

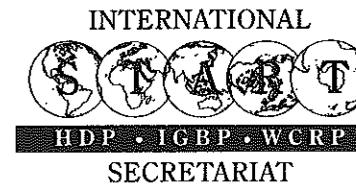
GLOBAL I G B P CHANGE

REPORT No. 29



Africa and Global Change

The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP)
of the International Council of Scientific Unions (ICSU)
Stockholm, 1994



IGBP REPORT No. 29

Africa and Global Change

Report from a Meeting at Niamey, Niger
23-27 November, 1992

arranged by

The Global Change System for Analysis, Research and Training (START)

on behalf of

The International Geosphere-Biosphere Programme (IGBP)

The Human Dimensions of Global

Environmental Change Programme (HDP)

and

The Joint Research Centre

of the Commission of the European Communities (CEC)

In collaboration with

National Meteorology of Niger

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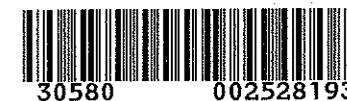
French Ministry for Cooperation and Development

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and

The Consortium for International Earth Science Information Network (CIESIN)

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Opening Addresses and Brief Messages

Dr. Mohamed Boulama Chair of the National IGBP Committee for Niger

Distinguished Ministers, Your Excellencies Ambassadors, Honourable Representative of the Commission of European Communities, Honourable Executive Director of the IGBP, Honourable Delegates, Dear Colleagues, Ladies and Gentlemen,

I would like first of all, in my name and in that of all my colleagues who are members of the National IGBP Committee of Niger, to welcome our eminent guests to our country.

The International Geosphere-Biosphere Programme, as it is established, is of particular interest to Africa in its search for solutions to problems posed by changes that are occurring at a global scale. The gathering of many experts, particularly those from Africa, who are working in different fields in relation to climate and the environment, is for me evidence of the resolve of our continent to work towards finding solutions.

Niger, a country with a fragile ecosystem, can only rejoice at the theme chosen today. The wealth of research information on the climate and the environment which we have in Niger, thanks to the existence of many research institutions, will, I am sure, contribute positively to our action.

Distinguished Ministers, in the name of my colleagues of the National IGBP Committee for Niger, and certainly also in the name of the eminent delegates here today, I thank you for the interest which you have shown in accepting to honour us with your presence at the opening ceremony of the conference. Your presence is proof of the great importance which Niger attaches to the problems of the environment of the globe in general, and to the African environment in particular, that the meeting here in Niamey will address today.

I have the pleasure of asking the Distinguished Minister of Commerce, Transportation and Tourism, to officially open this meeting.

H.E. Mr. Souley Abdoulaye
Minister for Commerce, Transportation and
Tourism, Niger

Your Excellencies, Ministers; Your Excellencies, Ambassadors and Representatives of international institutions and organisations; Professor Rosswall, Director of the International START Secretariat; Dr. Contzen, Director General of the Joint Research Centre of the Commission of the European Communities; Honourable Delegates; Ladies and Gentlemen:

It is for me a great honour and a pleasure to welcome you to our country to participate in this important regional meeting on Africa and Global Change. We are honoured by the choice of Niamey as a venue for this conference, as the theme, Africa and Global Change, holds a particular interest for us.

Honourable Delegates, Ladies, and Gentlemen.

Indeed, the 1992 agricultural campaign in Niger has ended with a cereal deficit of 250,000 tons. This deficit is a cruel reminder of what we have already known during the 1970s and 1980s. In addition, we often ask ourselves what happened to the climate during the last decades in this part of Africa. The link between these deficits and the delay of the onset of the rainy season, not to mention its poor distribution in time and space, appears evident to us. In addition, one should point out the persistence of the economic crisis and the continual degradation of the environment.

The different intergovernmental reflections on climatic change have concluded that we are in a vulnerable region from a climatic point of view. This is to say that the changes will affect all our natural resources, notably the agriculture that employs 80 percent of our population.

It is thus urgent to better apprehend the diverse factors influencing cereal production in the vulnerable regions, and to develop strategies that will permit the stabilisation of food production in the future. This will occur with appropriate management of our agro-ecological systems.

To do this - and in order to arrive at a better comprehension of the different aspects of our ecosystems - the contributions of scientists working in different disciplines such as meteorology, agronomy, hydrology, sociology, etc. are indispensable if we concur that scientific research necessitates a global approach to problems to end up with concrete and durable solutions.

It is evident that today one must ask the following questions: have we sufficiently studied what has occurred with the climate in the past years; are we acting differently in comparison with previous centuries; and, as citizens of planet Earth, have we become aware of our role and our responsibility in the safeguarding of our natural resources for the generations to come? One could also ask whether we know how to judiciously use our soil, our forests and our atmosphere.

These few questions that I have just raised are, I am sure, the worries that African countries and the international community share at the current time. In this face of this challenge, what are we to do? The answer depends much on what we know from our analysis and on our capacity to foresee with a certain precision what may happen. And this is precisely the reason for which we must assemble scientists like yourselves to tell us what has occurred in the past, what could occur and to counsel us at the same time on what it is necessary to do.

Niger finds itself already at the forefront of climatic research in Africa and, thanks to the presence in our capital of regional and international institutions such as Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle (AGRHYMET), HydroNiger, Ecole Africaine de la Météorologie et de l'Aviation Civile (EAMAC), African Centre of Meteorological Applications for Development (ACMAD) and International Centre for Research in Semi-Arid Tropics (ICRISAT), will continue to focus the work of these organisations and national institutions on the important problem of global change.

The very important points that will be examined in the course of the present meeting - such as, but not limited to, the effects and the human dimension on global change, research initiatives, and political and social institutions - will permit you, I am convinced, to define the outlines of these complex problems. Also, I express the hope that recommendations and resolutions will result from your meeting.

I wish you much success in your work and I declare open the regional workshop on Africa and Global Change.

Thank you.

Prof. Thomas Rosswall Interim Director, The International START Secretariat

START (Global Change System for Analysis, Research and Training) is the acronym for a system of interconnected regional research networks being developed by the International Geosphere-Biosphere Programme (IGBP) of the International Council of Scientific Unions (ICSU), in cooperation with the World Climate Research Programme (WCRP); ICSU; the International Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the World Meteorological Organisation (WMO); and the Human Dimensions of Global Environmental Change Programme (HDP) of the International Social Science Council (ISSC).

START is the international scientific community's response to the need for regional research with a global scientific perspective and the development of competence and consensus on scientific issues world-wide. The fundamental purpose of a system of networked regional research centres and sites is to promote research on the regional origins and impacts of global environmental changes such as global warming and, through vigorous training and fellowship programmes, to enhance indigenous scientific capacity to engage in focused research on critical regional environmental issues of global importance.

START will be a world-encompassing system of Regional Research Networks (RRNs), each of which includes at least one Regional Research Centre (RRC) and a number of Regional Research Sites (RRSs). Each of the RRCs serves as the information centre for the RRN, with additional coordination functions both within and between the regions. A major function of the RRC is to provide a multidisciplinary setting within which results from various disciplines concerned with global change phenomena can be synthesised into a framework that is policy relevant. Thus, by necessity this synthetic function will include both natural and social science aspects. The RRCs will also have access to regional and global data bases that are necessary for analysing both the contribution of the regions to global change phenomena as well as the impacts of global changes within the regions. The RRSs are institutes in the region with specialised expertise that allows them to carry out research on important components of the specific core projects of the global change research programmes. Both RRCs and RRSs will also host training courses and provide foci for capacity building in the region.

Within START, 13 regions have been identified covering the globe. All of these biogeographic regions are important in terms of global change because each is distinctive, and only together can they provide a complete representation of environmental changes in a global context. Priority has been given to developments of RRNs/RRCs in regions covering primarily developing countries. Considering the combined factors of sensitivity to global and climatic change, scientific unknowns, and the existence of available infrastructure, three regions have been identified as of highest, immediate priority for assistance in establishing START RRNs: Equatorial South America (ESA), Northern Africa (NAF) and the Tropical Asian Monsoon (TAM) region.

This is one in a series of regional workshops organised by the IGBP to ensure that regional priorities and perspectives have appropriate influence on the development of the international programme and to address how further regional collaboration can be promoted. Previous such workshops have been arranged for the Southern Hemisphere (Swaziland, 1988), South America (Brazil, 1989), Asia (India, 1991) and Southeast Asia (Thailand, 1992).

As the planning for START has been initiated, the regional workshops have been charged with outlining the appropriate modalities for regional collaboration in global change science and research. Attempts have also been made to expand the initial IGBP focus to consider its two sister programmes, the WCRP and the HDP. The current workshop will discuss modalities for collaboration in the three START regions covering Africa: the Mediterranean, Northern African, and Southern African regions.

The meeting objectives are to:

- Present current information on global change research issues important for Africa
- Identify key areas of global change research in both natural and socio-economic sciences
- Review IGBP and HDP Core Projects and set priorities for African scientific participation in these projects, including the identification of impediments
- Discuss global change research networks as part of the IGBP/WCRP/HDP initiative for START in the Mediterranean, Northern African, and Southern African regions
- Review possibilities for strengthening collaboration with other relevant research and monitoring programmes.

To meet these objectives, the meeting has been structured in four sections: (i) presentations of global change problems in relation to Africa (these papers will be published in full in the proceedings from the meeting); (ii) working group sessions to discuss and define research priorities for African participation in global change research (the report from these discussions will be included in the report from the meeting to be published in the IGBP Report Series); (iii) working group sessions to discuss initiatives for the establishment of Regional Research Networks for the three regions covering the African continent; and (iv) general recommendations from the meeting, which shall address the most urgent needs for follow-up action.

On behalf of the organisers of the meeting, IGBP, HDP and the Joint Research Centre of the Commission of the European Communities (JRC/CEC), the programme has been developed by a committee with the following members: M.V.K. Sivakumar, ICRISAT, Niger; M.A. Ayyad, National IGBP Committee, Egypt; M. Boulama, National Meteorological Office and National IGBP Committee, Niger; M. Boulahya, ACMAD, Niger; R.G. Chimonyo, National IGBP Committee, Zimbabwe; E.S. Diop, Coastal Marine Research and Training in Africa (COMARAF), Senegal; F. Geiss, JRC/CEC, Italy; F. Gnoumou, AGRHYMET, Niger; S.P. Kagoda, National IGBP Committee, Uganda; S. Klersy, JRC/CEC, Italy; K.M. Mungomba, National IGBP Committee, Zambia; T. Mkandawire, Council for the Development of Economic and Social Research in Africa (CODESRIA), Senegal; R.H. Moss, HDP, Sweden; L.J. Ogallo, University of Nairobi, Kenya; K.F. Seddoh, National IGBP Committee, Togo; and myself. Members of the committee have met twice (Lomé, Togo, and Niamey, Niger). We are very grateful to them for their devoted work. In addition to the IGBP, HDP and CEC, the meeting is cosponsored by the United Nations Development Programme (UNDP); the United Nations Environment Programme (UNEP); the Third World Academy of Sciences (TWAS); the French Ministry for Cooperation and Development; Réseau de Recherche Régionale pour le Bassin Méditerranéen et l'Afrique Subtropicale (MEDIAS); the US Committee on Earth and Environmental Sciences (CEES); and the Consortium for International Earth Science Information Network (CIESIN). Their support is gratefully acknowledged.

We have challenging tasks ahead of us. We have exciting possibilities to further develop scientific collaboration in new partnerships; between disciplines as well as nations. We are charged with

addressing one of the key environmental issues, one that is particularly difficult due to its global nature and potentially threatening consequences. This necessitates unprecedented collaboration within the international scientific community involving both the natural and social sciences. It is also necessary to promote appropriate and efficient linkages between the science community conducting research to narrow the scientific uncertainties, the international and national efforts to assess global change phenomena and their consequences, and the political process addressing the need for international agreements to address this important issue.

We will have to work hard during this week, but I am sure that the results will well worth our efforts. This is just one step, but an important one, towards the development of new collaborative efforts, in which African scientists will play an essential role.

Dr. Jean-Pierre Contzen
Director General, Joint Research Centre
Commission of European Communities

Distinguished Ministers, Excellencies, Dear Colleagues, Ladies and Gentlemen,

It is with great pleasure that I speak to you, in the name of the Commission of European Communities, to wish every success for the conference that opens today. I would like to thank the Authorities of the Republic of Niger, and the organisers stationed in Niamey, for the support that have provided, for the efficient preparation of this meeting, and for the warm and friendly hospitality extended to us. When the directing body of the International Geosphere Biosphere Programme suggested that the Commission of European Communities, through the Joint Research Centre, could sponsor this meeting, we answered affirmatively without any hesitation.

The problems raised by global change, the needs it creates for Research and Development, are of immediate interest to the Europe of Twelve Nations. The European Communities were an active partner in organising the United Nations Conference on Environment and Development (UNCED) in Rio, and intend to participate fully in its follow-up. For example, the European Communities have set objectives to eliminate chlorofluorocarbons (CFCs) and halons that are much more ambitious than those set by the Montreal Agreement. At the same time, the Communities actively propose measures that will lower methane and nitrogen oxides in order to take concrete action in 1994.

At Rio the European Communities signed the Convention on Biodiversity and the Framework Convention on Global Change, promising to reduce, by the year 2000, the emission of carbon dioxide in Europe to the same level as 1990. Finally, the European Communities confirmed their resolve to contribute to halting the destruction of tropical forests, and to reverse this tendency with measures for reforestation, beginning by the year 2000.

The Fifth Plan of Community Action for the Environment, now being proposed by the Commission to the Member States (entitled "Towards Sustainable Development"), attaches great importance to the questions which will be discussed in today's conference, just as it does to the specific research programmes carried out as part of the community policy in Science and Technology. In addition, I would like to point out here the will of Europe to join the efforts to promote growth in Africa, the Caribbean and the Pacific (ACP), that has been formalised in the successive Lomé Conventions, signed by the European Communities with the ACP countries; they attest to our commitment in this part of the world.

The problem of global change is of interest to all the countries on our planet Earth, independent of their stage of development. They all should be associated to work actively on its analysis, its diagnostic, and to find the right corrective action. This is why the Commission of European Communities has suggested to its Member States to take on a new initiative with the aim, among others, to strengthen indigenous capacity in developing countries, in particular those of Africa, in the field of research on global change.

The work, which begins here today, should be an assessment of the situation in this part of the world, make a survey of initiatives already begun in this field, and ascertain what action would give the necessary coherence to these initiatives, and what should be done to make them most efficient.

Distinguished Ministers, Excellencies, Dear Colleagues, Ladies and Gentlemen, one of the important questions which needs to be resolved as this second millennium draws to a close is that of a balanced relation between science and democracy, that of harmonious interaction between the scientific community that is rightfully concerned with assuring its independence of thought and action, and governmental powers who can no longer avoid the incorporation of scientific elements into their socio-economic endeavours and who, in addition, are more and more solicited to fund research and development.

An open dialogue, based on mutual respect for the competence of each of the two parties, should be carried on, if not increased. This is why we are particularly happy to be associated with non-governmental organisations, representatives of the world scientific community, in the process of which today's conference is a stage. Our aim is not to dictate the scientific content of the work to be carried out, but to incorporate it into a much broader socio-political context, to insure adequate financial and human resources to put it into action, especially to stimulate an efficient transfer of the results of scientific research to the level of political decisions. I would like to remind you, in this respect, of the final paragraph of the 5th plan for Community Action for the Environment: "The environment depends upon our collective action; tomorrow's environment will be decided by the way we act together today".

Distinguished Ministers, Excellencies, Dear Colleagues, Ladies and Gentlemen, these are the few comments I wished to make at the beginning of this conference from which we expect fruitful results, and that has the advantage of taking place in the beautiful setting of the capital of Niger.

Thank you for your attention.

Working Group Reports

Interactions between Land Use Changes, Climate Changes and Energy Use

Chairmen: E. Laing (Ghana) and M. Diallo (Mali)
Rapporteurs: N.H. Ayodele Cole (Sierra Leone) and N.R. Yao (Ivory Coast)

Introduction

The report is presented according to the major ecosystems in Africa operating for each of the six sections discussed under Working Group 1, namely:

- Deforestation identified as a problem in forests and savannah woodlands
- Desertification as a problem of arid areas and semi-arid lands
- Climate, energy balance and soils, as problems in land use systems
- Genetic resources and biodiversity relating to vegetation cover changes
- Infrastructural development, including establishment of national IGBP Committees, sub-and regional coordination, and the like.

Relevance for Africa

- Desertification and deforestation are human activity-driven problems affecting the socioeconomic-economic fabric of all African countries from the moist to the arid ecosystem.
- The human dimension of land use changes cut across various economic development sectors: agricultural, industrial, energy production, human settlements, health and education as the most important.
- Due to the social and economic crisis of the 1980s, African development has declined; hence African countries' responsiveness in terms of preparedness to detect global changes is inhibited.
- The impact of atmospheric pollutants from biomass burning and domestic energy production and use can produce greenhouse gases. In addition, health hazards, such as respiratory diseases in humans, can occur from some emission of aerosols.
- Potential impact of climate changes, especially in the Sudano-Sahelian region and Namibian aridlands, can worsen human health and welfare, through drought and famine from reduced precipitation, increasing dust storms during the harmattan season in West Africa, and flooding due to sea-level rise.

- Changes in vegetation cover in the major African ecosystems can lead to a loss of natural biological resources (food, fodder, drugs, industrial products), of genetic resources (plants, animals, microbial genotypes for agricultural improvement) and of the tropical biodiversity with increase in the threatened and endangered species in the continent.
- It is very important for the long-term pursuit of science in Africa to include capacity building for indigenous scientists to study local and regional problems within the framework of the international scientific programmes, for dependable, reliable contributions to global climate studies.

Current Research

These research projects are either regional, sub-regional, or are being carried out at or within national institutions, but they will be categorised under the major African ecosystems. The following are only a few indicative examples:

Aridland ecosystem and desertification control

- Observatoire du Sahara et du Sahel/Comité Inter-Etats pour la Lutte contre la Sécheresse au Sahel (OSS/CILSS) programme to create ecological observation sites within each member State in the Sudano-Sahelian region.
- Inter-Governmental Authority on Drought and Development (IGADD) programmes on combating desertification from coastal sand dunes.
- Sahara/locust monitoring project in Algeria.
- Arid Zone Ecology Forum under the Foundation for Research and Development in Pretoria, South Africa, coordinates land use degradation and desertification projects undertaken at various research sites, such as the Stress Ecology Unit of the National Botanical Institute and the Agricultural Research Institute.

Forest and savannah-woodland ecosystem and projects on deforestation

- Tropical Ecosystem Environment observations by Satellite (TREES) projects for tropical forest monitoring, sponsored by CEC and ESA and involving several African countries
- BACFE continental biomass burning, monitoring and analysis of satellites data (USA, Germany and Italy), involving southern African countries
- National projects on deforestation impact study are carried out by, e.g.,
 - University of Port Elisabeth, FOREST of the Council for Scientific and Industrial Research (FOREST of CSIR), FOREST FORUM of the Foundation for Research Development of South Africa
 - University of Botswana Project on woodland degradation and soil losses for agriculture
 - Ecole National Supérieur d'Agronomie (ENSA) of Ivory Coast has a United States Agency for International Development (USAID) Project proposal on evapo-transpiration in fast growing tropical forest trees
 - University of Sierra Leone, Fourah Bay College, Botanical Reserve project on forest microclimate
 - Université du Bénin (Togo) has a project on the control of floristic diversity of national grasslands, including recent history of the forest and savannah of Togo and the transformation of natural savannah into forestlands
 - University of Lagos project on the role of tropical forest on the hydrological cycle
 - Unité de Recherche sur les Ressources Biologiques Terrestres (URBT, Algeria) has a

study on the distribution and dynamics of steppe and Sahara ecosystems
Savannes à Long Terme (SALT) project for long term study of West African savannah ecosystem with its aridland ecotones through monitoring at ecological observation sites. France is sponsoring the project and Burkina Faso, Ivory Coast, Mali, Niger and Senegal are participating countries.

Climate Changes, Energy and Soils

- AGRHYMET Project
- Dynamique et Chimie de l'Atmosphère en Forêt Equatoriale (DECAFE) project deals with the chemistry and dynamics of the atmosphere in Equatorial Africa
- International Global Atmospheric Chemistry (IGAC) investigation on the interactions between land use practices and greenhouse pollutant gases as atmospheric trace gases arising from fossil fuel burning, biomass burning
- RAMESES-I project on monitoring aerosols (dust, H₂O₄, O₃) transportation, deposition and impacts all over northern and western Africa to determine solar extinction modelling
- Hydrologic-Atmospheric Pilot Experiment (HAPEX) Sahel project is carrying out pilot studies on atmospheric hydrologic interrelationships in the Sahel
- Many scientific and technological institutions in Africa are generating useful information that may serve as baseline on the natural system in Africa, some of which are related to climate change
- (EPSAT (Global Energy and Water Cycle Experiment (GEWEX)) estimation of rainfall in West Africa from satellite, radar and raingauge network (Burkina Faso, Niger, France, UK.)
- IGBP-WCRP (wind erosion) production, transfer and deposit of dust (Cap Vert, Niger, France)
- Monitoring of Tropical Vegetation (MTV) research conducted in Africa by the common research centre of the CEC and the southern Saharan countries.

Monitoring Needs

The scientific capabilities required in Africa for monitoring global changes relate to climate, vegetation cover, land use degradation processes (deforestation, desertification, soil losses), hydrometeorological for water resources availability, and socio-economic to cover the human dimensions. Scientific monitoring is necessary to build up database and knowledge required for economic development and planning for resource use and management in African countries. However most monitoring exercises are project-oriented with specific, short-lived deadlines. These activities should be of longer term for optimum effectiveness.

Existing monitoring centres in Africa need to be strengthened at the regional, subregional, and national levels for climate parameters such as greenhouse gases, radiation balance components, ozone depletion and UV radiation fluxes and synoptic data for weather forecasting at a sub- and regional basis. For example, ACMAD as a regional centre for the collection and analysis of climatic observations for regional weather forecasting; the Food and Agriculture Organisation (FAO) Early Warning subregional stations in Kenya, Zimbabwe and Ghana; the water resources subregional stations for AGRHYMET, Hydroniger, Agency for the Safety of Aerial Navigation in Africa (ASECNA).

The Brazilian experience has shown that up to 90 percent statistical sampling is required to remove heterogeneity in data analysis for high quality information. Therefore, near-total coverage is needed for the monitoring of vegetation cover and land use degradation processes, even though

this endeavour is quite expensive. Such intensive sampling and inventory for biodiversity and natural resources in the ecosystem can be limited to once every 5 to 10 years, although land use degradation monitoring data can be obtained from satellite imagery much more frequently (yearly).

Although the majority of existing monitoring sites in Africa need strengthening, a few new ones should be established for specialised information required by scientific professionals, at each of the major ecosystems. Such specialised areas with global data gaps are: atmospheric physics, biodiversity assessment, natural vegetation microclimate, and so on.

Availability of Data Bases

It was noted that most of the long established regional and subregional monitoring centres, as well as national institutes and universities, have developed data bases and data banks; for example, AGRHYMET, CILSS, and some others. However, most African governments consider information as a natural resource for economic planning and is not readily available to all, especially outsiders. Through regional technical cooperation between member states in an organisation such as START, such an embargo can be surmounted.

Although data banks exist at various levels in Africa management may not be very effective or efficient for accessing. African professional and scientists should not waste valuable time collecting data but should be able to access such data from existing data banks. Also standardisation of methodology for data collection is necessary for comparison of results. Also, computer capability is a *sine qua non* for accessing data which exists in electronic databases within the United Nations system and in universities overseas.

The experience of WMO's Background Air Pollution Monitoring (BAPMON) programme on the monitoring of background radiation levels of various African countries was discussed. The project was not very successful because of poor quality data obtained due to the non-involvement of local research scientist, in most cases, for quality control of national scale data outputs.

Quality data collected at the national level is the building block for analysis of global change with an emphasis on dynamic processes rather than descriptive weather forecasting. Some of the climate data collected at national level may be of no use at that level but will be required to fill gaps at the global and regional levels.

Socioeconomic databases for the human dimension, especially of ecosystem degradation processes (deforestation and desertification) must be collected and existing data banks in the African Institute for Economic Development and Planning - Regional Institute for Population Studies (IDEP- RIPS) identified for sustainable development.

Impediments to Further Regional and International Cooperation

The heading seems to have a negative impact, hence suggest strengthening of technical cooperation may have a positive approach to the problem, especially for the development of suitable infrastructure and capabilities.

Within the framework of IGBP activities at the national level political interference on scientific endeavours should be avoided in the light of the ICSU principle on free exchange of material. However, political will and commitment are necessary for governmental and financial support to

African sub- and regional centres contributing scientific knowledge for understanding global change.

As of now, only eight African countries have established national IGBP Committees. More need to be formed as local scientists feel the need to coordinate national activities on global change, and also to enable technical cooperation for information exchange within and outside the region.

The eight coordinating networks already established by African Ministerial Conference on the Environment (AMCEN/UNEP), based on major ecosystems within the continent, can form the links for regional technical cooperation. Those of significance for IGBP's global change in Africa/START programmes are: Climatology Network, Forests and Woodlands Network, Aridland Network, Rivers and Seas Network, Soils Network, African Genetic Resources Network.

It was noted that although deforestation was a major component of global change, six African countries having most of the rain forests (Zaire, Congo, Cameroon, Central African Republic, Equatorial Guinea, Gabon) were not represented at the START meeting. This has created a serious gap for regional technical cooperation the area.

An important practical impediment is the almost complete absence of capabilities to facilitate electronic linkages to available data bases and data banks. START can play a significant role by providing a standardised network or access to the existing computerised information systems.

Recommendations for Action

- Creation of national IGBP Committees, although suitable existing national committees dealing with environmental matters may be used
- Two important research gaps: a) The definition of historical changes in five regions (both in Southern, Central and Eastern Africa (SAF) and Northern African Region (NAF)/START); b) The interactions of dust aerosols with global change (SAF and NAF)
- 10% of the funds available from the Global Environmental Facility (GEF) should go to START
- Need, on a practical scale to: a) perform inventory of relevant data bases; b) link the relevant institutions electronically
- Need to perform inventory of desertification and impacts of drought for southern Africa (lagging behind West and North Africa in studies of this phenomenon) and the role of Albedes' in food production and food security this impact on rainfall
- Need to assess the implications for regional hydrology of deforestation in Africa, for impact on energy use, supply and availability
- Need to assess the extent and effects of greenbelt revegetation/ reforestation projects
- Need to assess the implications of deforestation in the humid coastal regions of West African on the desertification process in the Sahel
- Need for socioeconomic databases of land use degradation processes leading to global change.

Land Use and Climate Change Impacts on Water Resources, River Basins and Coastal Systems

Chairmen: Lekan Oyebande (Nigeria) and E.S. Diop (Senegal)
Rapporteurs: Bruce Hewitson (South Africa) and Diafara Touré (Senegal)

Introduction

The discussion dealt with how the topic related the developing nations of Africa against the background of the need for sustainable development. The topic was interpreted to be one of how two forcing factors, land use and climate change, impact on three aspects of the hydrological system; water resources, river basins, and coastal ecosystems and processes. In particular it was noted that many of the African States have their economic development based on renewable agricultural and marine resource, and that for some decades much of Africa has suffered under climate degradation, one of a number of factors compromising their development. The priority and status of research into these areas were identified, and the discussion closed with recommendations for specific actions in which START may be able to assist.

Relevance for Africa

Water resources in Africa were identified to be of great importance given the high degree of dependence of society on water, and the nature of water availability in Africa. In particular it was noted that much of Africa has a low rainfall, and greater than 60% of the land surface has for the immediate past been under water stress. Furthermore, there is significant variability in the seasonal precipitation placing many regions in a vulnerable position. In the face of a growing population, intensified land use and potential climate change induced reduction in precipitation, water resource research is urgently needed.

Related to this issue is that of the dynamics of the river basins. A large portion of agriculture relies on the river systems whose quantity, and increasingly their quality, can be highly variable. Many of the river systems, but in particular the Sudan and Sahelian zones, and the basins of the Niger, Nile, and Zambezi Rivers, have over the last 25 years been under a severe water deficit. Further changes in climate, or increased stress through land use practices, may have untold consequences on society and agriculture. Notable problems include that of sediment loads with respect to their influence on the increasing number of dams, and greater topsoil losses through poor land management. Consequently, research into the changing dynamics of river basins under the influence of climate change and land use is identified as a second urgent priority.

The third area of research to be discussed was that of the coastal systems. Much emphasis was placed on this aspect as large portions of the African coastline carry a substantial segment of the total population. In the coastal zones, global change and land use affect principally some sensitive areas. For example, the estuary and delta systems where the persistence of drought has transformed some rivers into hyper saline regions, where the development of resources (such as shrimp) becomes impossible. Also the near shelf zone is important, where changing behaviour of the upwelling impacts on the normal high productivity of the marine coastal waters. Further

research into this area is deemed important to gain understanding of how future change will impact on societies' usage of these regions.

Current Research

While there are a number of research projects underway in Africa that deal with the above issues, it should be noted that these are generally focused on specific local problems. Nonetheless, a number of key areas are being investigated:

- Afforestation, e.g., mangrove afforestation by a project based at Abidjan University
- Coastal erosion, mangrove conservation, upwelling and shelf productivity, e.g., COMARAF project by UNESCO/UNDP based in Dakar, Senegal
- Basin hydrology, e.g., Mgeni River catchment model in South Africa, HAPEX -Sahel Project in Niamey, Niger
- Land use and land cover, e.g., activities of ICRISAT, AGRHYMET and the University of Lagos/International Development Research Centre (IDRC).

Research is currently limited in some areas by data, and future research prospects will require improvements in monitoring and data collection. Key areas for improved monitoring requirements are identified and include:

- Improved precipitation networks to close gaps in the precipitation database
- Sediment and erosion rates in river systems and estuaries
- Temporal and spatial characteristics of soil moisture
- Sea level change
- Upwelling dynamics for coastal shelf productivity purposes
- Transport of organic material by river systems into the sea
- Coastal fluxes of sediments and particulates
- Ocean-atmosphere exchanges in the coastal zone
- Survey and mapping of species composition and diversity.

While there are these data needs, much data already exists and some are readily available. In particular, land use and climatic data are available through ICRISAT, AGRHYMET, ACMAD, and OSS. Oceanographic data pertinent to coastal systems is obtainable from the Oceanographic Institute in Dakar, and the Department of Oceanography at the University of Cape Town. Data pertinent to water resources is found in the Global Resource Information Database (GRID) data base from UNEP, the Nigeria Water Research Institute, Kaduna, and the Computer Center for Water Research at the University of Natal. Of particular importance is the Argos hydrological monitoring, forecasting and early warning system of the Niger basin by the Hydroniger project based in Niamey.

Recommendations for Action

The one problem that stands out from all the rest is that of communication difficulties on the African continent. This is pertinent to all forms, be it travel, telephonic, or more advanced computer based networking. Second to this is the issue of funding, which severely constrains research activities. This applies to both local and international funding. Related to the shortage of local funding is the apparent difficulty to adequately communicate the research priorities to the respective government organisations. Collaboration, be it on the continent or with institutions in

the USA or Europe, is very weak, as it suffers inevitably as a consequence of different priorities and funding difficulties.

To address some of these issues the working group identified four general lines of action that could be taken, and a number of subsidiary specific tasks:

Develop lines of communication: Ideally this would be in the form of electronic networking, but beginning with encouraging regional conferences and workshops, and in particular, compiling and distributing data on climate change and land use impacts research

Training: This could be as specific as summer workshops on Land-Ocean Interaction in the Coastal Zone (LOICZ), or simply dissemination of ideas and techniques through seminars and publications distributed to interested parties

Establishing national IGBP committees: The establishment of such committees would aid in the communication process by providing foci within each national entity

Dissemination of results and data relevant to Africa: This would perhaps make use of the vehicle provided by the national IGBP committees, and whatever networking structure that evolves through the START initiative.

A large number of specific research tasks were identified as needing attention, a few of which included:

- Compilation and combination of regional data sets
- A specialised workshop in LOICZ
- Socio-economic impact studies involving the human dimension of global change including response strategy
- Interdisciplinary projects set up to focus on a large river system and a large marine ecosystem
- The development of regional climate change scenarios to aid impact assessment and policy development
- Development of regional modelling of land use and hydrological processes (including soil-vegetation and water-resource management systems).

Past Climatic Changes in Africa Related to Global Change

Chairmen: Eric O. Odada (Kenya) and Julia Lee-Thorp (South Africa)
Rapporteur: Pascal Affaton (Togo)

Introduction

Past Global Changes (PAGES) addresses the key issue of past natural and anthropogenic-induced variations in the earth's climate system, and the responses of geophysical and biological systems, through the interpretation of a variety of natural and written records. A primary objective is to establish an accurate global environmental history based on high-resolution proxy-data, in order to provide a historical perspective of natural climate variability which extends much further back in time than the earliest meteorological records. Data documenting past environmental changes provides a crucial test for the validation of physical Global Circulation Models (GCMs) developed to describe present circulation systems. Practical constraints have directed efforts into two temporal streams, the first concentrated on the last 2000 years, and the second directed at the last full glacial cycle. At the same time, it is vital that our understanding of the forcing and dynamic response mechanisms of climate systems be improved. Improved understanding of these relationships may prove to be of great importance for predicting regional-scale changes.

Importance of Past Global Changes to Africa

Research on palaeoenvironments and palaeoclimates is of great importance in the African continent for several reasons. It provides a historical perspective on past variability due to natural and human causes, and thus provides a baseline for efficient long-term management of natural resources; this is essential in a poor continent subject to frequent droughts and famine. Meteorological records and written observations are limited to the very recent past (often only the past few decades in Africa); thus data on longer term cyclical fluctuations is very limited, as is our understanding of how these impact on regional environments and human societies, or how these various components interact. On the other hand, palaeorecords of all kinds are richly represented in Africa, and are as yet largely unexploited. This includes by far the longest record for the activities of the human family anywhere in the world. The unparalleled archaeological record, together with unique geological features such as the Rift Valley, combine to make the African palaeorecord one of the richest potential archives of earth system history. The continent also occupies a unique global position: between the Atlantic and Indian Oceans in the "midst" of the global oceanic thermo-haline conveyor belt, and spanning two hemispheres. A very wide range of habitats are represented. Therefore, the African evidence could address important global problems such as hemispheric phase differences, sea-levels and ocean-atmospheric heat exchange.

Recognising the severe practical and financial limitations, and taking into account existing projects, the working group suggested that the African PAGES programme should be centred around one or two foci of common interest. One suggestion which emerged strongly at the meeting was the study of African palaeomonsoons, another was coastal history, and some overlap between the two was recognised. These would form a core around which the "Research Themes", "Cross-Project Activities" and "Research Tasks" as set out in PAGES (IGBP Report No. 19) could be focused. A comprehensive study of the processes responsible for changes in monsoon intensity

and extent, and their effects on the biosphere and human settlement patterns, for instance, would integrate several PAGES research themes. For this purpose, acquiring the following data will be especially important:

Lacustrine records: Lacustrine records providing information on past precipitation ratios through salinity, seasonality, level and other geochemical and biological changes.

Fluvial records: Historical records of changes in volume and floods, morphological evidence (terraces, changes of drainage patterns and source lands, remote sensing evidence).

Vegetation changes: Pollen, charcoal and other macro-remains, diatoms, charophytes etc.

Faunal changes: Invertebrates (insects, forams, ostracodes, aquatic and terrestrial molluscs), vertebrates (amphibians, fish, reptiles, rodents, mammals, Man) as a marker for surface or near-surface fresh water.

Aeolian records: Eolian formations and aerosol tracks as evidence for Palaeowind strength and directions.

Extreme events: For example, records from tephra.

Coastal records: Upwelling processes, changes in sea level and temperatures, changes in current dynamics. Changes in coastal ecosystems.

The working group recommended that the following research topics are of particular interest:

- Comparison of the past evolution of the African (West Africa) and Indian (East Africa) monsoons
- Interhemispheric comparisons
- Relationships between monsoon evolution and:
 - Short term (PAGES Stream I) and long-term (PAGES Stream II) astronomical forcings
 - Global surface temperature changes
 - Past oceanic circulation
 - Changes in ratios of key atmospheric variables
 - Ice records
- Relationships between climate dynamics and human settlement patterns, cultural evolution and health problems.

Existing and Ongoing Research Activities

Current research is directed at a variety of archives. Lacustrine and fluvial records provide information on past precipitation and evaporation through morphological evidence, water volume, salinity, seasonality and other geochemical and biological changes. Rare speleotherms and aquifers provide both important chronological and environmental controls, while tufa flows remain to be exploited for similar purposes. Past floral and faunal changes are indicated by studies of pollen, charcoal, diatoms, various micro- and macro-fauna, stable light isolates in fauna and soil profiles; in addition, archaeological studies of human settlement patterns can be used as indicators of factors such as water availability, arable land, etc. The role of fire in shaping past environments remains to be investigated in lake, peat and other deposits. Palaeowind strengths and directions may be determined through aeolian records in fossil dune formations as well as current and upwelling regimes. Coastal ecosystems are extremely sensitive to shifts in sea-level,

temperature, upwelling and current regimes. Evidence for past extreme events such as vulcanism and floods may be discerned from tephra and fluvial terraces, respectively.

As is noted in the PAGES policy document (IGBP Report No. 19), until recently much of the work investigating past environments has been carried out by individuals or laboratories, and has been directed at the interpretation of regional histories. While this is still often the case in Africa, the number of international and national collaborative projects has grown in recent years. Some of these programmes are listed here (the list is not complete). Projects are described below according to the type of archive investigated.

Lakes: International Decade for the East African Lakes (IDEAL), the International Geological Correlation Programme (IGCP) 252 (Deserts) Joint Collaborative Research Project, "Arid and Semiarid Areas" (Eastern Sahara and Somalia), International Union for Quaternary Research (INQUA)/PAGES Palaeomonsoons Project, South African Climate Change, Analysis, Interpretation and Modelling (SACCAIM) Pretoria Saltpan Project (South Africa).

Fluvial and aeolian records: International Geological Correlation Programme (IGCP) 252 Joint Collaborative Research Project, "Arid and Semiarid Areas," INQUA-PAGES Palaeomonsoons Project, Namib Desert Research Project, Southern African Association for Quaternary Research (SASQUA) (Southern Africa).

Biosphere: African Mountain Project, Frankfurt Joint Research Project "Sahel and Sudan", INQUA-PAGES Palaeomonsoons Project, Liege Group "Equatorial Geomorphological Research", SACCAIM.

Vulcanism and extreme events: Brazilian/Cameroon Research Project, INQUA-PAGES Palaeomonsoons Project (floods are dealt with under Fluvial records).

Coastal evolution: IGCP 274 (UNESCO/International Union of Geological Sciences (IUGS)/IGCP, COMARAF Project (UNESCO/UNDP), Climates of the Past (CLIP)/UNESCO-IUGS, UNEP SEAS Project, West Indian Ocean Palaeocirculation Project.

Many of these collaborative programmes overlap with other Global Change Programmes, such as Antarctic and Greenland Ice Project (GRIP), CLIP, IGCP, INQUA-PAGES Palaeomonsoons Project, Palaeoclimates of the Northern and Southern Hemispheres (PANASH), Palaeoclimates of the Southern Hemisphere (PASH) and the Ocean Drilling Programme (ODP). One of the advantages of the PAGES programme in Africa is that intra- and inter-hemispheric comparisons are facilitated. After compilation and synthesis of multi-proxy data along the lines indicated above, meaningful comparisons can be made between events in the northern and southern hemispheres. Another useful comparison is between the African and Indian monsoon systems (West-East Africa), and the development of these systems in relation to short- and long-term astronomical forcings, sea and land surface temperatures, past oceanic circulation patterns. This requires chronological control, which may be internal (e.g., lake varves, dating), or established in relations to other records such as ice cores or coral records. These records remain to be synthesised.

Availability of Data Bases

Palaeoenvironmental data is available in the usual way via publication in international journals. The problem here lies in the specialised nature of many journals, so that data-bases are not consolidated and synthesised, as well as lack of availability in generally poor African academic institutions. Large data bases are organised through the International Centre for Training and

Exchanges in Geosciences / Pan African Network for a Geological Information System (CIFEG/PANGIS), RECOCIX/UNESCO, and UNEP, but coverage is not continental and access may be difficult. A multi-proxy data base for Southern Africa is currently being compiled by SACCAIM.

Impediments to Progress

The last section highlights some of the main impediments to further progress in the field. Major problems are the lack of resources and trained scientists, and the "patchiness" of existing research and data. Much useful data exists, but it is not necessarily readily available, or adequately broadcast.

Recommendations for Action

We need to: (a) improve communication and; (b) remedy the lack of resources and training.

(a) There are a number of ways to improve communication links, some of them relatively simple. The first is to hold a series of workshops, ideally in association with other large international symposia, such as INQUA, CLIP, IDEAL or IGCP. A first general workshop could take place in late 1993; it should be widely advertised in national and international journals in several languages, in order to attract representative scientists. A recent attempt to resuscitate the African Commission on the Quaternary, initiated by INQUA, might be integrated into this effort. Better exchange of data and information could be achieved by improved cooperation between the organisations dealing with large data-bases (CIFEG (PANGIS), RECOCIX (UNESCO), UNEP, SACCAIM, etc.) perhaps to establish a common repository, and by making these data-bases more widely available. Greater collaboration and communication is required between all the organisations and individuals involved in PAGES research, so that efforts are not duplicated, and scarce resources are used to maximum advantage. The compilation and rapid publication of a directory of "palaeo" scientists active in Africa, including name, address and three relevant keywords, would also be another relatively simple way of improving direct links and communication.

(b) The lack of trained scientists and resources is more expensive to remedy. The study of earth system history and palaeoclimatology should be encouraged at all levels of tertiary education - undergraduate, postgraduate, postdoctoral and senior scientist. This will require funding for fellowships and grants, in order to foster active involvement of African students and researchers in specific activities at institutions where appropriate training is offered. Few universities world-wide, and no African ones currently offer specialised training in palaeoclimatology *per se*. However, there are good facilities available at some African universities, e.g., Nairobi, Cape Town, Witwatersrand, for training in related fields such as geology, geomorphology, archaeology and isotopic biogeochemistry. Where possible, training at African universities is less expensive and often more appropriate than universities in the USA or Europe, and exchange of students and researchers at all levels should be encouraged. This policy would encourage the formation of a few "centres of excellence" in Africa.

A related problem is the lack of laboratory facilities and other infra-structures necessary to train young people to use the "tools of the trade", e.g., coring equipment, microscopy, isotope spectrometry, computer science and remote sensing. Again, many of these facilities are available at a limited number of African universities, but since national educational budgets are very limited, increased international funding will be necessary to enable African students to study at these institutions, or those in the USA and Europe where necessary. In the longer term, it is desirable that more African universities build up the required infrastructures and skills, again this will require international funding efforts.

Global Change Impacts on Agriculture and Food Security

Chairmen: Z. M. Kasomekera (Malawi) and G. Faustin (Niger)
Rapporteur: R. Gomme (Italy)

Relevance for Africa

Most crops are produced by African farmers at the subsistence level and over 90% of the population depends on subsistence agriculture for both their food and cash supply; weather and rainfall variability remain the largest single factors behind the irregular food production.

Due to complex interactions between human population dynamics, the inappropriate use of technology, permanently degraded land and deteriorating nutrition levels, many of the low potential areas have become very vulnerable. Global change may as well bring opportunities in addition to hazards, in ways we cannot predict with any accuracy.

The main challenge facing African agriculture is to cope with the largely unpredictable future, capitalising on the beneficial effects, while avoiding likely adverse effects.

Current Research

- There is substantial classic agricultural research by national, regional and international agencies. However, most of it is not of direct use for global change impact studies. This is because some of the variables needed for predictive model parameterisation are not routinely collected, and those that are may not be collected at appropriate frequencies
- Of the substantial amounts of data which are likely to be available, further interpretation is necessary
- Guidelines are required so that future research activities will generate data suitable to address global change related issues. Existing data will be useful when complemented by additional variables
- Efforts are under way by key international agencies in the region for inventory crop monitoring, forecasting and simulations
- Intergovernmental organisation and Non-Governmental Organisations (NGOs) are collecting and distributing relevant data to end users
- Many long-term experiments which have been established in Africa, are useful in assessing key global change issues; these must be reevaluated and expanded
- Few formal global-change related simulations of agricultural production are under way using Intergovernmental Panel on Climate Change (IPCC) scenarios.

Monitoring Needs

In general, environmental monitoring in Africa suffers from a lack of multidisciplinary outlook, and there are some major gaps, such as information on wind erosion processes and general resource maps. To monitor global change impact on food security, there is a need to integrate and to systematically gather data at all scales.

Monitoring philosophies should frequently be rethought, as data collection networks have rarely been designed with a global perspective in mind.

Satellite data are invaluable, but this information must be complemented by such variables as: Climatic parameters; cropping systems and patterns; soil, plant and animal resources, including genetic resources; human population distribution and dynamics, including malnutrition; and indicators and urbanisation patterns.

The working group stressed the importance of and the potential for monitoring new and changing strategies developed by human populations to adapt to global environmental changes. Changes in rural energy and food consumption patterns were deemed to be very important.

However, the working group recognised that the current monitoring capability in Africa remains very low, and that national efforts will benefit from international integration and coordination.

Availability of Data Bases

A fair amount of data are available, but they are usually dispersed, patchy and often of unknown quality. Some of the global data sets are kept at regional or international centres and not readily available at the national level. Particularly for global studies, there is a need for inter- and intra-regional data integration.

Terminology must be harmonised; data media and data formats need standardisation. There is also a need to prepare an inventory of existing data bases (Particularly as regards agricultural reference material) and to assess their quality.

Impediments to Further Regional and International Cooperation

Impediments to regional and international cooperation can be classified under technical, political and institutional constraints.

On the technical side, limited data availability, incompatible media, poor communication and long delays were listed as major bottlenecks.

Political and institutional problems include the lack of trained manpower (and its inefficient use or mismanagement), poor infrastructure, lack of exchange of know-how and experience between national and regional institutions, competition between interests or institutions.

In general, the global nature of the ongoing changes, and the magnitude of the impact are frequently underestimated by decision makers.

Recommendations for Action

Education and training: Education of the policy makers and the general public is seen as one of the most efficient ways to attract general interest and, in some cases, to reduce the prevailing scepticism.

Training at all levels is the most efficient way to ensure the optimum use of climate and global change advice and information. Research results must be made available and understandable through advisory services to a largely rural population.

Research and applications: The working group saw the development of the global change predictive capacity as one of the key issues in the impact assessment on food security. It was felt that a more mechanistic research approach is needed. This would include a systems approach integrating agronomic, macro-economic and socio-economic modelling, in a realistic cultural setting.

Long-term trials from agronomic research stations should be encouraged. Monitoring efforts need particular emphasis, particularly their multi-disciplinary and global aspects.

Natural vegetation, which still constitutes the basis of the livelihood of most rural people in Africa, as a source of food (livestock) and energy, appears to deserve particular attention.

Further, monitoring should be integrated into a multipurpose tool based on different data types, sources and scales.

Information management and exchange: The working group recommends that data bases should be inventoried, quality-controlled and standardised. Data should be freely available. This constitutes the basis for an improved accessibility by users, and will result in more efficient decision making.

Policies and institutional aspects: National food security strategies must take into consideration global change, and its inherent cross-sectoral aspects. National decision makers should be aware of the regional and long-term implications of most decisions regarding the environment, particularly as regards the potential changes in food production and marketing, population shifts across boundaries, and food consumption patterns.

In order to be sustainable, policy decisions can no longer be taken at the national level only.

It is one of the roles of the scientific community to draw the attention of decision makers to unsustainable policies in the field of agriculture and energy. Scientists should assist decision makers to ensure that food security policies will not, in the long run, exacerbate current difficulties.

The importance of preparedness plans and contingency planning are well recognised as a means to reduced the impact of global change. However, they rank only second in importance to long-term cross sectoral measures to improve food security in a changing environment.

Human Dimensions of Global Environmental Change

Chairman: O. Davidson (Sierra Leone)
Rapporteur: R. H. Moss (IGBP Secretariat, Sweden)

Introduction

Many areas of Africa are expected to be extremely sensitive to global environmental changes such as global warming, changes in precipitation, drylands degradation, deforestation, loss of biodiversity, and changes in coastal zones brought about through sea-level increase or over-use of resources. Many African nations are now unable to cope with normal variations in rainfall and temperature associated with current climatic regimes, as evidenced by the human suffering that has accompanied recent droughts. Shifts in climate will have immediate and possibly severe consequences for the ecosystems of the region and thus for the human communities which rely on those resources.

The international community is beginning to address the causes and consequences of potential global environmental changes. At the United Nations Conference on Environment and Development (UNCED), a framework convention on climate change and a convention on biodiversity were signed, as was a declaration of principles on forests. While no formal action was taken on "desertification", a broad agreement was reached to work toward a conference and a convention in the near future. These international agreements will have major implications for both economic development and environmental conditions in Africa. They are being formulated on the basis of national interests, as well as these can be identified, through negotiation.

How much is really known about these potential global environmental changes and what they may mean for Africa? At present, the scientific community is unable to answer even the most basic questions. For example: Are the world's deserts really spreading, and if so, why? How are deforested areas of land used, and what are the implications of these different uses for the net emission of greenhouse gases, for biodiversity, for management of water resources, or for the transport of sediments to coastal receiving basins? Are population pressures and/or the economic interests of multinational corporations extending agriculture, grazing, fishing, or settlement to areas that are ill-suited to these purposes or to intensities that are not sustainable?

It is crucial for researchers from Africa to address the aspects of these issues that are important to Africa, so that the nations of the continent have the knowledge necessary to shape international agreements, to pursue economic development without jeopardising their resource base, and to respond effectively to changing environmental conditions. For these reasons, establishing a regional network to facilitate research on global environmental change by African scientists is a high priority.

START and Research on the Human Dimensions of Global Environmental Change in Africa

Those scientists with special interest in the human dimensions of global environmental change met as a separate group at Niamey to discuss the special opportunities and tasks confronting the African social science community in becoming more fully involved in research in START. The group agreed that:

- Human dimension issues are important, because climate change is a result of human activities
- Human dimensions should be seen within an integrated framework of social, cultural, institutional, economic, legal and political issues
- Societal changes and human capacities to adapt to such changes are crucial
- Certain human dimension issues are unique to the African region
- Certain existing known social science systems must be reformed to cope with global changes. *and the reverse*

The group discussed a number of topics in the social sciences that cut across the emerging research priorities identified by the other working groups at the workshop. By way of illustration, two of these issues are elaborated below:

Population growth and environmental change: "Overpopulation" the rate of population growth, and the uneven distribution of the population across the landscape are major concerns. Yet African population density, when distributed across the land mass of the entire continent, is low. As in the rest of the world, much of the population of the continent is concentrating along the coastal margins. According to projections, in approximately 25 years, the 30 largest cities in Africa may all be within a few miles of a coast. Much of this increase is due to migration from the interior. Research is needed to examine the reasons, processes, and consequences of population growth along the African coastal margins, and its implications for the terrestrial and aquatic resources of the coastal zones. *Research*

The process of innovation and technological diffusion: Adoption of new technology will be crucial for Africa, particularly under the impacts of changing climatic conditions. For example, the best prospect for relieving Africa's chronic energy shortage is biomass burning using radically improved and more efficient technologies. New crop strains and agricultural management practices may be necessary to adapt to changes in precipitation or temperature extremes. Several observers have noted the complex relationships between living on the margin, as so many in Africa do, and the willingness to innovate. If there is no cushion from previous years' production, even a new technology or crop with an 80 percent chance of success, and hence a 20 percent chance of failure, presents an unacceptable risk to survival. The resulting conservatism of marginality adds to the drag on technology transfer and innovation created by chronic shortages of both capital and technologically trained manpower. Research in the entire range of social sciences is needed to understand the impediments to adoption of new technologies, and how to overcome these barriers. *Research*

The researchers who participated in the working group on the human dimensions of global environmental change did not set out to provide an exhaustive set of ideas regarding possibilities for research in the social sciences related to the human dimensions of global environmental change. Rather, they intended to explore for themselves the possibilities for conducting basic research of theoretical and methodological significance to the social sciences, within the research priorities being identified within START. Their conclusion was not just that there was ample opportunity for the social sciences to conduct basic research within the START programme, but that this research was essential to meeting the broader research goals that were articulated by the other working groups at the Niamey workshop.

The Niamey human dimensions working group discussed the next steps that should be taken to increase the participation of the social sciences within START activities in Africa. They decided not to form a special human dimensions research network within START, but rather to remain in contact informally while continuing to work within their areas of interest in the overall African regional priorities. To this end, it was recommended that articles on human dimensions be included in the IGBP Newsletter, as well as the future START newsletter. In addition, it was

agreed that an information document should be produced with regard to human dimension issues of global change.

Plans were made to enlarge the group of researchers interested in the human dimensions of global environmental change by ensuring that some of the participants in the Niamey workshop were able to attend two meetings on the human dimensions of global environmental change in Africa planned for early 1993. The first of these meetings is to be held in Accra, Ghana, from 22-26 March, under United Nations University sponsorship. The second is being organised by the Organisation for Social Science Research in Eastern Africa and will take place in Maseru, Lesotho, from 26-30 April 1993. Other ways to increase the number of human dimensions researchers were discussed: it was agreed that existing members should submit names of other people interested in this field, and that they should be involved in local START regional committees or similar committees. In addition, it was thought that human dimensions researchers should form small national groups and develop a research project for small grants. Tentative plans were also discussed for an additional workshop on the human dimensions of global environmental change within Africa.

Northern Africa and the Mediterranean Regions

Chairmen: M.A. Ayyad (Egypt) and A.T. Ba (Senegal)
Rapporteurs: M. Brini (Tunisia) and J.H. Kinuthia (Kenya)

Introduction

The working group for Northern Africa and the Mediterranean regions discussed the need to establish Regional Research Networks (RRNs) and agreed to establish the Mediterranean (MED) and Northern African (NAF) RRNs in close collaboration with MEDIAS.

Establishment of a NAF Committee

The working group agreed to establish a Northern Africa Regional Committee for START (NAFCOM), with the following terms-of-reference:

- Provide input to the development of the GEF/UNDP project document and oversee implementation of the project
- Provide the initial NAF focal point for the START Global Network of Networks
- Assist the countries in setting up IGBP National Committees and also to help strengthen the existing National Committees.

The working group agreed to recommend the following initial members of NAFCOM: M. Boulama, Niger; O. Davidson, Sierra Leone; A.A. Konan, Ivory Coast; E. Laing, Ghana; E. Odada, Kenya; A.T. Salau, Nigeria; K.F. Seddoh, Togo; D. Touré, Senegal; G. Traoré, Mali.

The Working Group also nominated M. Seck (Senegal) to be the liaison person with IPCC.

Some of the representatives of African countries bordering the Mediterranean Sea expressed concern that they were not represented on NAFCOM but rather on MED. The working group agreed to consider the inclusion of one or two members of the region in the committee. (The meeting later appointed M.A. Ayyad as liaison person with MED).

Programme for RRN Developments

The working group reviewed the process followed by the Southeast Asia Regional Committee for START (SARCS) in establishing different structures of START and decided to emulate this committee and organise workshops for:

- Defining scientific priorities
- Defining initial project framework
- Setting priorities for funding needs
- Identifying key institutions in each nation for each project (RRS).

The working group also reviewed the planned process to be followed by SARCS for:

- Agreeing on guidelines for acceptance of RRC
- Identifying individuals responsible for project in each participating institution (RRS).

Secretariat

The working group accepted the offer of the Committee on Science and Technology in Developing Countries (COSTED) for its West African Regional Secretariat to host the *ad hoc* START Secretariat for NAF.

The working group recommended that a scientist be seconded to the International START Secretariat to provide a focal point for discussion with UNDP, the World Bank, etc., and to ensure that MED-NAF become fully integrated components of the START global network of networks. The working group further agreed that NAFCOM should identify a suitable candidate to fill this position.

Role of National Committees

The working group requested that each national committee further discuss their interest to participate in the priority areas proposed by the scientific working groups, and to identify institutions that may become RRSs for specific components of the scientific agenda. The working group also charged NAFCOM with the task of identifying regional institutions that can become partners in the RRN. Representatives of the countries which have not yet established IGBP National Committees are strongly encouraged to work towards the formation of such committees, taking into account the existing institutions working on climate and global change.

MED-NAF Collaboration

The working group requested that NAFCOM and MED hold joint meetings in the framework of MEDIAS in order to set priorities regarding workshops and elaborate the scientific agendas for collaborative activities.

Other

The working group recommended that all activities undertaken within the framework of START-Africa take into account the existing institutions such as ACMAD, CILSS, ICRISAT, IGADD, etc.

Southern, Central and Eastern African Region

Chairmen: V.F. Ferrao (Mozambique) and V.S.B. Mtetwa (Swaziland)

Introduction

The monitoring of global change and subsequent experimentation to model likely impact on the environment necessitated establishment of centres that can be charged with these responsibilities. IGBP Report 15 lays down the modalities on how effective global change monitoring and modelling should be effected.

Realising the global nature of task, IGBP Report 15 proposes the need for national and regional participation in all sectors of the globe in order to develop a representative data base. It is within this regional aspect that a Southern, Central and Eastern African Region Network is proposed.

This network will be responsible for establishing functional national data collecting points, in accordance with perceived global parameters to be monitored, and will also synthesise the collected data in order to establish global trends. It is also expected that the regional network will establish research priorities that will be conducted in appropriate institutions of excellence under the guidance of a coordinating centre.

In order to facilitate information exchange and regional collaboration, a centre or centres will be established whose mandate will be to coordinate rather than to carry out research on global issues. It is proposed, therefore, that the priority will be the review of existing global-related institutions in the region in order to establish the regional potential in global change research.

With the global change capability established, then networking will be initiated.

Southern, Central and Eastern African Region

For purposes of this network, the Southern, Central and Eastern African Region will include countries south of the Equator, although it is for the science community in each region to decide on the most appropriate framework for regional collaboration. It is anticipated that further regrouping into sub-regional sectors may be desirable based on agroecological zones.

Implementation

In order to launch this programme, it was observed that the region was underrepresented, and synthesis of global issues would require greater participation of scientists; hence, a workshop for the region was proposed. To facilitate the regional workshop, the following were elected to form the organising committee: Z.M. Kasomekera (Chairperson), Malawi; G.R. Chimonyo, Zimbabwe; P.O. Dube, Botswana; V. Ferrao, Mozambique; B. Hewitson, South Africa; R. Mwangi, Kenya.

It was agreed that the organising committee should meet from 15 to 16 February, 1993 in Malawi to prepare for the regional workshop in November 1993.

The Southern and Eastern African Network on Global Change

The structure of the proposed network should be based on the START guidelines, but will not adhere to the rigid RRC set up; rather, the emphasis will be on coordinating global change issues from viable national systems. With this respect, the following points were raised:

- (i) The need for a RRC not regarded a first priority; rather, there should be an administrative/coordinating entity that should harmonise and synthesise national global issues into regional perspective.
- (ii) Currently there is need for an inventory of national institutions in order to assess and categorise the potential of these institutions to fully participate in the proposed network.
- (iii) It is from the inventory in (ii) that shortfalls of some nations/centres to have the critical mass of expertise to participate in START will be identified, and whenever possible remedied for full participation in START.
- (iv) The network has to initially start with the creation of a culture for sharing information and development of mechanisms for information transfer in the region should be implemented.
- (v) Existing networks should be identified, strengthened and encouraged to focus on global change ideals so that in the long run, the region will have strong units that will result in a strong network.
- (vi) Information exchange capability enhancement will include the establishment of electronic communication systems for the region.
- (vii) The national systems will require strong standardised data collection and analysis systems in areas of expertise that they are involved in. It is expected that within the region, there will be demarcation of areas of expertise specific to sectional or national boundaries.
- (viii) As a first step in networking the region, the participants from the region will provide the organising committee in section 3 with their professional details and names of other scientists that can participate in global change issues.

Common Issues

It was observed that the region has a number of common problems that impinge on environment, hence either influencing or reacting to global change. These issues ranged from human (deforestation, pollution, populations, etc.,) to natural (drought, floods, coastal changes, etc.)

General Recommendations

The following general recommendations were presented to and discussed by the meeting during the final session:

- (i) The meeting welcomed the START initiative and agreed to support the development of RRNs the Mediterranean (MED) region, the Northern Africa (NAF) region, and the region covering Southern, Central and Eastern Africa (SAF). The meeting stressed that there was a need for close collaboration between the regions, that the science community of each country decides on appropriate modalities for regional collaboration including the grouping into regions, and that any development of regional collaboration should have appropriate links to the development of regional networks in other continents in order for a global network of networks to be developed.
- (ii) It was agreed to establish planning committees for NAF and SAF and that there should be an exchange of scientists between the two committees to ensure complementarity between the planned activities. In addition, it was recommended that a similar planning committee be established for MED and a member from the MED region was added to the NAF committee. Note was taken of the interest of the Commission of the European Communities in developing a partnership between the plans to develop a European Network for Research on Global Change (ENRICH) and global change research efforts in Africa. In addition, the meeting noted the MEDIAS initiative, which would be an important component in developing closer links between MED and NAF.
- (iii) The offer to host an initial NAF Secretariat at the Ghana Academy of Arts and Sciences was gratefully noted.
- (iv) The attempt to secure funding for an African scientist to the International START Secretariat was supported, as this would insure that an African perspective was included in the further central planning of START.
- (v) The establishment of National IGBP Committees will be important in promoting the development of national plans for global change research. National committees will be an efficient focus between the national programmes and the regional efforts as well as the international programmes. In establishing such committees, efforts should be made to involve all relevant scientific disciplines and in many instances it may also be advisable to include social scientists on the committees, so that the committees can address all aspects of both the regional collaboration and the three international programmes (IGBP, WCRP, HDP).
- (vi) The meeting recognised that, although the current meeting has been a success in outlining the importance of global change research and assessments in an African context and for fostering interdisciplinary research, it is necessary to further develop the ideas brought forward in the working group reports. It was thus recommended that further planning meetings be organised within the framework of the emerging START RRNs for Africa. These meetings should focus on the further development of the scientific agendas for collaborative activities.
- (vii) The meeting stressed the need to further promote education and training activities related to global change research. The development of fellowships for graduate students was stressed. Also, short-term and small research grant schemes, such as those promoted by the International Foundation for Science (IFS) in other areas of scientific research, would be appropriate. Within the

framework of the international programmes, developments of technical training courses on important methodologies should also be encouraged. In addition, due to the multi-disciplinary nature of global change research, special attention needs to be given to training and educational initiatives that fosters a common understanding among the relevant disciplines.

(viii) There is a need for infrastructural support, and in many instances the research institutions cannot fully participate in the relevant research activities due to a lack of equipment. There is also a need to develop specialised resources for advanced analysis, data management, and access to data bases necessary for global change research activities.

(ix) Lack of efficient communication is often a major constraint for inter- and intra-regional collaboration. It was recommended that efforts should be made to ensure that RRSs in the developing START RRNs have access to electronic mail facilities (e.g., through Internet) and that, as the networking activities increase, attention be given to the development also of networks for file transfer and exchange of large data sets. It is also necessary that attention be given to the development of an appropriate data management system for the developing RRNs. It is necessary that the researchers have access to the appropriate regional and global data sets and appropriate technologies (e.g., Geographic Information Systems (GIS)) for handling and working with geographically referenced data bases. Attention should be given to the role that, for example, the IGBP Data and Information System (IGBP-DIS), HDP-DIS and UNEP-GRID and PANGIS may play in such developments.

Closing Session

Vote of Thanks

Prof. Thomas Rosswall
Interim Director, The International START Secretariat

Your Excellency, Dr. Seck, Dr. Sivakumar, Dear Friends,

It is both a singular honour and rare privilege for me to present the vote of thanks on behalf of all the sponsors and co-sponsors of this workshop. The fact that this workshop was opened by His Excellency the Minister of Commerce, Transport and Tourism of the Government of Niger and was witnessed by His Excellency the Minister of Communications and by representatives of major research organisations and donor agencies and the fact that over 120 scientists from five continents participated in the five day meeting have made this workshop a memorable event. It was made even more significant by the participation of the members of the Standing Committee of START.

I now have a very pleasant task to perform. Firstly, on behalf of the sponsors and co-sponsors, I wish to extend our sincere thanks to the Government of Niger, particularly the Ministry of Commerce, Transport and Tourism for their support in organising this workshop. In the planning and organisation of this workshop we have received excellent support and cooperation from all the members of the Niger National Committee of IGBP. To all the session chairmen, and to the discussion leaders of different working groups I would like to convey my very sincere thanks for their help in ensuring that all the sessions are finished on time. We owe you, the distinguished participants and speakers at this workshop, our very grateful thanks. You have shown commitment, and have travelled long distances to participate in this meeting.

The workshop could, of course, not have been organised without generous financial support. In particular I wish to express my gratitude to the co-sponsor, the Joint Research Center of the Commission of the European Communities and its Director General, Dr. J.-P. Contzen. The link to the United Nations is also particularly important and the United Nations Development Program and the United Nations Environment Program have generously contributed travel support for African participants. MEDIAS, the French Ministry of Cooperation and Development, the Third World Academy of Sciences, CIESIN, and Air Afrique have also contributed towards the success of the meeting.

Many staff from the ICRISAT Sahelian Center, National Meteorological Services and the Ministry of Foreign Affairs worked very hard over long hours on many days before and during this workshop. I would like to present them to you now and would request you to hold your applause until all of them are presented. On my right, the personnel from the secretariat, personnel who helped in airport reception, air ticket confirmation, and the personnel from the protocol. On my left, we have the personnel who helped with coffee service, transport, and with arrangements in the auditorium. Let us give them all a big hand. The two young ladies in the

booths above you, Mme. Jacqueline L'Amour and Mlle Hadizata Ibrahim have helped us understand each other. Let us show them our appreciation.

And finally, it is my privilege to specially recognise the help and support of my good friends and co-organisers of this workshop, Mr. Mohamed Boulama, the Director of National Meteorological Services and Dr. M.V.K. Sivakumar, Program Leader at the ICRISAT Sahelian Center. Unfortunately, Mr. Boulama could not be here today with us as he had to travel to Mauritius to attend the African Met Directors Meeting. Since I first broached the idea for this workshop with Dr. Sivakumar in Cameroon in 1989, Mr. Boulama and Dr. Sivakumar have been of tremendous support and help. They left no corner unturned to ensure the full success of this workshop. Let us give them a big hand. Let me assure you that this is only the first important step in a continuing process that I am proud to be involved with. Dear friends, I wish you all a very pleasant and safe journey back home.

Vote of Thanks

Dr. Mansour Seck Ministry of Equipment, Transportation and the Sea Republic of Senegal

As our work draws to an end, the participants at the Workshop on Africa and Global Change, held from 23 to 27 November 1992 in the Conference Hall of the Ministry of Foreign Affairs and Cooperation in Niamey, Niger, express their heartfelt thanks deep gratitude to:

- His Excellency, General Ali Chaibou,
President of the Republic
- His Excellency, Monsieur André Salifou,
Chairman of the Supreme Council of the Republic
- His Excellency, Monsieur Amadou Cheiffou,
Prime Minister
- the Government and the people of Niger.

for the warm and brotherly welcome and African hospitality that they have received.

They extend particular thanks to the organisers, the START Secretariat, Direction of the National Meteorology Agency of Niger, the International Centre for Research in Semi-Arid Tropics (ICRISAT) and the National IGBP Committee of Niger for the kind attention they received, the quality of support, and the efficient way in which the Workshop was carried out.

These excellent work conditions allowed us to reach, in only a few days, appreciable results, and to look to the future with an assurance of success.

Closing Address

H.E. Mr. Souley Abdoulaye Minister of Commerce, Transportation and Tourism

Your Excellencies the Ministers, Your Excellencies the Ambassadors, and Representatives of International Institutions and Organisations, The Executive Secretary of IGBP, The President of the International Committee of Organisations, Honourable Delegates, Ladies and Gentlemen:

At the conclusion of this important workshop on Africa and Global Change, allow me first of all to express my satisfaction for the frank and cordial atmosphere in which your debates took place.

You have in the course of these five days accomplished a work of great importance in relation to global change in Africa and at the same time, have identified themes of interest for our continent.

I bring up from among the recommendations from your workshop, the one relating to forests and to desertification. The results of your discussions on this theme are of great interest for African leaders. In effect, we are conscious of the high rate of the disappearance of certain forests and of the necessity to put in place conservation policies. Concerning the Sahelian zone, it is evident that everything related to desertification and to strategies to combat or control this phenomenon rate a capital importance.

The impact of global change on agriculture is certainly the subject that concerns us the most, considering that more than 90 percent of Africa's population relies on it for subsistence.

Our efforts aim to develop policies that will assure a more productive, stable agriculture, in order to attain self-sufficiency in food production. If the climatic changes particularly affect this area, we must then know the measures to take in the view of adaptation. From all evidence our immediate worries are concerned with the character of the rainy seasons to come and, in a general sense, with the future behaviour of rain, particularly in areas defined as vulnerable to global change.

Your meeting has permitted us to note the importance of the human dimension of global change, according the socio-economic and political aspects that you have outlined.

It is comforting to note that important organisations such as UNEP, ACMAD, the Research Center of the European Community, the OSS, MEDIAS and CIESIN have initiatives to counter global change in Africa. It is important to us that these initiatives develop in direct relation with national, regional, or international research institutions in our countries.

We have noted with satisfaction the initiative of START to develop research networks associating operational services in relation to global change concerns. It appears necessary to us first to evaluate what is being done, future needs, and to assure the reliability of the data for regional or international collaboration. Happily, the working groups that you have put into place have tackled these aspects. I congratulate them.

Honourable Delegates, Ladies and Gentlemen, the very pertinent recommendations which you have achieved, as we had hoped at the opening of this workshop, bear witness to the perfect success of your forum.

We take the greatest interest in these recommendations, in particular those relative to initiatives to take in Africa. I can assure you that they will find as large distribution as possible and that they will be the object of attentive examination at the national, regional and international level due to their success.

I can only congratulate you for these positive results which you obtained, because they constitute a priceless acquisition for our country.

Niger, for her part, will not spare any effort to support and encourage all programmes in this area.

Wishing you a pleasant return to your respective homes, I declare closed the Regional Workshop on Africa and Global Change.

Thank you.

Womage, F. Na Giada
22 Grande letter
Gambia, Niger
x Teoria, Maslone

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Acronyms and Abbreviations

ACMAD	African Centre of Meteorological Applications for Development (WMO)
ACP	Africa, the Caribbean and the Pacific
AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
AMCEN	African Ministerial Conference on the Environment
ASECNA	Agency for the Safety of Aerial Navigation in Africa
BACFE	
BAPMON	Background Air Pollution Monitoring Network
CEC	Commission of the European Communities
CEES	US Committee on Earth and Environmental Sciences
CFC	Chlorofluorocarbon
CIESIN	Consortium for International Earth Science Information Network
CIFEG	International Centre for Training and Exchanges in Geosciences
CILSS	Comité Inter-Etats pour la Lutte contre la Sécheresse au Sahel
CLIP	Climates of the Past (IUGS/UNESCO)
CODESRIA	Council for the Development of Economic and Social Research in Africa
COMARAF	Coastal Marine Research and Training in Africa (UNESCO/COMAR)
COSTED	Committee on Science and Technology in Developing Countries
CSIR	Council for Scientific and Industrial Research (South Africa)
DECAFE	Dynamique et Chimie de l'Atmosphère en Forêt Equatoriale
DIS	Data and Information System (IGBP, HDP)
EAMAC	Ecole Africaine de la Météorologie et de l'Aviation Civile
ENRICH	European Network for Research in Global Change (CEC)
ENSA	Ecole National Supérieur d'Agronomie
EPSAT	(GEWEX)
ESA	Equatorial South America
FAO	Food and Agriculture Organization (UN)
GCM	Global Circulation Models
GEF	Global Environmental Facility (World Bank/UNDP/UNEP)
GEWEX	Global Energy and Water Cycle Experiment (WCRP)
GIS	Geographic Information System
GRID	Global Resource Information Database (UNEP)
GRIP	Greenland Ice Project
HAPEX	Hydrologic-Atmospheric Pilot Experiment
HDP	Human Dimensions of Global Environmental Change Programme (ISSC)
ICRISAT	International Crops Research Institute Semi-Arid Tropics
ICSU	International Council of Scientific Unions
IDEAL	International Decade for the East African Lakes
IDEP	African Institute for Economic Development and Planning
IDRC	International Development Research Centre
IFS	International Foundation for Science
IGAC	International Global Atmospheric Chemistry Project
IGADD	Inter-Governmental Authority on Drought and Development
IGBP	International Geosphere-Biosphere Programme
IGCP	International Geological Correlation Programme (UNESCO/IUGS)
INQUA	International Union for Quaternary Research (ICSU)
IOC	International Oceanographic Commission (Unesco)

IPCC	Inter-Governmental Panel on Climatic Change
ISSC	International Social Science Council
IUGS	International Union of Geological Sciences
JRC	Joint Research Centre (CEC)
LOICZ	Land-Ocean Interactions in the Coastal Zone Core Project (IGBP)
MED	Mediterranean Region (START)
MEDIAS	Regional Research Network for the Mediterranean Basin and Subtropical Africa
MTV	Monitoring of Tropical Vegetation
NAF	Northern African Region (START)
NAFCOM	Northern Africa Regional Committee for START (START)
NGO	Non-Governmental Organization
ODP	Ocean Drilling Programme
OSS	Observatory of the Sahara and the Sahel
PAGES	Past Global Changes Core Project (IGBP)
PANASH	Palaeoclimates of the Northern and Southern Hemispheres (PAGES)
PANGIS	Pan African Network for a Geological Information System
PASH	Paleoclimates of the Southern Hemisphere
RAMESES	
RECOCIX	(UNESCO)
RIPS	Regional Institute for Population Studies (University of Ghana)
RRC	Regional Research Centre (START)
RRN	Regional Research Network (START)
RRS	Regional Research Site (START)
SACCAIM	South African Climate Change, Analysis, Interpretation and Modelling
SAF	Southern, Central and Eastern Africa (START)
SALT	Savannes à Long Terme
SARCS	Southeast Asia Regional Committee for START
SASQUA	Southern African Association for Quaternary Research
SEAS	
START	Global Change System for Analysis, Research and Training
TAM	Tropical Asian Monsoon region
TREES	Tropical Ecosystem Environment observations by Satellite
TWAS	Third World Academy of Sciences
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URBT	Unité de Recherche sur les Ressources Biologiques Terrestres
USAID	United States Agency for International Development
WCRP	World Climate Research Programme (WCP)
WMO	World Meteorological Organisation (UN)

IGBP Reports

*Reports marked with an * are no longer available.*

- No. 12 The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP). The Initial Core Projects. (1990)
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