



CARBOAFRICA

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

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FORWARD

Research on carbon cycle and other greenhouse gases (GHGs) constitutes a main priority of European research. Several projects are funded under the 5th and 6th Framework Programs with the aim to understand the key processes and feedbacks of the coupled human-biosphere-climate system in Europe and beyond. These projects are implemented under the management of the Climate Change and Environmental Risks Unit of the Environment Directorate.

CARBOAFRICA, is the first EU project dealing with carbon cycle and greenhouse gases in Sub-Saharan Africa; a region highly vulnerable to climate change but with significant knowledge gaps on issues related to greenhouse gases and carbon cycle. The project aims to improve our understanding and predictive capability of carbon cycle and GHGs and evaluate the potential for carbon sequestration in that region. In that respect, I am very pleased to welcome this first issue of the CARBOAFRICA newsletter.

Anastasios Kentarchos (Scientific Officer, EC)

WELCOME!

I am pleased to announce you the first issue of the CARBOAFRICA newsletter. CARBOAFRICA is the first EU project addressing the need of quantify, understand and predict the greenhouse gases budget of Sub-Saharan Africa. The challenging research we have in front of us requires much more than the few institutions involved in the project. For this reason we would like to use the Newsletter to bring together scientists working in Africa on carbon research, and to create synergies with African stakeholders.

Prof. R. Valentini (Project Coordinator).

CARBOAFRICA

CARBOAFRICA is a 3-year project funded by the European Commission under the Sixth Framework Programme, within the Global Change and Ecosystems priority.

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. 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.

During the development of CARBOAFRICA 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.

OBJECTIVES

The **objectives** of CARBOAFRICA include:

1. Consolidate and expand terrestrial carbon and other GHG fluxes monitoring network of Sub-Saharan Africa;
2. Provide an analysis of the requirements in order to establish an optimal terrestrial GHG monitoring system for Sub-Saharan Africa;
3. Understand quantify and predict the GHG budget of Sub-Saharan Africa and its associated spatial and temporal variability;
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.

PROJECT STRUCTURE

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 (Figure 1).

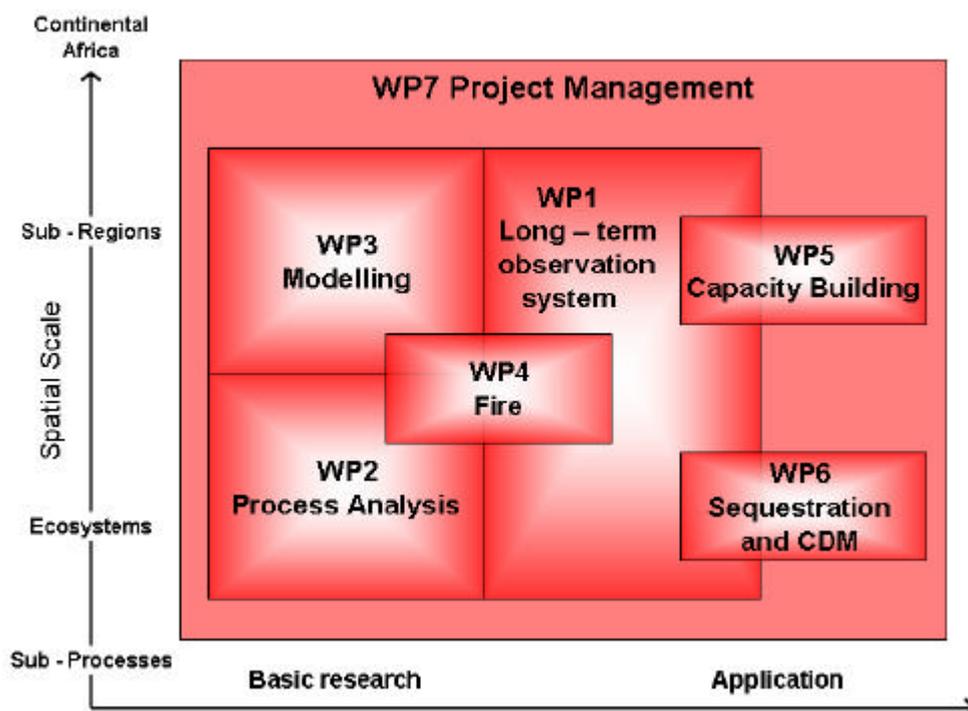


Figure 1: Diagram showing the integration and interrelations of the CARBOAFRICA workpackages

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

RESEARCH AREA

The project will be implemented in at least 11 African countries (Benin, Botswana, Burkina Faso, Gabon, Ghana, Mali, Niger, Congo, South Africa, Sudan, Zambia). The study will be conducted at two levels of scale. The first is the sub-regional scale including Open Forest, Mixed Crop, Open Fallow, Mopane savanna, Eucalyptus natural hybrid, Gravelly red soil,

Grassland, Acacia Forest, Desert, Fallow Bush, Degraded Fallow Bush, Millet, Fineleaf/broadleaf savanna, Savanna/grassland, 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 that will be reached with the spatial and temporal extrapolation models that will be developed and tested using the more intensive key studies. See Figure 2 for the location of the eddy covariance sites.

The Consortium

CARBOAFRICA is a Specific Targeted Research Project (STREP) that involves **15 organizations** from 5 European and 3 African countries. Below follows a short presentation of all institutions that are taking part in CARBOAFRICA:



Università degli Studi della Tuscia, Italy. The Department of Forest Science and Resources (DISAFRI) of University of Tuscia has been working in the field of eddy covariance fluxes of carbon, water, energy and volatile compounds, modelling of ecosystem biogeochemical cycles, remote sensing of forest ecosystems processes, rehabilitation of degraded areas, Kyoto protocol and landscape planning, for more than 15 years. DISAFRI has also considerable expertise in managing national and international projects, and is currently the CARBOAFRICA coordinator.

Max Planck Institute
for Biogeochemistry



Max Planck Institute of Biogeochemistry (MPI-BGC), Germany. TMPI-BGC is a new research institute of the German Max-Planck Society, founded in 1997. Its research mission is the investigation of the global biogeochemical cycles and their interaction with the climate system. The institute combines strong observational and process-based studies (soil carbon, plant community structure, nutrition and growth, vegetation-atmosphere fluxes, convective boundary layer) with global scale modeling (e.g. vegetation dynamics, global carbon cycle, aerosol modeling). In CARBOAFRICA, MPI-BGC will coordinate WP2 and WP3.



Lunds Universitet (ULUND), Sweden. The Dept. of Physical Geography and Ecosystems Analysis (INES) is investigating biosphere-atmosphere interactions, vegetation dynamics and geomorphology on a wide range of spatial and temporal scales. Within CARBOAFRICA, ULUND is coordinating WP4 (fire-climate-carbon interaction), participating in WP1 (providing flux data from Sudan), WP2 (processed based assessments of water, CO₂ and energy exchanges), and WP3 (modelling of carbon fluxes and vegetation at tower sites).



Global Terrestrial Observation Systems, Food and Agriculture Organization of the United Nations.

The Food and Agriculture Organisation of United Nations has the specific mandate to ensure food security for all people of the world. FAO has an established track record in land cover and land degradation mapping, management of Clean Development Mechanism projects, forestry, agricultural production and rural education and training, and

communication. FAO has extensive experience in running international research and capacity building projects in developing countries.



Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France. CIRAD is a French public scientific organization. The mandate is to contribute to the sustainable development of rural areas in tropical and sub tropical regions. Within CARBOAFRICA, CIRAD coordinates the scientific and field activities of WP6 and participate to the field works in Congo-Brazzaville with UR2PI for WP1, WP2 and WP6 (Eddy flux tower on savannah, collection of ancillary data, consequences of land-use changes - i.e., afforestation- on the main fluxes of the ecosystems: carbon, water and nutrients), as well as contributing to WP5.



Centre for Ecology & Hydrology (CEH)
NATURAL ENVIRONMENT RESEARCH COUNCIL

Natural Environment Research Council Centre of Ecology and Hydrology (NERC-CEH), United

Kingdom. The Centre for Ecology and Hydrology (CEH) is the UK's Centre of Excellence for research in the terrestrial and freshwater environmental sciences. Within CARBOAFRICA; NERC-CEH is responsible for scaling from the point to region to continent using a three stage process: 1) calibrate and validate the model against data from available flux sites. 2) Upscale to the region of West Africa using JULES assimilating satellite data (MODIS, MSG etc) and reanalysis products to provide both the surface state and high resolution meteorological forcing.. 3) Estimate long-term (1979-2008) pan-African fluxes. These fluxes will be validated using the outputs from 2 above.



Consiglio Nazionale delle Ricerche

Consiglio Nazionale delle Ricerche Istituto di Biometereologia (CNR-IBIMET), Italy.

The Institute of Biometeorology (formerly IATA-CNR) was created at the beginning of 1980s to meet the national need for a reliable research base, in agrometeorology and environmental analysis for agriculture sectors. Within CARBOAFRICA, CNR-IBIMET will provide data from the CARE experiment to interpret regional variability of fluxes and links with remote-sensing-derived vegetation indices. It will analyse the results of CARE – CARBOAFRICA Regional Experiment and will be responsible for developing and testing the aircraft facility that will be operated in Africa, for transferring the aircraft to the experimental region and to perform flux measurements as well as airborne remote sensing campaigns involving thermal, multispectral and hyperspectral data.



Istituto Agronomico per l'Oltremare (IAO), Italy.

The Natural Resources unit IAO has a long experience in land cover mapping and natural resources evaluation. Within CARBOAFRICA, IAO

will focus on the study of the aboveground carbon stock distribution in Sub-Saharan Africa through the integration of satellite images, land cover information and associated ecological variables. The analysis of different techniques for the integration of data sources and the relationship between carbon stock and the input data will be explored.



Seconda Università di Napoli Dipartimento di Scienze Ambientali (SUN-DSA), Italy.

SUN-DSA is a research and didactic organization covering a broad range of disciplines. The Ecology group is specialized in soil biogeochemical cycles with particular focus on the carbon and nitrogen cycles and related production and consumption of greenhouse gases (GHG). Within CARBOAFRICA, SUN-DSA will measure soil-atmosphere gas exchange of GHG in key sites of the project, defining the main driving environmental factors, and producing an estimate for the Sub-Saharan Africa of N₂O and CH₄ soil net gas exchange.



Council of Scientific Research (CSIR), South Africa.

CSIR in South Africa is a large, government-owned research institution. It has been operating a flux tower near Skukuza, in the Kruger National Park, since 2000. Through the CARBOAFRICA project it will extend the flux measurements to three other sites, to allow a comparison of transformed and protected savannas, and semiarid and arid savannas. The CSIR is also involved in other work packages, especially those on fire and capacity building.



Unité de Recherche sur la Productivité des Plantations Industrielles (UR2PI), Congo.

UR2PI is a Congolese research association created in 1995 by the government of the Republic of Congo, an industrial partner (Eucalyptus Fiber Congo), and CIRAD. Its main mandate is to manage research projects devoted to the improvement of the productivity and the sustainable management of the forest plantations. UR2PI is in charge of the field activities in Congo in WP1, WP2 and WP6 (among other: eddy flux tower on savannah, monitoring canopy dynamic, above- and belowground plant growth, litterfall and fine root turnover, total and heterotrophic soil respiration). UR2PI is also deeply involved in capacity building and training (WP5) as regional centre for central Africa.



Agricultural Research Corporation (ARC), Sudan.

ARC is a nationwide governmental research organization founded 1902 by the Ministry of Science and Technology. Its main activities are in the field of applied agricultural research in response to the needs of the various agricultural production systems. Within CARBOAFRICA, ARC will contribute to the maintenance of measurement equipment and

data collection (climate data, eddy covariance data, site ancillary data) and the provision of mandatory parameters for basic site characterization.



Commissariat a l'Energie Atomique Laboratoire des Sciences du Climat et de l'Environnement (LSCE), France.

LSCE has been developing and managing a network of about 15 sites in the world for measuring the atmospheric composition. On the modeling part, LSCE is leading the development on the vegetation component of the ORCHIDEE global biosphere model (<http://www-lscea.cea.fr>). LSCE is also developing inverse methods to infer the surface fluxes from the observed atmospheric concentrations. Within CARBOAFRICA, LSCE will compare ORCHIDEE model and flux measurements and improve the ORCHIDEE parameterizations based on these results. It will also setup two stations for the measurement of atmospheric CO₂ concentrations and investigate the benefit of 6-month seasonal forecasts of NPP for the African continent.



King's College London (KCL), United Kingdom.

The Department of Geography has a long established international reputation as a centre of research excellence. The Department has long-standing expertise in studies related to both fire and the African continent, including associated perturbations to the land and atmosphere. Within CARBOAFRICA, KCL will provide EO-derived active fire location and fire radiative power and energy data, will investigate the relationship between fire radiative energy and fuel mass consumed, estimate and validate (with partners) fire-related carbon emissions from combined active fire location, burned area, and FRE datasets.



University of Leicester (ULEICS), United Kingdom.

The Dept. of Geography carries out interdisciplinary research into the nature and dynamics of human-environmental systems. In CARBOAFRICA, ULEICS is contributing to WP4 through the estimate of carbon emission from fires combining burned area and fire radiative energy data (from KCL), derivation of remote sensing datasets of fire variability and an analysis of influencing factors, including climatic oscillations like El Niño, population density, land cover type and meteorology, and investigating the coupling of interannual climate variability, population density, land cover type and fire frequency / intensity using a remote sensing data analysis approach.

PROJECT SITES

The observational backbone of the project is constituted by a set of experimental sites either already existing or newly established during the course of the project. The project will enjoy the collaboration with other ongoing initiatives such as AMA, AFRIFLUX and ACE, thus ensuring the optimization of resources. The figure below shows their geographic location.

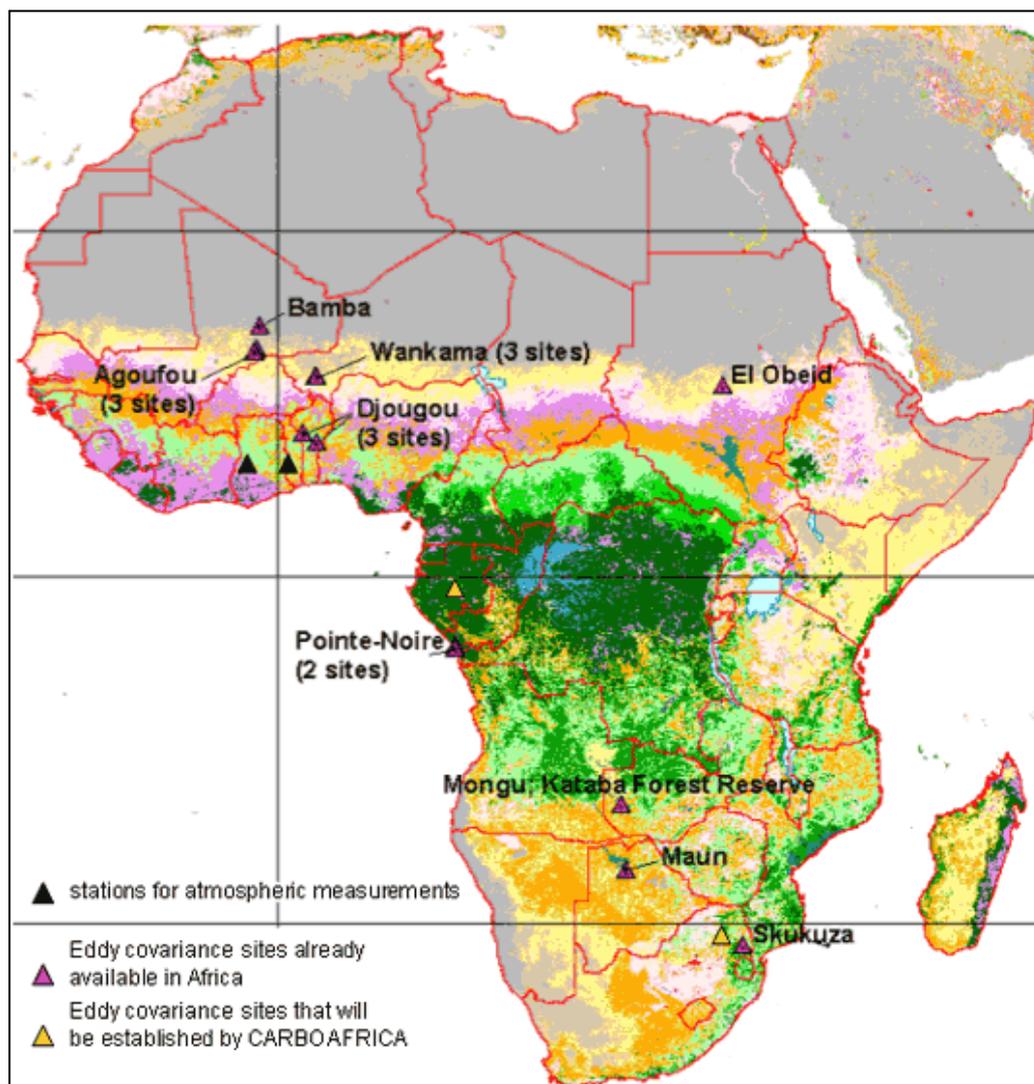
EXPECTED RESULTS

We are aware that GHG emissions is not the top priority on the African development agenda. Africa's GHG emission is low respect to the rest of the world, but it is increasing, due to urban expansion, deforestation, fire, and human activities. Moreover, the sustainable development of Africa depends on the mitigation of the negative consequences of climate change at the global scale, and it is likely that some or all African countries will be called upon to join global efforts in this regard at some stage, possibly as soon as 2012.

Therefore, CARBOAFRICA aims to inter-relate basic and applied research on GHG emissions with other aspects of sustainable development. One integrating aspect will be the Clean Development Mechanism (CDM).

The main results expected from the CARBOAFRICA implementation are:

- the expansion, through the establishment of new infrastructures, of the existing carbon observing systems 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 of the potential for carbon sequestration in Sub-Saharan Africa;
- the suggestion for an effective use of the economic mechanisms of the Kyoto Protocol;
- the recommendation for the implementation and management of mitigation strategies.



Moreover, CARBOAFRICA network will strengthen the capacity of Europe to lead carbon cycle research and to understand global change process, contributing to the GEO main aim, i.e. the enhancement of a global earth observations system. 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, enhancing an active

Figure 2: 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. Global Land Cover 2000 gives 1 Km resolution coverage taken from SPOT imagery based on images from the year 2000 (<http://www-gvm.jrc.it/glc2000/>).

involvement of Sub-Saharan African countries in the international environmental policy, and supporting them on the path of a sustainable development.

At the end of the three years, CARBOAFRICA will produce the following **outputs**:

- * Fully operational Carbon monitoring network within key regions;
- * Carbon/Meteo/Soil/Vegetation data and public-domain database;
- * Thematic maps and remotely sensed products of Sub-Saharan Africa, harmonized and geo-referenced;
- * Fire mapping and emissions;

- * Models tested and validated, from region to continent level;
- * Standards and protocols;
- * Publications;
- * Web and electronic dynamic tools;
- * Communication and capacity building activities;
- * Sub-regional seminars, scientific conferences, training courses;
- * Production of national and regional carbon strategies;
- * Training on the Kyoto Protocol and CDM opportunities;
- * Final plan for using and disseminating knowledge.

RELATED LINKS

ACE – African Carbon Exchange (ACE) Project

<http://www.nrel.colostate.edu/projects/ace>

AMMA - African Monsoon Multidisciplinary Analysis

<http://amma.mediasfrance.org/>

CARBOEUROPE (Integrated Project CarboEurope-IP, Assessment of the European Terrestrial Carbon Balance)

<http://www.carboeurope.org>

EO-LANDEG (Earth Observation initiative in a former homeland of South Africa in support of EU activities in land degradation and integrated catchment management)

<http://www.eolandeg.com>

ESASTAP - European South Africa Science and Technology Advancement Programme

<http://www.esastap.org.za/esastap/home/index.php>

GCP - Global Carbon Project

<http://www.globalcarbonproject.org>

FLUXNET (Integrating Worldwide CO₂ Flux Measurements)

<http://www.fluxnet.ornl.gov/fluxnet/index.cfm>

ILEAPS - Integrated Land Ecosystem-Atmosphere Processes Study <http://www.atm.helsinki.fi/ILEAPS/>

NEPAD - New Partnership for Africa's Development

<http://www.nepad.org/>

TCO - Terrestrial Carbon Observation

<http://www.fao.org/gtos/TCO.html>

TroFCCA - Tropical Forest and Climate Change Adaptation

<http://www.cifor.cgiar.org/trofcca>

EXPRESSION OF INTEREST

Any collaboration with other new or ongoing initiatives is welcome: if you are interested in collaborating to CARBOAFRICA you are encouraged to send us a letter of interest downloading the template available on CarboAfrica website (section Documents/miscellaneous). We will get back to you as soon as possible.

CONTACT CARBOAFRICA

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