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Engineering Geology for Society  
and Territory – Volume 6

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Giorgio Lollino • Daniele Giordan  
Kuroschi Thuro • Carlos Carranza-Torres  
Faquan Wu • Paul Marinos  
Carlos Delgado  
Editors

# Engineering Geology for Society and Territory – Volume 6

Applied Geology for Major Engineering Projects

*Editors*

Giorgio Lollino  
Daniele Giordan  
Institute for Geo-Hydrological Protection  
National Research Council (CNR)  
Turin  
Italy

Kuroschi Thuro  
Department of Engineering Geology  
Technical University of Munich  
Munich  
Germany

Carlos Carranza-Torres  
Department of Civil Engineering  
University of Minnesota Duluth  
Duluth, MN  
USA

Faquan Wu  
Institute of Geology and Geophysics  
Chinese Academy of Sciences  
Beijing  
China

Paul Marinos  
Geotechnical Engineering Department  
National Technical University of Athens  
Athens  
Greece

Carlos Delgado  
Escuela Universitaria de Ingeniería Técnica  
de Obras Públicas  
Universidad Politécnica de Madrid  
Madrid  
Spain

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*Cover Illustration:* Pont Ventoux, Val di Susa, north western Italy. Tunnel Boring Machine(TBM) used during the construction of the gallery used as deviation channel for a hydroelectric power plant. The TBM was used to drill a gallery of 4.3 km long and with circular diameter of 4.05 meters. *Photo:* Giorgio Lollino.

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## Foreword

It is our pleasure to present this volume as part of the book series on the Proceedings of the XII International IAEG Congress, Torino 2014.

For the 50th anniversary, the Congress collected contributions relevant to all themes where the IAEG members were involved, both in the research field and in professional activities.

Each volume is related to a specific topic, including:

1. Climate Change and Engineering Geology;
2. Landslide Processes;
3. River Basins, Reservoir Sedimentation and Water Resources;
4. Marine and Coastal Processes;
5. Urban Geology, Sustainable Planning and Landscape Exploitation;
6. Applied Geology for Major Engineering Projects;
7. Education, Professional Ethics and Public Recognition of Engineering Geology;
8. Preservation of Cultural Heritage.

The book series aims at constituting a milestone for our association, and a bridge for the development and challenges of Engineering Geology towards the future.

This ambition stimulated numerous conveners, who committed themselves to collect a large number of contributions from all parts of the world, and to select the best papers through two review stages. To highlight the work done by the conveners, the table of contents of the volumes maintains the structure of the sessions of the Congress.

The lectures delivered by prominent scientists, as well as the contributions of authors, have explored several questions ranging from scientific to economic aspects, from professional applications to ethical issues, which all have a possible impact on society and territory.

This volume testifies the evolution of engineering geology during the last 50 years, and summarizes the recent results. We hope that you will be able to find stimulating contributions, which will support your research or professional activities.



A handwritten signature in blue ink, appearing to read "Giorgio Lollino".

Giorgio Lollino



A handwritten signature in blue ink, appearing to read "Carlos Delgado".

Carlos Delgado

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## Preface

Engineering geology, a relatively young field, emerged through recognition of the need for geologic input into engineering projects. Today, this primary field has expanded as the statutes of its learned society, the IAEG, define: “Engineering geology is the science devoted to the investigation, study and solution of the engineering and environmental problems which may arise as the result of the interaction between geology and the works and activities of man as well as to the development of measures for prevention or remediation of geological hazards.”

The role of engineering geology for major engineering projects and infrastructure construction is well represented in the papers included in this volume of the proceeding of the 12th IAEG congress, devoted to major engineering projects. The geologic input is not only confined to the initial stage of such projects but the contribution of engineering geology includes all stages for their completion, reflecting the present standing of engineering geology in geotechnical engineering.

A retrospective review of the development of engineering geology shows that in the early days, up to the 1950s or even the 1960s, what was understood as engineering geology was restricted to assessments, with general and qualitative engineering descriptions. Then this is followed by a second period of development until about the 1980s. The demands of the development of society required more knowledge for the behaviour of the ground. Now meaningful geological models could be provided. However, the quantitative component was weak, and contributions to the design of structures were limited. Although improved, the understanding of geology in the engineering milieu is not satisfactory. A third period starts from the 1980s but mainly from the 1990s. Engineering geology, keeping the core values so far developed, is now evolving towards geoengineering.

Indeed, today engineering geology not only offers services but is also a substantial and an integral component of geotechnical engineering in construction. It is present in all phases of investigation, design and construction:

1. Engineering geology defines the geological conditions, provides the geological model (formations, tectonics and structure), and translates it into engineering terms, providing suitable ground profiles at the appropriate scale. Its role is decisive for detecting the presence of geological hazards, in the selection of the site or the alignment of the engineering structure and for the basic principles of the construction method. It makes no sense to proceed without a sound knowledge of the geological model. Let us be a little dogmatic here: in the absence or misinterpretation of the geological model the construction or operation will almost certainly be associated with problems either small or large, as accidents, delays, cost over-runs or even failures may occur. On the contrary, if this model is known from the very beginning of the design, half the game has already been won ... *if at the very start the geological structure of the site is misinterpreted, then any subsequent ... calculation may be so much labour in vain.* (Glossop 1968, 8th Rankine Lecture). Therefore: start from the forest and then look at the trees.

2. After having understood the behaviour of the ground, engineering geology contributes to the definition of the properties of the geometrical, the selection of suitable design parameters and of the appropriate criteria. This a stage with a close synergy with engineering. An understanding of in situ stresses and groundwater conditions complete this stage.
3. Engineering geology is and should also be present at the design phase to ensure that calculations and simulations do not misinterpret the geological reality. John Knill in his first Hans Cloos lecture, in 2002, expressed strong concern that the *effectiveness of the integration of engineering geology within the geotechnical engineering remains to be improved*. This integration is a field of development in today's engineering geology, and papers in this volume contribute towards such advance.
4. Engineering geology is involved in construction in order to validate the assumptions of the design, to contribute in the application of measures in unforeseen or unforeseeable circumstances and to secure the implementation of the contract.

And, undoubtedly, geological and engineering judgement should never be neglected in this whole process of creating an engineering project. Next to knowledge, experience is needed for this judgment. Mark Twain said *Good judgment comes from experience. But where does experience come from? Experience comes from bad judgment*. However, the correct application of geological and engineering principles means that experience can also come from good judgement.

It is very satisfactory that this volume of proceedings of the 12th congress of IAEG embraces all the above mentioned, and a large variety of cases of engineering works is presented. Dams and tunnels are the majority of these cases but also foundations, offshore structures, roads, railroads, slope design, construction material, tailings, repositories are dealt with. Papers on engineering properties and geotechnical classifications, site investigation issues and influence of groundwater are present together with contributions on the behaviour of soft rocks and weak rock masses. Active tectonics also attract special attention.

The volume is expected to constitute a valuable and lasting source of reference in the field of engineering geology, in particular, and in geotechnical engineering, in general.

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The Istituto di Ricerca per la Protezione Idrogeologica (IRPI), of the Italian Consiglio Nazionale delle Ricerche (CNR), designs and executes research, technical and development activities in the vast and variegated field of natural hazards, vulnerability assessment and geo-risk mitigation. We study all geo-hydrological hazards, including floods, landslides, erosion processes, subsidence, droughts, and hazards in coastal and mountain areas. We investigate the availability and quality of water, the exploitation of geo-resources, and the disposal of wastes. We research the expected impact of climatic and environmental changes on geo-hazards and geo-resources, and we contribute to the design of sustainable adaptation strategies. Our outreach activities contribute to educate and inform on geo-hazards and their consequences in Italy.



We conduct our research and technical activities at various geographical and temporal scales, and in different physiographic and climatic regions, in Italy, in Europe, and in the World. Our scientific objective is the production of new knowledge about potentially dangerous natural phenomena, and their interactions with the natural and the human environment. We develop products, services, technologies and tools for the advanced, timely and accurate detection and monitoring of geo-hazards, for the assessment of geo-risks, and for the design and the implementation of sustainable strategies for risk reduction and adaptation. We are 100 dedicated scientists, technicians and administrative staff operating in five centres located in Perugia (headquarter), Bari, Cosenza, Padova and Torino. Our network of labs and expertizes is a recognized Centre of Competence on geo-hydrological hazards and risks for the Italian Civil Protection Department, an Office of the Prime Minister.

