

4. Research area

This research will be carried out in eleven Sub-Saharan countries: Benin, Botswana, Burkina Faso, Gabon, Ghana, Mali, Niger, Congo, South Africa, Sudan, and Zambia. All of these are INCO countries (target developing countries for specific measures in support of International Co-operation).

The study will be conducted at two levels of scale. The first is the sub-regional scale which include the following ecosystem types: open forest, mixed crop, mopane savanna, Eucalyptus plantations, gravelly red soil, grassland, Acacia forest, desert, fallow bush, degraded fallow bush, open fallow, Millet, fineleaf and broadleaf savanna, Miombo woodland, where it is possible to investigate in depth the processes and parameters leading to improvement of models and algorithms. The second level is the whole regional scale which will be reached with the extrapolation of in space and time models which will be developed and tested using the more intensive key studies. See Figure for the location of the field sites.

5. Advances of the state of the art

The advances of the state of the art that the project aim to achieve are: the expansion, with the establishment of new infrastructures, of the existing carbon observing systems, to setting up a first attempt of a greenhouse gas monitoring network in Sub-Saharan Africa; the design of an optimal monitoring system network and the identification of its components; the consolidation of reviews of the greenhouse gas budget for all relevant Sub-Sahara African ecosystem-types; the improvement of the understanding of the role of fires in the carbon cycle; the provision of the elements necessary for reducing uncertainty and bias in GHG budget estimates and to contribute to the revision of the IPCC guidelines; the evaluation regarding the potential for carbon sequestration in Sub-Saharan Africa, and the recommendations for

the management actions needed to implementing the strategies necessary to mitigate global change in the context of the Kyoto protocol.

Moreover, the CARBOAFRICA network will contribute to the enhancement of an Earth observations system, strengthening the capacity of Europe to understand global change process. The scientific and technological results will be published in international journal, and, in addition to the capacity building activities, will promote the integration of the environmental dimension in the social and economic context, supporting Sub-Saharan African countries on the path of a sustainable development.

6. Consortium

The CARBOAFRICA consortium is composed by the following 15 European and African organizations:

- University of Tuscia (IT)
- Max Planck Institute - BGC (DE)
- Lund University (SE)
- FAO - GTOS programme (International)
- CIRAD (FR)
- NERC-CEH (UK)
- CNR-IBIMET (IT)
- IAO (IT)
- 2nd University of Naples (IT)
- CSIR (ZA)
- UR2PI (CG)
- ARC (SD)
- CEA-LSCE (FR)
- King's College of London (UK)
- University of Leicester (UK)

Moreover an official link with the AMMA-EU consortium has been established. The project will be implemented in at least 11 Sub-Saharan African countries (Benin, Botswana, Burkina Faso, Gabon, Ghana, Mali, Niger, Congo, South Africa, Sudan, Zambia) involving all the relevant local organizations.

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Quantification, understanding and prediction of carbon cycle, and other GHG gases, in Sub-Saharan Africa

European Commission, 6th Framework Programme
Priority 1.1.6.3: Global Change and Ecosystems
STREP (Specific Targeted Research Project)
Proposal no. 037132
Duration: 3 years (01/10/06 – 30/09/09)

Coordinator Prof. Riccardo Valentini
University of Tuscia, Italy.

1. Project Introduction

Africa is a region highly vulnerable to climatic change due to both ecological and socio-economic factors; however it is the least well-covered region by studies on climate change. For these reasons, the overarching goal of CARBOAFRICA is to set up a first attempt of a greenhouse gases (GHGs) fluxes monitoring network of Africa, in order to quantify, understand and predict, by a multi-disciplinary integrated approach, GHGs emissions in Sub-Saharan Africa and its associated spatial and temporal variability. The state of the art of the carbon studies in Africa will be analysed in order to fill the gaps of knowledge, and then the existing carbon observing system in Sub-Saharan Africa will be utilized and improved, by the establishment of new infrastructures. In particular the first eddy covariance flux tower in an African tropical forest will be built.

The GHGs observations capabilities for fluxes and stocks of carbon, their geographical distribution, the user requirements for UNFCCC and IPCC guidelines implementation, will be used to design an optimal monitoring system network for Sub-Saharan Africa and the identification of its components.

Specific regional studies in key areas will be conducted, considering both carbon sources and sinks, and the current land use change will be assessed, evaluating the potential for carbon sequestration in Sub-Saharan Africa in the context of the Kyoto Protocol.

A set of communication and capacity building activities, dedicated in particular to African institutions and stakeholders, is foreseen to maximise the exploitation of the project's achievements, promoting also the integration of the environmental dimension in the social and economic context.

2. Project objectives

Objective 1: Consolidate and expand terrestrial carbon and other GHG fluxes monitoring network of Sub-Saharan Africa

CARBOAFRICA project will expand and improve the existing carbon observing systems in Africa. We will collect existing knowledge and coordinate existing efforts through harmonization and exchange of methodologies for flux measurements and ecological sampling across the regions. We will enhance the monitoring capabilities by expanding flux towers and ecological measurements in different ecosystem-types, representative of the Africa's biodiversity and will be the first initiative to cover tropical forest which was not considered so far. Those actions will be the base for setting up a full greenhouse gas monitoring system in Sub-Saharan Africa. We will also integrate the TEMS (Terrestrial Ecosystem Monitoring Sites) existing network for input to model parameterization.

Objective 2: Provide an analysis of the requirements in order to establish a terrestrial GHG monitoring system for Sub-Saharan Africa

One of the aims of CARBOAFRICA is to make use of the existing GHG observations capabilities for fluxes and stocks of carbon,

their current geographical distribution, the end users requirements for UNFCCC and IPCC guidelines implementation, to design an optimal monitoring system network and the identification of its components.

Objective 3: Understand quantify and predict the GHG budget of Sub-Saharan Africa and its associated spatial and temporal variability

By an integrated approach, considering flux measurements together with specific models which assimilate data on soil, atmosphere, agriculture, hydrology, fires and ecological variables, we will identify the links between carbon cycle and nutrients, hydrology, fires, and land use, which will be used as a first broad attempt to produce spatial distribution of sources and sinks and their time behaviour. Water and the nutrient cycles are important drivers of the carbon dynamics in savannas, and fires control carbon allocation as well, both directly and indirectly. A complex interaction between these factors also controls vegetation types and dynamics, thus indirectly carbon allocation.

Data assimilation will comprise own measurements around the identified core sites with flux towers but also integrating the relevant amount of knowledge that was achieved during seven decades of ecological research in Africa. Models will be validated using flux tower data at specific locations. A specific activity will be conducted to evaluate models estimates at regional scale by using aircraft based measurements across a regional transect in west Africa (see CARE experiment, WP3). The process level understanding will help to consolidate reviews of the greenhouse gas budget for all relevant Sub-Sahara African ecosystem-types (tropical forests, savannas, shrublands, grasslands, deserts). The results of this work will provide the knowledge elements necessary for reducing uncertain and bias in GHG budget estimates and to contribute to the revision of the IPCC guidelines.

Objective 4: Assess the current land use change and evaluate the potential for carbon sequestration in Sub-Saharan Africa in the context - inter alia - of the Kyoto Protocol

An attainable objective will be the recommendations regarding the potential of natural ecosystems to act as carbon sinks, and the management actions that would need to take place to achieve this, thus implementing the strategies necessary to mitigate global change. In particular also the potential role of CDM mechanisms concerning afforestation and reforestation will be evaluated in Sub-Saharan Africa. Within this objective we will provide: the dissemination of data on carbon sequestration and other GHG fluxes to States and Stake Holders; recommendations for a sustainable use of land and a rational use of natural resources in the main African ecosystems.

3. Workplan

The above mentioned objectives will be achieved by a multi-disciplinary research approach and careful project coordination, through the division of main tasks in seven complementary workpackages, working in close collaboration.

WP1: Long term observation systems and data integration and consolidation

WP2: Process understanding of carbon fluxes of Sub-Saharan African ecosystems

WP3: Model-data integration for up-scaling to region and continent

WP4: Fire-Climate-Carbon cycle interactions on regional and continental scale

WP5: Communications and Capacity Building

WP6: Evaluation of a sustainable sequestration potential in relation with CDM

WP7: Project Management

Figure - Global Land Cover 2000 map of Africa showing the location of the sixteen eddy covariance sites already available in Africa, and the two new eddy covariance sites and the two stations for atmospheric measurements that will be built by this project.

