AI WORKSHOP ON GLOBAL CHANGE RESEARCH IN THE AMERICAS

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COOPERATION OPPORTUNITIES IN TROPICAL ECOSYSTEMS AND BIOGEOCHEMICAL CYCLES

A contribution by

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To establish general guidelines and recommendations for the scientific agenda of the priority theme Tropical Ecosystems and Biogeochemical Cycles of IAI, a workshop was held in São José dos Campos, São Paulo, Brazil, on April 4-7, 1994, following the March 1992, Silver Spring, MD, Meeting of Scientific Experts which provided the basis for discussions.

The objectives of the workshop covered aspects of the functions of the tropical ecosystems and biogeochemistry of wetlands, terrestrial, and aquatic ecosystems, land use change and its interactions with the carbon-water-energy cycles, exchange of trace gases between ecosystems and the atmosphere, greenhouse gases emissions, global change implications of land use conversion and atmospheric chemistry, ocean-atmosphere-land interactions, paleo climates of the tropics and the human dimensions implications of changes. Social-economics aspects and the role of field research and community involvement in global change research relevant to the Americas were also covered.

Major findings from the working groups:

1) Land Use Change

The over-arching/organizing theme: **What are the effects of land use and cover change (LUCC) on biogeochemistry (BGC), water and energy cycles, and in turn their effect on LUCC?**

Special research efforts should be placed to define the driving forces, the models and the scales of this theme. To develop this, the following scientific/action issues are needed: a) current land use change distribution of the tropical region; b) pattern distribution and rate of land cover conversion; c) knowledge on the effects of LUCC on sustainable development; d) criteria for measurement of sustainability; e) models for LUCC processes, and f) dissemination of information to decision makers. This working group discussed appropriate scales in spatial and temporal domains, the linkage of IAI action with on-going international programs by examining the data provision efforts, analysis and modeling efforts. The UNEP GRID node in South America was identified as one possible outreach.

The group also outlined a framework designed to integrate regional scale analysis with local case studies through modeling, comparative synthesis and links with BGC, water and energy cycles, based on input data from remote sensing, physical/natural resource surveys, census statistics and field work/surveys.

Important issues such as the need to separate the concept of land cover from land use change were also identified by this working group. Land cover change is a function of land use change which in turn is a function of land cover characteristics, incorporating all the human dimensions aspects; therefore, LUCC is global change and even though it is a major cross cutting theme for BGC, water and energy cycles studies, it was concluded that it has its own right in the IAI agenda.

2) Ecosystems Processes and Biogeochemistry

This group discussed a broad range of issues including: a) land-atmosphere interactions (carbon and nutrient cycles); b) land-water interactions (rivers and lakes, wetland processes, coastal and estuarine processes, and ground water); c) water-atmosphere interactions; d) agricultural landscapes (biogeochemical successes, consequences of intensification); e) functional significance of biodiversity (conservation of function, functions of species); f) biogeochemistry of restoration (methodology, evaluation, and consequences); and g) pollution and contamination.

Three sets of priorities were identified:

I. Baseline Studies - Consequences of Land Use Change. Important issues are: a) links of C and H_2O; b) links of N, P. S, (bio-elements); c) physiologically mediated processes (fast processes); d) decomposition, soil, and ground water (slow processes); e) trace gas release (CH_4, N_2O, reactive gases); f) links to atmospheric properties (e.g. radiative balance); and g) sensitivities to climate (baseline models and experiments). For these studies, systematic data sets are needed and IAI should make inventory of existing data, facilitate access, and identify further needs of data gathering.

II. Biogeochemical Aspects of Restoration. This should include: methodology development, regional applicability, monitoring of consequences, and evaluation of outcomes. As a new scientific area for the tropical ecosystems, there is a need for an additional workshop to further evaluate this priority item. Another priority is the **Biogeochemical Aspects of Urbanization** which should include: economic and social aspects, impacts on systems, and needs for resources. Again, there is a need for another workshop to develop this item further.

III. Future Issues - As IAI is developing the initial priorities on BGC of the tropics, the following issues should be considered: industrialization, history of land use, biodiversity, human health impacts, water rights and management (quantity and quality), and biotechnology.

This group proposed a strategy to cover the above priorities: transect-based studies across spectrum of land use types, including comparisons of "pristine" and transformed ecosystems in terms of functioning through: 1) long-term research studies in selected sites with intensive process studies in small network and extensive studies in larger network; 2) process model development; and 3) case studies, securing regional applicability.

3) Water and Energy Cycles

This working group identified the following scientific-relevant questions: 1) What are the relative roles of regional evapo-transpiration and horizontal transport of

water vapor in determining precipitation over Amazonia? How are the energy and water balances affected by changes in the vegetation cover of the basin? 2) What is the impact of biomass burning on: a) the redistribution of nutrients; b) modification of regional and global surface temperatures; and c) regional and global geochemical changes. 3) How do the distributions of soil moisture, climate variability, and other climatic factors control the distribution of biomes in the tropical Americas? 4) What micrometeorological measurements/processes must be made (understood) to adequately specify the soil-vegetation/atmosphere exchange processes? 5) What is required to predict the surface and subsurface hydrologic flows of the Amazon basin?

The group also identified the following policy-relevant questions: 1) Variations in the moisture transport out of the Amazon basin can have major impacts on hydro-electric power generation outside of the basin (e.g. Itaipu) and present energy policy does not take into account changes in the hydrologic cycle; 2) Quantification of the water and energy cycles in the basin may eventually help to develop sustainable agriculture in the humid tropics; 3) Variations in moisture transport out of the Amazon basin will have major impacts on agricultural practices in the extra tropics (e.g. "cerrado"); 4) Biomass burning in Amazonia has both regional and global policy implications (e.g., human health, agriculture, transportation, global climate) and 5) Transport of industrial contamination (e.g., mining activities) can impact human and agricultural development.

Overall conclusions from all three working groups:

In terms of data collection and management needs, IAI should develop regional and disciplinary data bases using a centralized management for archival, continuity, integration, and quality control. Priority should be given to initiate a compilation of information on national and regional activities, with standardization of information across countries and followed by accessibility to data sets through installation of appropriate hardware and software, a major lacuna in the tropical region as a whole.

The assessment of the community readiness indicated that there is a basic personnel infrastructure that could be employed to address several issues; however, great regional discrepancies were identified. There is a need for IAI to convene a series of specific workshops (e.g. biomass measurements, biogeochemical aspects of ecosystem restoration or of urbanization) to better address the community readiness issue. Training and education for researchers, technicians and decision makers were found to be important. Also, there is a need to guarantee access to Internet not only to improve communication but also to serve as an education tool. Short-term fellowships (1-4 months) for training courses (e.g. INPE) and Doctoral/Post-doctoral fellowships (1-4 years) involving multinational, multicultural research within IAI priorities were identified to be important. Outreach for society should include education seminars, elucidative material and training for solutions - link of global change to local change.

Another major finding of this workshop was that IAI should benefit from the already existing specific science planning such as the existing proposal of the *Large-Scale Biosphere-Atmosphere Experiment in the Amazon Basin - LBA,* planned for the 1996-98 time frame. The science plan of this experiment covers the scientific priorities identified by the three working groups of this workshop and IAI could complement this experiment not only by coordinating the regional activities but also by stressing the human dimensions aspects of it.

ON-GOING PROJECTS AND ACTIVITIES

IAI could significantly enhance several on-going initiatives by providing the regional coordination. Here, are several examples:

Panamazonia Project

Panamazonia Project is a joint effort of South America countries to monitor the Amazonia Forest, with a standardized methodology and regional participation. The project involves different agencies in Brazil, Bolivia, Colombia, Guyana, Peru, Ecuador, French Guyana, Surinam and Venezuela. The project is mapping the cover types in several classes such as forest, no-forest and clear cuttings, at 250,000 scale for two periods (1984-1987 and 1988-1991).

First results of deforestation extent and rates of Bolivia, Brazil, Colombia, Peru, and Venezuela were presented in the International Space Year Conference on Global Forest Monitoring held in São José dos Campos in late May 92. More recent Country Reports by IGAC-Colombia Team and by the Venezuela Team have been reported. Partial results achieved up to May 1992 were reported by Martini (1992) in SELPER Newsletter[1]. The Panamazonia project has objectives that meets the identified priorities of the theme "Tropical Ecosystem and Biogeochemical Cycles". This seems to be a great opportunity for IAI to take the lead in the coordination and broadening up this initiative.

The large-Scale Biosphere-Atmosphere Amazon Experiment (LBA)

This is perhaps the most ambitious and comprehensive experiments ever planned over the tropical ecosystem. In addition to the large-scale atmospheric studies it will include site specific process studies of the ecosystem and biogeochemistry of the Amazon region that meets the priorities identified at the São José dos Campos workshop. IAI could take the lead in the coordination of this experiment to guarantee regional participation. Due to its relevance, this experiment is described in some detail elsewhere in the white papers for this workshop.

The Earth Observing System (EOS) for Amazônia.

This is a large-scale, long-term program dedicated to observing and determining the biophysical bases for human induced global change. Within the overall structure of EOS, there exist an on-going interdisciplinary project in the Amazon region in collaboration between the Instituto Nacional de Pesquisas Espaciais (INPE) and the University of Washington and other organizations (USP, INPA, UCSB, NASA/GSFC) with the overall goal of determining, how extensive land use change in the Amazon would modify the routing of water and its chemical load from precipitation, through the drainage system, and back to the atmosphere and to the ocean and to determine how these changes affect the carbon cycle. The research focuses on 1) Modeling the transport and distribution of water, sediment and biogenic chemicals along the Amazon valley network; 2) Modeling the transfer of biogenic gases between the land surface and the atmosphere and mobilization of bioactive dissolved and particulate matter from the land surface through the

[1] Martini P.R.: Panamazonia Project: an Executive Report. SELPER Magazine vol.8 nr.2. June-1992.

river system to the ocean. 3) Analysis of Amazon vegetation and its interaction with climate, hydrology, and land use. Due to its scientific focus, IAI may want to increase the regional participation in this project.

Global Change and Terrestrial Ecosystems Project (GCTE)

This is a core project of the International Geosphere-Biosphere Programme (IGBP), focused on understanding the response of terrestrial ecosystems at local and regional scales to the interacting suite of global change drivers - atmospheric composition, climate and land use. It is having a key role, in concert with START, in building the capacity of the scientific community in the developing world to undertake its own research and assessment. It is important that IAI coordinate the regional activities of this initiative especially the transect study, an initial emphasis of IGBP.

Global Resource Information Database (GRID)

The Global Resource Information Database (GRID) is a system of cooperating centers dedicated to making digital environmental information readily available to international and national decision makers and environmental analysts. Its mission is to provide timely and reliable geo-referenced environmental information and access to a unique information data service to help address environmental issues at global, regional and national levels. There is a GRID node established at INPE, Brazil with activities focused but not restricted to the Amazon Basin area.

Dissemination of data sets are being carried mostly through the National Research Network (RNP), a computer network run by the National Scientific and Technological Council (CNPq). RNP is connected to the Internet so access to the data is available worldwide. Distribution of data on magnetic media via regular mail is also supported.

The scope of GRID goes beyond TE&BGC, but their experience could be used by IAI as a starting point for data exchange through Internet, a major need identified at the workshop. Similar experience could be drown from **CIESIN**, a consortium that is putting together significant datasets for global change research, especially with emphasis on human dimensions aspects.

Carbon in the Amazon River Experiment (CAMREX)

The objective of CAMREX over the last decade has been to define by mass balances and direct measurement those processes which control the distribution of bioactive elements (C, N, P, and O) in the mainstem Amazon River of Brazil. Samples have been collected on 13 different cruises (1982-91) during contrasting hydrographic stages. This experiment has been run by the University of Washington, US and by USP/CENA and INPA, Brazil.

Smoke. Clouds, Aerosols and Radiation (SCAR) Project.

This project in cooperation between US and Brazil organizations has as objectives the study of interactions of aerosols particles and smoke with clouds and climate; the determination of the rate of emissions of trace gases and aerosol particles from biomass burning; and the effect of biomass burning on surface vegetation properties and their remote sensing from space in the presence of smoke, among others objectives. An intensive campaign is taking place from mid August to mid September of 1995 in the Brazilian tropics.

Humid Tropical Forest Inventory Project (HTFIP)

This is a NASA Pathfinder project which is providing wall-to-wall coverage of the closed tropical forest of the world with Landsat MSS and TM at three points in time from the 1970s to the mid 1990s. This has been a NASA and EPA initiative.

International Geosphere-Biosphere Program and NASA 1 km AVHRR dataset Project

This dataset contains daily acquisition obtained from ground stations around the world. Data are being processed into 10 day composites for intra-annual multi-temporal analyses for land cover mapping, analysis of seasonal phenology, and derivation of a global fire product.

The Commission of the European Communities TREES Project

This project is compiling a 1 km tropical forest dataset and will make it available in both raw and high level products, such as GIS-based forest maps.

The AVHRR Pathfinder Dataset

This is an 8 km global, 10-year dataset being developed as part of NASA's Pathfinder Program. It provides long term record of global radiances and NDVI for multi-year and inter-annual analyses of land cover dynamics.

Global Series of Test Sites using Landsat TM Data

The NASA Pathfinder Project with the support of EPA is acquiring a series of test sites datasets to calibrate global analysis using coarse resolution data such as AVHRR for the development of site-specific models of ecological processes in places where detailed in-situ measurements have been made in conjunction with satellite acquisitions.

The Human Dimension Project [redacted] (HDP)

This project involves social and physical scientists to understand the driving forces of land use land cover change in order to provide information useful for the decision-makers.

Studies on Human Impact on Forests and Floodplains in the Tropics (SHIFT)

This project being conducted in cooperation between EMBRAPA/CPATU and the University of Göttingen has the objective of deriving knowledge to be used to maintain or increase the primary production capability and the biodiversity of the oriental Amazon region by improving the managing, especially of the slash and burning system to avoid new deforestation without putting in risk the subsistence or the chances of a better level of life of the small producer of the region.

Amazonian and Yucatan Secondary Successional Changes and Carbon Cycling as Affected by Human Activities (IU/ACT)

The Anthropological Center for Training and Research on Global Environmental Change from Indiana University is studying a number of sites in Amazonia and Yucatan forests with emphasis on the human dimensions and carbon cycling of secondary growth forests.

The Canada's Tropical Forest Initiative - SAREX-92 Project

It was a radar campaign held in Latin America sponsored by the European Space Agency and the Canadian International Development Agency. This experiment obtained in 1992, C-band SAR data in several test sites of Brazil, Costa Rica and Venezuela in order to prepare for the use of RADARSAT. The Tropical Forest Initiative is to be continued through the launch of RADARSAT and beyond.

The Evolution of the Continental and Coastal Environments during the Last Climatic Cycle in Brazil (120 KY B.P. to Present)

Studies done with the support of Brazilian Research Agency, CNPq and the French organization ORSTOM, allowed the envisage of the general trend of climatic changes over the last 60,000 years[2].

Ecosystem and Paleoecosystems of Brazilian Tropical Forest (ECOFIT)

In the context of IGBP, this project is studying the current ecosystems and their history since the last glacial period, involving botany, palinology, anthracology, wood anatomy, archeology, and computer science and in the future many other disciplines. The project involves several study sites and organizations. Coordination of the project is from the Instituto de Biologia of University of Rio de Janeiro. Department of Geophysics of CNPq and FEEMA from Rio de Janeiro.

AmaSeds Project

This was a cooperative, multidisciplinary research between Brazilian and American universities working on physical oceanography, water-column

[2] Suguio, Kenetiro et al. Instituto de Geociências, USP, São Paulo, Brazil.

geochemistry, sediment transport, diagenetic chemistry and associated benthic biology and sedimentology/stratigraphy of the Amazon shelf. The project included several cruises from 1989 to 1991, and a large contingent of scientists from Universidade Federal Fluminense, Universidade Federal do Pará, Universidade de São Paulo (IOUSP & CENA), Universidade Federal do Rio de Janeiro, Museu Emilio Göeldi and several universities from US led by the State University of New York.

Fluxes of Dissolved Material and Particulates from Bolivian Amazon Rivers (PHICAB)

This project is studying the fluxes of dissolved and suspended materials of the Madeira River[3].

Hydrology of Tropical Ecosystems - HYTRECS

This research effort aims at a better understanding of hydrologic and erosion processes in humid tropical ecosystems based on two watersheds: one in natural rainforest and the other in pasture land. these two small basins will be continuously monitored for four years. This is an initiative from USP/FCTH and UNESCO, effectively started in 1993.

Pan-American Climate Studies (PACS)

This NOAA initiative will contribute to understand the monsoon and summertime precipitation throughout the Americas. Interannual climatic variability such as those associated with El Niño-Southern Oscillation events will continue to be a focus of PACS research.

CONCLUSIONS

There are a number of on-going projects studying tropical ecosystem and associated biogeochemical cycles that IAI should coordinate with. A natural start on the operational studies would be to establish a land use land cover change study based on the progress made by the Panamazonia Project. This would benefit from the first IAI / WMO Project currently being implemented which will build the necessary facilities and training to successfully conduct such project.

On the scientific actions it is recommended that IAI coordinate the regional activities of the LBA experiment which would cover several scientific priorities of the TE&BGC focus and advance in several other foci of IAI.

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[3] Quintanilla, Jorge A. IIQ-UMSA, C.P. 303, La Paz, Boliva