NATURAL HAZARDS IN AFRICA

This concept note is a proposal prepared for the African Union – Science and Technology Research Commission (AU - STRC)

It contains two main parts:

- Updated Regional Seismotectonic Map in Africa: A Key Component for the Seismic Hazard and Risk Assessment (page 2)
- Toward Climate Resilient Cities In Africa (page 7)

NB: A detailed proposal with documents and appendices are prepared along with this concept note.

February 2017

Part I :

Updated Regional Seismotectonic Map in Africa: A Key Component for the Seismic Hazard and Risk Assessment

Project leaders:

Prof. Mustapha MEGHRAOUI
Institut de Physique du Globe, CNRS-UMR 7516
Ecole et Observatoire des Sciences de la Terre
Université of Strasbourg
5, rue René Descartes, 67084 Strasbourg, France
Tel : +33 (0)368 850 111; Fax : +33(0)368 850 125
mailto:m.meghraoui@unistra.fr
http://eost.u-strasbg.fr/IPGS/Eq_DynGlobale/index_DG.php

and

Dr. Vunganai MIDZI, Pr. Sci. Nat.
Council for Geosciences
Geophysics Competency
280 Pretoria Street, Silverton,
Pretoria, 0001, South Africa
Tel: +27 (0)12 841 1492
Fax: +27 (0)86 552 9817
Email: vmidzi@geoscience.org.za
Website: http://www.geoscience.org.za

Key words: Active faulting, earthquake and real-time seismology, crustal structure, tectonic plate deformation, seismic hazard and risk evaluation, mitigation and prevention plans.

The working group:
Magda Roos (CGS, Pretoria, South Africa), Andrzej Kijko and Ansi Smit (UPNHC, Pretoria, South Africa), Ateba Bekoa (Buea University, Cameroun), Mohamed El Gabry (NRIAG Egypt), Abdunnur Ben Suleman (Tripoli Univ., Libya), Nada Ahmed (Khartoum Univ., Sudan), Atalay Ayele (Addis Ababa University, Ethiopia), Paulina Amponsah (Ghana Atomic Energy Commission, Accra), Youssef Timoulali (CNRST, Rabat, Morocco), Abdelhakim Ayadi (CRAAG, Algiers, Algeria), Benouar Djillali (USTHB, Algiers, Algeria), Ahmed Ksentini (Sfax Univ., Tunisia), Abdelkader Soumaya (Univ. Tunis, Tunisia), Georges Mavonga (Kivu Research Center, DRCongo), Damien Delvaux (Musée Afrique Centrale, Tervuren, Belgium), Aldo Zollo (University of Naples Federico II, Italy), Eric Calais (ENS, Paris, France), Cécile Doubre (IPG Strasbourg, France); Kuvvet Atakan (Bergen University, Norway), Rui-Manuel Fernandes (Beixa Univ., Portugal) and Joao Fonseca (Lisbon Technical Univ., Portugal).

Brief outline of the project

The seismic hazards being among the major threats for societies, seismotectonic studies and maps are a necessary step for the mitigation of earthquake disasters in Africa. Seismic risk is increasing sharply in African countries, due to rapid population growth and urbanization. The realistic seismic hazard and risk assessment at a regional scale along with the determination of geological and geophysical hazards requires the building of a databank and the analysis of major seismic sources. In this project, the preparation of thematic maps in seismotectonics, earthquake hazard and risk assessment including seismic scenarios for some of the major cities on the continent constitutes an important objective necessary for the social and economic development of Africa.

Estimated duration of the project: 5 years

Aims and background

The Seismotectonic Map of Africa initiated in 2011 with the support of the Organisation of the African Geological Surveys (OAGS) and the IGCP programme of UNESCO-IUGS (http://eost.u-strasbg.fr/igcp601/) is published at the CGMW (*see publication and map in annex*).

Previous objectives were devoted to the building of a databank (Satellite images, tectonic and geophysical background, major active faults, active volcanoes, historical and instrumental seismicity, earthquake focal mechanisms, geomorphology and topographic data, geodetic data, tsunamis and their coastal impacts, lithospheric and crustal structures, tomographic data) with harmonization and homogenization of parameters of catalogues, represented by means of an ArcGIS sub-project for all African countries.

Along with the seismotectonic databank of each province, tables of tectonic and seismic parameters (fault dimensions and mechanism, physical properties) are now integrated for seismic hazard studies. The data compilation and analysis will serve for implementing seismotectonic models and the integration of geotechnical studies (attenuation laws) for deterministic and probabilistic seismic hazards and risk assessment at a regional level. Models of seismotectonic zoning including earthquake frequency, ground motion prediction equations and vulnerability analysis need to be developed for several earthquake-prone regions in Africa. Test sites for the implementation of early warning seismic systems and mitigation strategies constitute a critical issue in this project.

Added value and significance

With the previous elaboration of the Seismotectonic Map of Africa and seismotectonic provinces, this new project benefits from an already constituted databank and working group of experts in the field of seismotectonics, seismic hazard and risk studies. Major earthquake-prone areas are identified but specific seismotectonic studies at the regional level are needed to implement earthquake hazard mitigation plans adapted to field conditions in Africa.

The project requires capacity building, training programmes and education plans with operational scientific and engineering programmes in the field of seismotectonics, seismic hazard and risk in Africa.

Project management

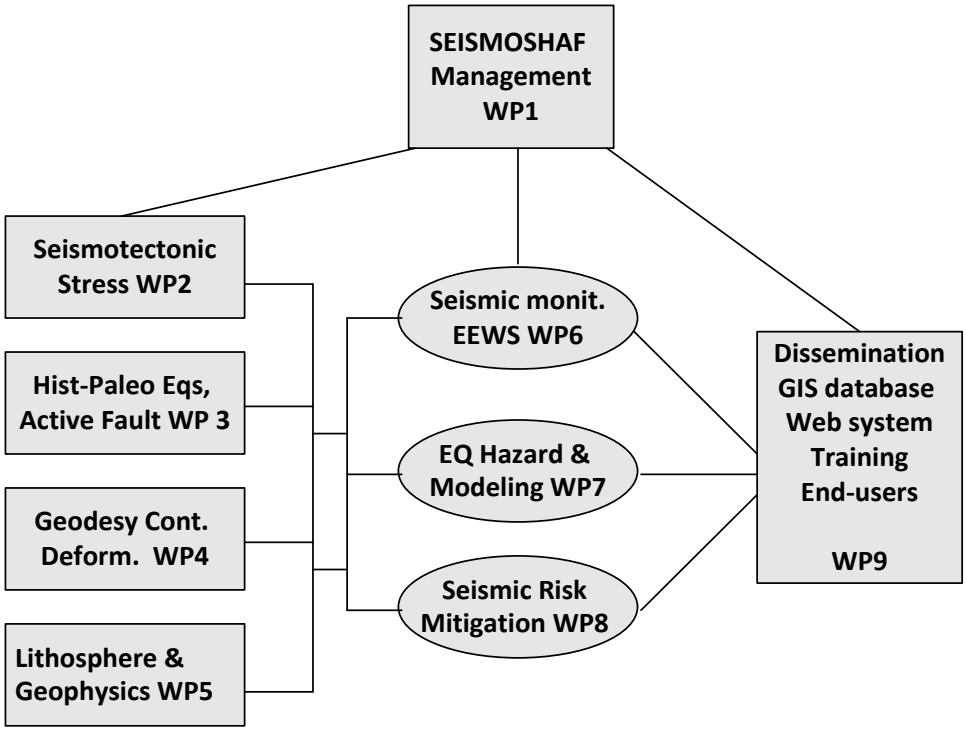
The SEISMOSHAF project consists in 9 work-packages (WPs) and will be undertaken as a collaboration between partners from scientific institutions in Africa and in Europe. It will be managed by the Council for Geosciences (CGS) in Pretoria and Institut de Physique du Globe of Strasbourg. In addition, both the CGS and the University of Strasbourg (and Centre National de la Recherche Scientifique - C.N.R.S. of Strasbourg) have special offices

dedicated to help scientists in the administrative and financial management of international projects.

The management of the project will be underpinned by a regular schedule of annual workshops and thematic meetings that will facilitate dissemination of data and results amongst the SEISMOSHAF working group (WG). Each WP will be conducted by scientific leaders and as indicated in the following table:

WP1:	Coordination and Management	Vunganai Midzi (CGS, Pretoria) and Mustapha Meghraoui (IPG Strasbourg)
WP 2:	Seismotectonics and stress distribution	Atalay Ayele (Addis Ababa Univ.), Joao Fonseca (Technical Univ. Lisbon) and Abdelhakim Ayadi (CRAAG, Algiers).
WP 3:	Historical earthquakes, paleoseismology and active faults	Mustapha Meghraoui (IPG Strasbourg), Kuvvet Atakan (Bergen Univ.) and Joao Fonseca (Technical Univ. Lisbon)
WP 4:	Geodesy and crustal deformation	Atalay Ayele (Addis Ababa Univ.), Abdelhakim Ayadi (CRAAG, Algiers) and Georges Mavonga (Kivu Research Center)
WP 5:	Deep crustal and lithospheric structures and geophysical data	Vunganai Midzi (CGS, Pretoria), Mohamed El Gabry (NRIAG, Cairo)
WP 6:	Real time seismic monitoring of natural/induced seismicity and Early Warning System	Aldo Zollo (Univ. Naples), Vunganai Midzi (CGS, Pretoria) and Abdelhakim Ayadi (CRAAG, Algiers)
WP 7:	Earthquake hazard assessment and modeling	Kuvvet Atakan (Bergen Univ.), Aldo Zolllo (Univ. Naples), Georges Mavonga (Kivu Research Center), Mohamed El Gabry (NRIAG, Cairo) and Vunganai Midzi (CGS, Pretoria).
WP 8:	Seismic Risk Assessment at selected sites and Mitigation Measures	Djillali Benouar (USTHB, Algiers), Andrzej Kijko (Univ Pretoria), Ahmed Ksentini (Sfax University)
WP 9:	Dissemination	(All members of the working group).

The Flow-Chart below establishes the interaction between the different WPs in the SEISMOSHAF project.



Milestones and Workplan

1st year (2017): The project launch during a meeting with the AU - STRC. Constitution of a steering committee responsible for each seismotectonic province. Implementation of test sites for early warning system. Installation of seismic and geodetic equipment.
2nd year (2018): Data compilation with seismotectonic and seismic hazards analysis; organization of regional seminars in each province.
3rd year (2019): Seismotectonic and seismic hazards analysis and progress reports with correlation with previous studies and maps for each province.
4th year (2020): First draft presentation of maps and results with detailed reports on the seismic hazard and risk evaluation. Plenary meeting with all participants during a meeting with the AU – STRC.
5th year (2021): A final version of the seismotectonic, seismic hazard and risk maps of Africa. Reports and publications.

A website will be activated immediately after the first meeting in 2017.

Budget - Funding Plans

The project that may benefit from the AU - STRC funding will primarily help to bridge the gap due to the distance in Africa by means of seminars, workshops and meetings between the African scientists from different research fields. The allocated funding will be exclusively devoted to networking and capacity building and addressed to scientific institutions involved in the project. The scientific program forecasts costs for a) equipment (seismic and geodetic stations), b) travel and subsistence for networking, c) sub-contracting (e.g., laboratory analyses), and d) publication and reporting for dissemination. Education (large public) and training strategy will require additional costs.

Estimated total cost of the project ranges between 1 000 000,00 € to 3 000 000,00 € (depending mainly on cost of equipment and hired PhD students and post-docs).

Expected Results

The analysis of basic data for the project will generate results as following:

I - The building of regional database in seismotectonics (i.e., for each seismotectonic province (year 1); different medium scale and qualitative regional maps (year 2).

II – The multidisciplinary data analysis and interpretation of results with seismic source models and scenarios (year 2 and 3).

III – The constitution of regional and continental seismic hazard maps (year 3); the related damage and lessons learned from past large earthquakes will be critical in the project.

IV – The preparation of risk assessment for pilot sites with earthquake early warning systems (EEWS) for large cities in seismogenic zones (year 3 and 4).

The seismic hazard and seismic risk assessment, and mitigation of disasters at the scale of the African plate is a challenge. Deterministic and/or probabilistic (or hybrid) methods will be employed (as a function of data richness and completeness) in order to assess the seismic hazard and risk in each seismotectonic province (year 2, 3 and 4). Mitigation strategies will be elaborated with local and national civil protections in Africa.

The project has a strong component in capacity building through knowledge transfer, training of young reserachers, workshops and networking.

Part II :

Toward Climate Resilient Cities In Africa

Project leaders:

Prof. Piero SALATINO
AMRA Scarl
Analysis and Monitoring of Environmental Risk
Via Nuova Agnano, 11, Napoli, Italy
Tel : + 39 081 7685093; Fax : +39 081 7685144
mailto: salatino@unina.it, info@amracenter.com ;
Website: http://www.amracenter.com/en/

and

Prof. Maurizio Giugni
AMRA Scarl
Analysis and Monitoring of Environmental Risk
Via Nuova Agnano, 11, Napoli, Italy
Tel : + 39 081 7685093; Fax : +39 081 7685144
Email: giugni@unina.it
Website: http://www.amracenter.com/en/

Key words: Africa • Urbanisation • Climate change • Hazard • Multi-risk • Vulnerability

The working group:
Sives Govender (CSIR, Pretoria, South Africa), Kombe Wilbard (Ardhi University, Tanzania), Nathalie Jean-Baptiste (Ardhi University, Tanzania), Guido Uhinga (Ardhi University, Tanzania), Kumelachew Yeshitela (Addis Ababa University, Ethiopia), Adrien Coly (Université Gaston Berger, Saint Louise, Senegal), Tonye Emmanuel (Université de Yaoundé I, Cameroon), Hamidou Toure (Universite OUAGA I, Joseph Pr Ki-ZERBO, Burkina Faso), Angela Di Ruocco (AMRA, Naples, Italy), Annamaria Criscuolo (AMRA, Naples, Italy), Alexander Garcia-Aristizabal (AMRA, Naples, Italy), Stephan Pauleit (Technical University of Munich, Germany), Gertrud Jørgensen (University of Copenhagen, Denmark), Paola Mercogliano (CMCC-Euro-Mediterranean Center on Climate Change, Italy), Sarah Lindley (University of Manchester, U.K), Sigrun Kabisch (UFZ-Centre for Environmental Research, Germany), Trond Vedeld (NIBR - Oslo and Akershus University College of Applied Sciences, Norway).

Brief outline of the project

Emerging economies and developing countries are currently struggling to implement an effective risk reduction strategy, and climate change has the potential to rapidly exacerbate this situation, particularly across the African continent.

Climate change threatens Africa's cities and rapidly urbanising coasts where about 40 % of Africa's population – some 400 million people – lives. Since 2010, the urban population growth rate in Africa has been 3.2 %per year on average. This is the highest in the world, resulting in more urban areas with bigger populations, as well as an expansion of the existing ones. Thus, urban and land use planners, managers and researchers within the African context need reliable forecasts of the local impacts of climate change and better equipment for strengthening the coping capacities of urban communities.

CLIM-AFRICA aims to develop urban climate knowledge and responses in the context of 5-40 year urban futures for selected African cities building on the results of the FP7 Project CLUVA (CLimate change and Urban Vulnerability in Africa, http://www.cluva.eu/) (see publication in annex). The project will develop climate change projections and maps of climate related hazards and risks assessing the social, physical and ecosystems' vulnerability of selected cities. The project will also develop innovative climate change adaptation strategies using a bottom-up approach and will be driven by the needs of end-users to mainstream selected climate change impacts and adaptation into existing policies and practices.

Estimated duration of the project: 5 years

Aims and background

Africa is fast becoming urban. By around 2030, some 50% of Africa's total population will have become urban dwellers. Almost all Africa's cities with one million inhabitants or more are currently located in areas exposed to at least one natural hazard. Inevitably, natural disasters in African urban areas are more likely to occur as expanding cities place an increasing number of people in the path of extreme natural events, often those in vulnerable accommodation, reliant on poor infrastructure with little resilience to impacts. According to the IPCC, Africa is one of the most vulnerable continents to climate change so climate drivers are likely to aggravate this situation still further. In spite of this knowledge, East, West and Central Africa are among the regions of the world that are least covered by climate change studies.

CLIM-AFRICA will centre on developing urban climate knowledge and responses in the context of 5-40 year urban futures, taking advantage of the considerable investment in research and capacity building established by the working group through the European Commission's 7th Framework Program project CLUVA (CLimate change and Urban Vulnerability in Africa).

CLUVA has been the first research project applying an inter- and trans-disciplinary approach to study African cities' vulnerability to climate change. CLUVA developed a systematic and comprehensive approach including: climate change modelling, probabilistic models of climate change hazards and risk; assessments of the vulnerabilities of the urban system and key exposure units (built and critical infrastructure, green structures and human populations); city-wide assessments of urban morphology and related urban scenario models; and analyses of the capacity to respond at city and local levels. Methods, tools and their outputs were developed to be complementary, rather than fully integrated. The focus was to provide points of potential intersection and a rich database of perspectives on issues and solutions to support city adaptation planning. Starting from the CLUVA outcome, this project will address the following challenges (CH), in order to improve the resilience of selected test cities to climate change, by focusing on a set of specific objectives:

- **CH1: Making Climate Information Relevant to Decision-Makers.**
  Objectives: development of high resolution (1-2 km), city-wide spatial and temporal analyses of extreme climate-related events; definition of a stakeholder-driven multi-risk (MR) framework that reflects the variety of interactions of different types of hazards and vulnerabilities to be encountered in specific urban settings; creation of urban development models and cost-benefit analysis, to be included into the MR frameworks, in order to help decision-makers to understand climate variability and change through feedbacks from urban development drivers developed with an 'African lens'.
- **CH2: Adapting Built Environment and Lifelines**
  Objectives: Vulnerability analysis of built environment and lifelines to floods by using micro-scale methods; development of guidelines
- **CH3: Promoting Urban Green Infrastructure**
  Objectives: to gain a deeper understanding of green infrastructure vulnerability to climate related hazards as well as the different processes that cause the loss of urban green to design appropriate response strategies (more evidence is especially required on the UGI's ecosystem services to support green infrastructure planning at the strategic city- and city regional level)
- **CH4: Preventive Action for Reducing Social Vulnerability**
  Objectives: exploring the exposure and the susceptibility of selected test cities and their residents to the consequences of climate related hazards and assessment of the copying capacity and the adaptation level of these communities to the impact of natural hazards.
- **CH5: Fostering Climate Change Governance and Strengthening Strategic Urban Planning**
  Objectives: identification and co-production of policy options and strategies for adapting to climate change (mainstreaming) and their validation in the selected test cities.

Added value and significance

CLIM-AFRICA moves forward the CLUVA project taking benefit of its results and multi-disciplinary team.

The proposal's team brings together interacting researchers from a range of African and European institutions with expertise in several fields ranging from climate modelling, natural and social risks to urban planning and governance. The heterogeneity of the available expertise enables this working group to apply a strong set of multi-scale and multi-disciplinary quantitative and probabilistic methods.

Furthermore the group will benefit of the experience of cooperation between African and European partners already established during the CLUVA project strengthening further the research capacity in Africa.

CLUVA made important steps towards developing an integrated approach to vulnerability assessment, but three years have been too short to see it through to its full implementation. There is further need for combining climate change dynamics and the dynamics of urbanisation into multi-risk and vulnerability frameworks in a foresighted approach. More work is due for identifying appropriate strategies to reduce the vulnerability of the built environment with its critical infrastructure, green infrastructure and society. Urban scenarios could gain additional value for decision makers by accompanying economic research efforts. Further investigation is required to gain more in-depth evidence on the correlation of climate projections with the full set of cascading effects on the cities.
CLIM-AFRICA will address these needs in order to provide planners and policy makers with more reliable tools for the development of climate resilient cities in Africa.

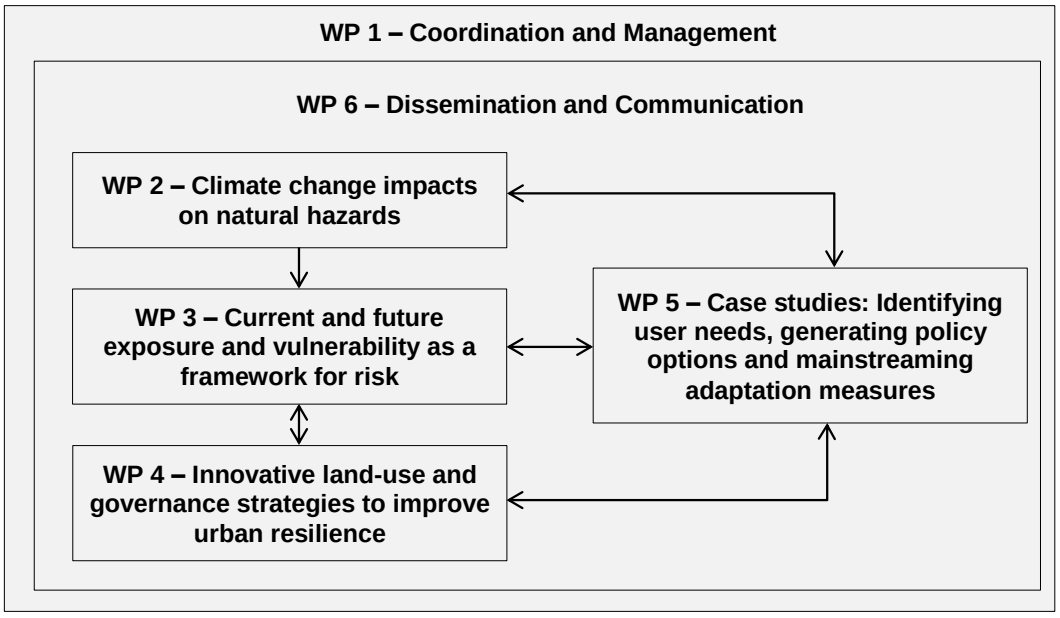
Project management

The CLIM-AFRICA project consists in 6 work-packages (WPs) and will be undertaken as a collaboration between partners from scientific institutions in Africa and in Europe. AMRA will coordinate the project taking advantage of its long experience in coordinating international research projects, including the CLUVA project.

The management of the project will be underpinned by a regular schedule of annual workshops and thematic meetings that will facilitate dissemination of data and results amongst the CLIM-AFRICA working group (WG). Each WP will be conducted by scientific leaders and as indicated in the following table:

WP1:	Coordination and Management	Alfonso Rossi Filangieri (AMRA)
WP 2:	Climate change impacts on natural hazards	Maurizio Giugni (AMRA), Angela Di Ruocco (AMRA), Annamaria Criscuolo (AMRA), Paola Mercogliano (CMCC), Sives Govender (CSIR), Wilbard Kombe (ARDHI), Kumelachew Yeshitela (AAU), Hamidou Toure (UO), Adrien Coly (UGB), Emmanuel Tonye (UY1)
WP 3:	Current and future exposure and vulnerability as a framework for risk	Stephan Pauleit (TUM), Sarah Lindley (UoM), Maurizio Giugni (AMRA), Alex Garcia (AMRA), S. Kabisch (UFZ), Wilbard Kombe (ARDHI), Kumelachew Yeshitela (AAU), Hamidou Toure (UO), Adrien Coly (UGB), Emmanuel Tonye (UY1)
WP 4	Innovative land-use and governance strategies to improve urban resilience	Gertrud Jorgensen (UCPH), Trond Vedeld (NIBR), Wilbard Kombe (ARDHI), Kumelachew Yeshitela (AAU), Hamidou Toure (UO), Adrien Coly (UGB), Emmanuel Tonye (UY1)
WP 5:	Case studies: Identifying user needs, generating policy options and mainstreaming adaptation measures	Gertrud Jorgensen (UCPH), Trond Vedeld (NIBR), Wilbard Kombe (ARDHI), Nathalie Jean Baptiste (ARDHI), Kumelachew Yeshitela (AAU), Hamidou Toure (UO), Adrien Coly (UGB), Emmanuel Tonye (UY1)
WP 6:	Dissemination and Communication	Angela Di Ruocco (AMRA), Annamaria Criscuolo (AMRA)

The Flow-Chart below establishes the interaction between the different WPs in the CLIM-AFRICA project.



Milestones and Workplan

1st year (2017): The project launch during a meeting with the AU - STRC. Stakeholder/expert workshops in each of the case studies to identify set of feasible adaptation options and user needs. Collection of available data in each case study.
2nd year (2018): Climate projection delivery: downscaled data. Preliminary study of climate-related hazards in the case studies based on available data. Desk-study about CC-related exposure and vulnerability assessment.
3rd year (2019): Analysis of climate related hazards based on CC projections and first draft presentation of hazard maps for the selected case studies. Development of a conceptual framework for the multi-risk analysis. Preliminary identification of policy options for adapting to climate change.
4th year (2020): First draft presentation of single and multi-risk maps. Validation of the identified policy options/strategies for adapting to climate change.
5th year (2021): A final version of the climate change hazards and risks maps. Development of guidelines. Reports and publications.

A website will be activated immediately after the first meeting in 2017.

Budget - Funding Plans

The project that may benefit from the AU - STRC funding will primarily help to bridge the gap due to the distance in Africa by means of seminars, workshops and meetings between the African scientists from different research fields. The allocated funding will be exclusively devoted to networking and capacity building and addressed to scientific institutions involved in the project. The scientific program forecasts costs for a) personnel, b) equipment (software and data acquisition), c) travel and subsistence for networking, d) sub-contracting (e.g., laboratory analyses), and e) publication and reporting for dissemination. Education (large public) and training strategy will require additional costs.

Estimated total cost of the project ranges between 1 000 000,00 € to 3 000 000,00 € (depending mainly on cost of equipment and hired PhD students and post-docs).

Expected Results

The analysis of basic data for the project will generate results as following:
I - Case-specific reports on identified and co-produced policy options for adapting to climate change (mainstreaming) (year 1); Report on policy options/strategies for adapting to CC (year 4).
II – CC projections downscaled at a resolution of 1-2 km for selected case studies (year 2).
III – Maps of climate related hazards for the case studies (year 3 and 5). Maps of climate related risk and multi-risk for the case studies (year 4 and 5).
IV – Recommendation and guidelines (year 4 and 5).

The project has a strong component in capacity building through knowledge transfer, training of young researchers, workshops and networking.