha Nepal Geological Society

December 13, 2019 (Mangsir 27, 2076)



Dr. Ajay K. Jha presenting paper on “Real-time Health Monitoring of tunnels”.



Participants attending the talk program of Dr. Ajay K. Jha.

## A Glimpse of Scientific Talk Program by Dr. Ajay K. Jha Nepal Geological Society

December 13, 2019 (Mangsir 27, 2076)



Mr. Ajab Singh Mahara, Director of Nepal Electricity Authority taking part in discussion program.



Dr. Ramesh Man Tuladhar, former President of the Society and Mr. Ram Prasad Ghimire offering Khada and Token of Love to presenter Dr. Arun K. Jha.

## A Glimpse of Scientific Talk Program by Dr. Robert Jay Pulliam Nepal Geological Society

December 20, 2019 (Poush 04, 2076)



Dr. Robert Jay Pulliam presenting paper on “Structure of the crust and upper mantle beneath the SE United States’ continental margin from two applications of seismic interferometry”



Prof. Dr. Khum Narayan Paudyal delivering welcome speech and highlighting the talk program of Dr. Jay Pulliam.

## **A Glimpse of Scientific Talk Program by Dr. Robert Jay Pulliam Nepal Geological Society**

December 20, 2019 (Poush 04, 2076)



Participants attending the talk program of Dr. Jay Pulliam.

## **A Glimpse of Training Program by Dr. Upendra Baral Nepal Geological Society**

January 10, 2020 (Poush 25, 2076)



Participants attending training program of Dr. Upendra Baral.



Mr. Ram Prasad Ghimire offering Khada and Token of Love to Trainer Dr. Upendra Baral