Training Course

IGCP- 659 ANNUAL MEETING

"How to mitigate the seismic risk in Africa: A multidisciplinary approach"

Sousse (Tunisia), 25 November 2019

The technical and scientific IGCP-659 meeting alongside with the 2nd Springer CAJG 2019 (cajg.org) addresses the topic on the seismic risk assessment in Africa. Presentations and discussion sessions are programmed on some targeted capital cities for the hazard and risk assessment. The IGCP-659 working group will meet in Sousse in order to establish plans for practical activities related with seismic risk reduction in selected major cities in Africa. https://www.cajg.org/index.php?p=IGCP-659

The training course is dedicated to PhD students and early carrier researchers in active tectonics, seismology, geology and geophysics. This course will include:

1) updated techniques for seismic source characterization from tectonic-remote sensing, seismology and geodesy (GPS),
2) The hazard and risk evaluation from multi-disciplinary approaches and most recent experiences.

Main lecturers:

Mustapha Meghraoui (IPG Strasbourg)
Silvia Pondrelli (INGV, Bologna)
Vunganai Midzi (CGS, Pretoria)
Esra Cetin (Muglà Univ.)
Moctar Doucouré (N. Mandela Univ.)
Ahmed Ksentini (Sfax Univ.)

Please send a message to register: mailto://m.meghraoui@unistra.fr

The training course and IGCP-659 session are organized in cooperation with
The 2nd Springer Conference of Arab Journal of Geosciences
(see venue and location at https://www.cajg.org/index.php)

2ND CONFERENCE OF THE ARABIAN JOURNAL OF GEOSCIENCES (CAJG)
25–28 NOVEMBER 2019, SOUSSE, TUNISIA

Course 4

How to mitigate the seismic risk in Africa: A multidisciplinary approach

25 November 2019
08:00 – 12:30
14:00 – 16:00
18:00 – 19:00

The IGCP-659 working group also organizes a training course dedicated to PhD students and young researchers in active tectonics, seismology, geology and geophysics, seismic hazard and risk assessment. The training course will cover:

- Updated techniques for seismic source characterization from tectonic-remote sensing, seismology and geodesy (GPS).
- The hazard and risk evaluation from multi-disciplinary approaches and most recent experiences.

Objective:

The course provides the basics and necessary explanations on how multidisciplinary but closely related interdependent themes in solid earth geophysics address the issue of seismic hazard and risk assessment, in either interplate and/or intraplate domains.

About 20 - 25 (maximum) attendees of mainly PhD students and young researchers are expected to attend this one-day course. However, senior participants are also welcome to attend.

The course will be based on 5 modules of 1h each (45' lecture, 15' exercise) except for module 5 which will be given in 2 h. We also will leave 1h at the end for a general discussion.

The course will be in English and will be based on the following 5 modules. Attendees will need a personal computer for the data treatment and exercises.

- 08:00 – 9:00
  Module 1: Plate Tectonics, Rheology and the behavior of the African lithosphere
  Instructor: Moctar Doucouré (Nelson Mandela University, South Africa)

  This first module will cover plate tectonics as it relates to the formation of the oceanic lithosphere and its mechanical behaviour, extension of such behaviour to the continental lithosphere of Africa, and relationship to earthquakes.

  The mechanical behaviour of the lithosphere will be described in terms of the flexure of an elastic plate model, using the elastic thickness as characteristic parameter. This thickness will be compared to that of the seismogenic crust from which the continental lithosphere derives its effective strength. This will lead, based on considerations of continental rheology, to an analysis of the African competent lithosphere and its variation with the age of the crust or tectonic domains. Participants to the module 1 will be given an opportunity to estimate the thickness of the competent lithosphere in various crustal domains of Africa.

- 9:00 – 10:00
  Module 2: Seismotectonics and Earthquake Geology
  Instructor: Mustapha Meghraoui (IPG Strasbourg, France)

  The realistic assessment and mitigation of geological and geophysical hazards requires the characterization of the main physical parameters and development of a database at the continental and regional scale. Therefore, the development of seismotectonic studies is a necessary step for the mitigation of earthquake disasters.

  In this module 2, we address the synthesis of earthquake studies and active deformation that serve as a basis for hazard calculations and the reduction of seismic risk. All large and small infrastructure projects need a seismic hazard and risk assessment due to their important implications in the socio-economic environment.

  Based on the local and regional studies, the characteristics of seismotectonic studies and earthquake geology are analyzed using the following items:

  1. The building of a homogeneous database of seismic parameters, fault kinematics with location of major earthquake ruptures and source parameters.
  2. The study of neotectonic structures with the identification of Quaternary and active faulting.
  3. Emphasize the paleoseismology database and the significance of seismic cycle.
  4. Improve the seismic faulting database in regions with low level seismicity and slow active deformation.

  Finally, we focus on the integration of tectonic, seismic and geodetic data into the seismic hazard assessment.

- 10:00 – 10:30
  Coffee break

- 10:30 – 11:30
  Module 3: Earthquake Mechanisms and their Application in Seismotectonics
  Instructor: Silvia Pondrelli (INGV-Bologna, Italy)

  During this class, I will describe:

  1. different methods of computation of focal mechanisms and seismic moment tensors
  2. different catalogs available worldwide and for the Mediterranean region
  3. use of these data for seismotectonic and seismic hazard studies

  1) different methods of computations of focal mechanisms and seismic moment tensors.
  What is a focal mechanism, and a seismic moment tensors? These data are a different way to describe a seismic source. When an earthquake occurs, it is possible to understand the kind of the fault and the type of motion that produced it, analyzing the recorded seismograms.

  Focal mechanisms can be obtained using the polarities of P-wave first motion. This old method is still used mainly for low magnitude events. At present it is more diffused to compute seismic moment tensors through the inversion of seismic signals. Some methods, as for instance CMT, apply an inversion over body and surface waves simultaneously, some others use just a portion of the waveform train. We will see several examples worldwide or on a regional scale.

  2) different catalogs are available worldwide and for the Mediterranean region.
  Several catalogs of seismic moment tensors are available worldwide and at regional scale. Worldwide, the most used and known catalog is the Global CMT Catalog, that includes CMTs for events with a Mw greater than 5.0 occurred all over the world starting from 1977. A well-known regional database is the European-Mediterranean RCMT Catalog that includes CMTs for events of moderate to great magnitude (Mw starting from 4.5) occurred in the Mediterranean region starting from 1997. After a description of these and other useful catalogs, we'll do a roundup of focal

mechanisms catalogs including information on very old events, i.e. for the last century. A comparison between all these different dataset allows to introduce to their use and applications.

3) use of these data for seismotectonic and seismic hazard studies As previously said, it is possible to understand the kind of the fault and the type of motion that produced an earthquake, analysing the recorded seismograms to compute a focal mechanism. A massive use of these data for a region that is active seismotectonically, allows to descrive the prevailing tectonic style, the strain and stress field acting and which faults are more prone to activate. Out of the help in a description of the seismotectonic of a region, the seismic moment tensors may be the starting point to evaluate the tectonic style of future possible earthquakes. We will see some examples already applied in the Mediterranean region and in particular in Italy, to produce the most recent seismic hazard map.

Examples and exercise:

b) How to compute seismic moment tensors components from focal plane data and vice versa (es. mt2fpl.f)

c) How to compute strain and stress dominant directions starting from seismic moment tensors (PNT axes, SH min, single data or using summation results)

- 11:30 – 12:30
  Module 4: Geodynamics and Space Geodesy (GPS - InSAR): Implications for the seismic hazard assessment.
  Instructor: Esra Cetin (Mugla Sitki Kocman University, Mugla, Turkey)

  The advanced development of the modern geodetic techniques has been proved to be more powerful to reveal the geophysical phenomena. Particularly GNSS (GPS) and InSAR are initially introduced to present their contributions in studying the seismic deformations with implications in the seismic hazard assessment.

  InSAR and satellite geodesy are particularly utilized to reveal the surface deformation according to coseismic and interseismic stages of the seismic

cycle. On the other hand, they have also significant contributions to investigate seismic cycle related slow crustal deformations such as postseismic transients and aseismic creep.

This 3rd module will focus on:
1) The global and continuous operations of geodetic techniques that provide us high-quality spatiotemporal measurements of pre-co- and postseismic deformation, and help us understand the spatial and temporal evolution of crustal motions. An effective way to study the temporal behavior is the generation of deformation time series.
2) Accordingly, InSAR and GPS time series will be presented as they allow us to determine the slip rates across continental faults in mm/yr resolution. The main contributions of InSAR and GPS are particularly on the determination of fault parameters, the distribution and partitioning of strain along faults, and the improvement of tectonic models.
3) The monitoring of surface displacements along active faults associated with dislocation modeling contributes to improve our understanding of the driving mechanisms behind earthquakes and the interaction between them.
Finally, attendees will test the knowledge of earthquake cycle using geodetic techniques as an important step, not only for the understanding of the short and long-term Earth deformation, but also for the seismic hazard assessment and the potential for the future earthquake generation.

- 12:30 – 14:00
  Lunch

- 14:00 – 16:00 **M5: Integration of seismic, tectonic and geodetic data into the Seismic Hazard assessment and Risk Mitigation**
  Instructors: Vunganai Midzi (Council for Geoscience, Pretoria, South Africa) and Ahmed Ksentini (Sfax University, Tunisia)

  In this 5th module, an introduction will be presented on the Probabilistic Seismic Hazard Assessment (PSHA) and its classical formulation. We will be starting from seismic source characterization towards recurrence

models and Ground Motion estimation. Attendees will learn in details all PSHA steps that include:

- Seismic source identification according to seismicity, tectonics, geodesy and crustal models. Discussion and exercises will be presented about integrating seismicity, paleoseismological data, geology, geodesy and tectonic settings (seismogenic depths) into the source model and the recurrence equations.
- Ground motion prediction equation integration and relevant uncertainties
- Logic tree approach and model calibration through branches weights.
- Open source software initiation to compute seismic hazard according to regional data.

The Seismic Risk Assessment (SRA) will be explained and will include:

- Exposure dataset and general building stock databases
- Fragility curves computation according to mechanistic models
- Vulnerability analysis through empirical laws
- Seismic risk computation, loss curves and collapse maps.
- Mitigation practices

This module will use open source software already installed on virtual machine and can be installed in students laptops.

- 16:00 – 17:00 Coffee Break

- 17:00 – 18:00 Questions and Specific Questions

- 18:00 – 19:00
  Questions and General discussion

List of registered participants:

N°	Name	Surname	Situation	University/Entreprise	Town	Country
586	Idris	Salhi	Student	University Elmanar Tunis	Kasserine	Tunisia
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535	MAKRAM	HARZALLI	Student	ENI, SFAX	Jelma. Sidi Bouzid	Tunisia
530	Nabiha	Ben Abid	Student	FSM	SOUSSE	Tunisia
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329	Hamida	Cherni	Student	geology	le kef	Tunisia
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300	Cherif	Aoudj	Student	ENSSMAL	Bejaia	Algeria
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