

# Innovative teaching methods and strategies in civil, hydrology and geological engineering in volcanic subjects

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## Abstract

Numerous Spanish and European syllabus of civil and mining engineering colleges lack contents related to volcanic environments, including oceanic islands such as Canary Islands or Azores. Knowing their particularities and being able to manage them complement the academic training needed to be applied to all types of territory in the current globalized work market. The technical singularities of the hydrology or geotechnics of volcanic environments are complex. Thus, the educational facilities related to them should be as efficient and innovative as possible. It is well known that the knowledge of the singularities of volcanic lands facilitate obtaining a job. Last, but not least, e-learning including virtual laboratories could globalize the training and internationalize the teaching and professional profiles.

**Keywords:** on-line resources, soil mechanics, rock mechanics, geological en-

gineering, civil engineering, volcanic.

## 1. Introduction

The study and evaluation of volcanic lands are difficult due to their heterogeneity, complexity, singularity and the partial absence of bibliographic references and works on hydrology or geotechnics carried out on them. Moreover, costs and complexity of developing water harvesting works (both superficial and subterranean ones) is considerably higher in volcanic terrains. Due to the fragility of this kind of environments, sustainability is also a key factor in this works.

Volcanic regions, mostly the insular environments, show a high population density. At European level, Macaronesian Islands' population (except Cape Verde) is significantly representative of the whole European population. This behavior is also shown worldwide, as for example at Latin-America or at the Pacific islands, where these technical subjects

could account for an improved development.

INGENIA is a research group belonging to the Universidad de La Laguna. It has a wide research experience and more than 10 years experience developing syllabus on the subject of water management and geotechnics in volcanic areas. Recently, the group has been designing teaching and training multimedia material using the most innovative educational technics to develop a course focused on the water management and geotechnics of volcanic areas. This course, based on the teaching and professional experience, intended to be objective, practical and useful in the work field.

## 2. Motivation and objectives

Knowledge on volcanic lands developed by the Laboratory and Building Quality Area of the Canarian Government (including groundwater, prospection technics and geotechnical evaluation) is unique globally and provide a singular experience increasingly demanded outside Canary Islands.

Both the singular geology of Canarian Archipelago and its hydrogeology are a real work opportunity at other volcanic areas. These subjects are not included in the syllabus of most civil or mining engineering colleges from Spain or even Europe, therefore their singularities from the point of view of building or water harvesting are misunderstood. This knowledge must be understood as an advantage to compete professionally, mainly in emerging economies (Central and South-America, where volcanic materials are significantly). Moreover, this training improves our professional potential in other regions. This is the key issue in the success of the specialized courses imparted by this group in both mainland Spain and Europe, and complemented by

the syllabus which emphasize the volcanic singularities.

In this section a brief summary to identify roughly some hydrological and geotechnical differences and singularities of the volcanic terrains is shown. These topics are organized as epigraphs in the imparted courses, allowing attendees to acquire general competences in this kind of terrains.

Generally, the courses are designed for technical degrees related to construction and water management. The main aim is to supplement the general knowledge with specific ones focused on volcanic areas and islands [2].

The courses has a duration of 25 hours, equivalent to 1.5 ECTS, includes a face-to-face training of around 20 hours, and includes also the work in virtual classroom and forums. Two subjects are developed by the courses: the hydrological, and the geotechnical training. The group has a laboratory available in Canary Islands to make this part of the course. In any other cases (courses outside the islands) is necessary to take a number of samples for analysis, and this part of the course is one of the most valued by students.

## 3. Methodology

In technical education, the use of new technologies to improve and enhance the learning process is widespread. Most teachers use digital resources and materials for students and these are generally located in digital repositories designed as virtual campus, virtual classroom or learning platform [4].

All training on volcano environments must be endorsed by a noticeably scientific knowledge of the area. In fact, much of the documentation was seen reflected in conference communications, papers in national and international journals, books published as well as technical guides re-

quired for construction use, further increasing the interest of the participants. So not only means that it is important to innovate in providing new disciplines that complement the traditional, but also to do in an innovative way with the support of new media technologies such as virtual laboratories, which will be discussed later.

Technical visits. In addition to conducting tests on different materials, on some occasions the course has been complemented with technical visits to water or geotechnics-related infrastructure. This activity, together with the visit to the laboratories, is the most widely accepted and valued teaching activity by students [1]. A possible alternative, in case you cannot make these visits, could be technical videos made by teachers which reflect technical processes, natural processes, laboratory tests or activities that could complement the training received and may be stored in virtual classrooms or in the course documentation repository.

One of the problem that have been discussed with regard to the course is the absence of a laboratory to test volcanic materials in the Canary Islands. To solve this problem, the group is currently working on developing a virtual laboratory of both disciplines. Firstly, to have educative material to show all possible geotechnical testing methods which can be carried out on volcanic materials and, secondly, a video explaining hydrogeological processes on water mining. The main aim of developing these two tools is to have an additional material to the digital content and clarify theoretical concepts introduced. When there is laboratory availability to explain procedures and tests, is the best option. However, quality of teaching can be affected if the number of participants is high. Therefore, these virtual laboratories could complement the training, especially because the absence

of enough resources at the course place [4].

Laboratory virtualization is also important because the university equipment are usually scarce, due to its high cost, not only at the installation but also in the maintenance. Another problem is the large number of students per computer, which sometimes means that the practice is limited to a lab technician running an experiment and 5 or 10 students watching. The evaluation method in some subjects is by questionnaire assessment or by solving a specific calculation that does not actually test knowledge in students of technical qualifications. Usually, the training at the laboratories are measured simply by attendance [2].

Finally, not all students can attend the countless teaching practices due to work or personal reasons. Usually, teaching and laboratory practices do not represent a high percentage of the final mark, which obviously discourages the student and is not very consistent, because these are the skills of students in the professional field what they it should be evaluated on.

Creating multi-media content, such as recordings of the tests with their explanations by the teacher (experiences and simulations) can contribute to reduce the effect of enumerated deficiencies. This proposed strategy involves several advantages in the realization of the course [3].

#### **4. Conclusions**

To sum up, the course helps to improve the flow of scientific and technical information among professionals and civil engineering, mining and geology students, to provide them with the necessary tools to tackle the problems of geotechnics and hydrogeology on volcanic environments which are unfortunately not solved by the national legislation currently in force.

The course has wide acceptance among the university community, as both students and teachers look for alternatives to the official teaching content, that facilitate the access to working field to the future graduates. Because these materials are very rare in our country and, except for the Canary Islands where a majority presence is observed, in the mainland are only anecdotally in some enclaves (subject to protection for their rarity and uniqueness), not being included in the curricula of schools of engineering and architecture. However, the knowledge of the volcanic territory, from the standpoint of hydrology and geotechnics, it is essential to enter the work field in the countries of Central and South American continent, where the presence of such materials is very important. Currently, these countries are in the process of economic growth and development, and they require skilled foreign university graduates, the Spanish being highly rated for their qualifications and language.

The course has been successfully performed in all its forms (interuniversity, summer courses, extension courses...)

## 5. Acknowledgements

This work has been developed in the framework of the INGENIA Research Group from the Universidad de La Laguna and Grupo de Innovación Tecnológica-Educativa de Ingeniería del Terreno (GInTE) from the Universidad de Alicante. Has been partially founded by

the Universidad de La Laguna through Teaching innovation projects and the European Union under projects 517629-LLP-1-2011-UK-ERASMUS-EMCR and 526746-LLP-1-2012-ES-ERASMUS-EMCR.

## 6. References

- [1] Menéndez Pidal, I. Santamarta Cerezal, J.C. Hernández Gutiérrez L.E. Sanz Pérez, E, *Learning experience on applied geology in civil engineering curricula by using university cooperation and practical trips*, EDULEARN11 Proceedings, Barcelona 2010.
- [2] Santamarta Cerezal, J.C. Hernández Gutiérrez L.E., *Estrategias para la formación de ingenieros sobre técnicas hidrológicas y geotécnicas en regiones volcánicas*, Revista Currículum, Universidad de La laguna, (in revision process).
- [3] Santamarta Cerezal, J.C. Arraiza, M.P. Ioras, F. López, J.V. , *Engineering 2.0, new digital strategies in technical education*, EDULEARN12 Proceedings, Barcelona. 2012
- [4] Santamarta Cerezal, J.C. Hernández Gutiérrez L.E. Arraiza, M.P. Neris Tomé, J., *Análisis de nuevas estrategias para la mejora del aprendizaje en enseñanzas técnicas dentro del Espacio Europeo de Educación Superior*. Servicio de Publicaciones de la Universidad de La Laguna, 2012.