

CATHALAC: a search for better understanding of the humid tropics of Latin America and the Caribbean

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Abstract The quest for coordination of hydrological research has led to the establishment of the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC, Spanish acronym). The centre stresses regional and international coordination and cooperation to increase the output of the available resources for research programmes. The existence of a network facilitates regional communication and gives organizations, institutes and governmental authorities the necessary support to cross (their) borders. CATHALAC has, within the setting of the region, divided its programme into the following seven programme areas of interest: (a) air–land–sea interactions; (b) hydrological process studies; (c) small islands; (d) integrated urban water management; (e) water quality control; (f) water resources assessment, management and conservation; and (g) knowledge, information and technology transfer. Under the umbrella of CATHALAC, several regional projects have been initiated to study regional hydrological processes and to transfer knowledge.

CATHALAC: la búsqueda por un mejor conocimiento de los trópicos húmedos de América Latina y el Caribe

Resumen La necesidad de coordinación de las investigaciones hidrológicas ha llevado al establecimiento del Centro del Agua del Trópico Húmedo para América Latina y el Caribe (CATHALAC). El Centro fortalece la esencia de la coordinación regional y internacional como también la cooperación para mejorar el uso de los recursos disponibles para programas de investigación. La existencia de una red o network facilita la comunicación regional y proporciona a organizaciones, institutos y autoridades gubernamentales el apoyo necesario para traspasar (sus) fronteras. Tomando como referencia el ámbito de la región CATHALAC divide su programa en las siguientes siete áreas de interés: (a) interacciones aire–mar–tierra; (b) procesos hidrológicos; (c) pequeñas islas; (d) manejo integrado de aguas urbanas; (e) control de calidad del agua; (f) evaluación, manejo y control de los recursos hídricos; y (g) transferencia de conocimientos, información y tecnología. En el marco de CATHALAC se han iniciado varios proyectos para estudiar procesos hidrológicos regionales y para transferir conocimientos.

INTRODUCTION

The humid tropics is defined by UNESCO (Chang & Lau, 1983; Hufschmidt & Tejwani, 1993), as the region comprised between the Tropics of Cancer and Capricorn—23.5° north and south of the Equator, respectively—with a monthly precipitation of over 100 mm during at least four and a half months of the year. This

region includes 22% of the world's land surfaces or $29.4 \times 10^6 \text{ km}^2$ and constitutes a treasure house of natural resources (Szollosi-Nagy, 1993).

The humid tropics are adversely affected by numerous problems that are characteristic of this region. The most rapid growth of the World's population is expected to occur in the developing countries, of which a significant part is located within the humid tropics and adjacent areas (Fig. 1; Hufschmidt & Tejwani, 1993).

Conditions in major cities within the humid tropics are already unstable from many perspectives (e.g. health, pollution, water supply) and it is inevitable that the even higher population growth in these urban areas (Fig. 2) will increase the pressure on the natural resources. In the absence of appropriate solutions, this will encourage unsustainable development policies and water management practices in the developing nations of the region. Another characteristic problem of the humid tropics is uncontrolled deforestation resulting from increasing demand for land due to population growth and inadequate land use practices. In addition, the humid tropics are under the constant impact of extreme climatological phenomena of diverse scales (hurricanes, monsoons, El Niño Southern Oscillation (ENSO), etc.). Their occurrence generally has a highly negative influence on the development of the region.

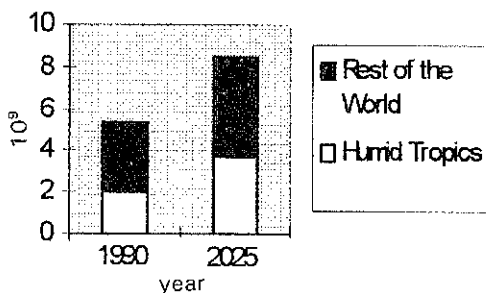


Fig. 1 Distribution of Earth's population (from Hufschmidt & Tejwani, 1993).

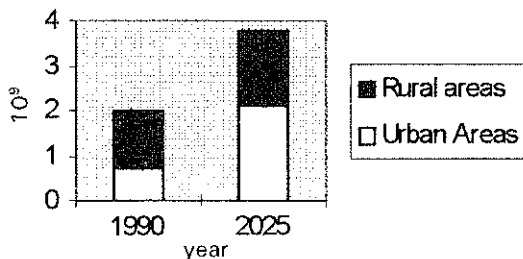


Fig. 2 Distribution of population in the humid tropics (from Hufschmidt & Tejwani, 1993).

INTRODUCING REGIONAL COOPERATION

During the 1960s, with the launching of the International Hydrological Decade (IHD) by UNESCO, a start was made to coordinate international research programmes in the field of hydrology. It was understood that hydrological processes are not obstructed by

national borders in completing their cycles; hence, research had to be able to follow the same route to come to a full understanding of the processes. Furthermore, in an international research setting, financial resources could be used more efficiently and effectively. The IHD was followed by the longer term International Hydrological Programme (IHP) to continue international cooperation (Bonell *et al.*, 1993).

Until recently, within regional hydrological studies, little coordinated attention was paid to studying the humid tropics. With plentiful rainfall, apparently endless forests, and major rivers dominating the landscapes, it did not seem that water could be a problem. Though, within the programme of the IHP it was perceived that the humid tropics significantly affect the global atmosphere and, hence, the world's hydrological processes. This perception led to the introduction of a separate theme in the planning of the IHP-IV in 1991: "Humid tropics hydrology and water management". This programme serves as a basis for the development of hemispheric units or administrative focal points to organize and coordinate research efforts in the humid tropics. This concept was first implemented in Latin America and the Caribbean forming a network under the coordination of a regional Centre.

COORDINATION OF EFFORTS THROUGH REGIONAL NETWORKS

The need to coordinate efforts to counter the complex problems of the humid tropics of Latin America and the Caribbean (LAC) and to describe the air-sea-land interaction processes in the region led to the establishment of the Centro del Agua del Trópico Húmedo para América Latina y el Caribe (CATHALAC); in English the Water Centre for the Humid Tropics of Latin America and the Caribbean.

CATHALAC's main purpose is to serve as administrative focal point in the LAC region for training, research and technology transfer in the field of water resources and the environment, with special emphasis on problems and issues related to the humid tropics. CATHALAC has created the following programmatic agenda, which consist of seven major areas of interest to the region: (a) air-sea-land interactions; (b) hydrological process studies; (c) small islands; (d) integrated urban water management; (e) water quality control; (f) water resources assessment, management and conservation; and (g) knowledge, information and technology transfer. Through participation in multiple regional activities, CATHALAC has built an extensive network of research institutes, universities, government authorities, and donors forming the basic prerequisite for regional cooperation and coordinated research.

Basic activities of the centre are: disseminating research results by presenting scientific papers; publishing documents related to specific problems of the humid tropics of Latin America and the Caribbean; organizing courses, seminars, and symposia; and building networks for closely coordinated scientific research on hydrology, meteorology, global change and related subjects. Furthermore, to realize the objectives of CATHALAC, the centre promotes, participates in, and coordinates the preparation of proposals for extensive regional projects.

In the following sections some of the major scientific research in the LAC region topics and their human dimensions are briefly described as well as the involvement of CATHALAC in these efforts.

EL NIÑO SOUTHERN OSCILLATION (ENSO)

A priority objective of research in the humid tropics is to acquire better understanding of the hydrological cycle and of all interactions that can change the course of the water. In the humid tropics in general air-sea-land interactions can be strongly characterized. The humid tropics of the LAC region can experience sometimes devastating impacts of processes like the El Niño Southern Oscillation (ENSO) or tropical cyclones. Anomalous occurrences, such as the warm phase of the ENSO are capable of influencing latitudes beyond our geographical borders. These processes modulate the state of the weather of the region (drought vs excess precipitation), thus influencing the socio-economic activities of the population. These impacts stress the necessity of improving our knowledge of the complex mechanisms that control these physical scenarios and our capability of forecasting these processes. Technologically, enormous steps have been made in the capability of General Circulation Models to reproduce these anomalies but still there is much work to be done. An important subject within the research on the ENSO is the human dimension. To develop an accepted and useful format of weather/climate forecasting, an intensive and open dialogue has to exist between the scientists who compile the forecasts and the users of these forecasts. Furthermore, to ensure that the scientific progress that has been made in the field of forecasting will be used to its full potential, the forms of distributing the information must also be optimized.

Within the quest for information on ENSO impacts and techniques to forecast future ENSO activity, CATHALAC is coordinating the organization of a series of workshops to create an opportunity for scientists and decision makers to communicate. During this "bilateral" exchange of information, the decision makers, *all* being potential users of the available weather forecasts to plan future activities, will have the opportunity to inform the scientists on their preferences for forecasting formats and on which parameters are most needed in the process of decision making. The first of a series of workshops on ENSO was organized in 1995 in Panama. In 1996, similar workshops were organized in Ecuador, Colombia and Costa Rica (CATHALAC, 1995c).

CLIMATOLOGICAL VARIABILITY IN THE TRADE CONVERGENCE CLIMATE COMPLEX (TC³)

The region of the Trade Convergence Climate Complex (TC³) covers most of the humid tropics of Latin America and the Caribbean and extends from southern North America to northern South America. In this region, the annual marches between tropical rainy and dry seasons are in turn related to the variations of trade wind intensity and tropical convergence activity, all surrounding the Inter Tropical Convergence Zone (ITCZ). Non-seasonal departures of the climates in this region are primarily related to anomalous meridional movements of the ITCZ and the associated fluctuations of the southeast and northeast trade wind regimes. Although the ITCZ tends to lose its clear identity over the less oceanic northern part of South America, one may consider that the southeastern trades portion of the complex stretches westward from Surinam and the Guyanas, through Venezuela, Colombia and Ecuador to the far

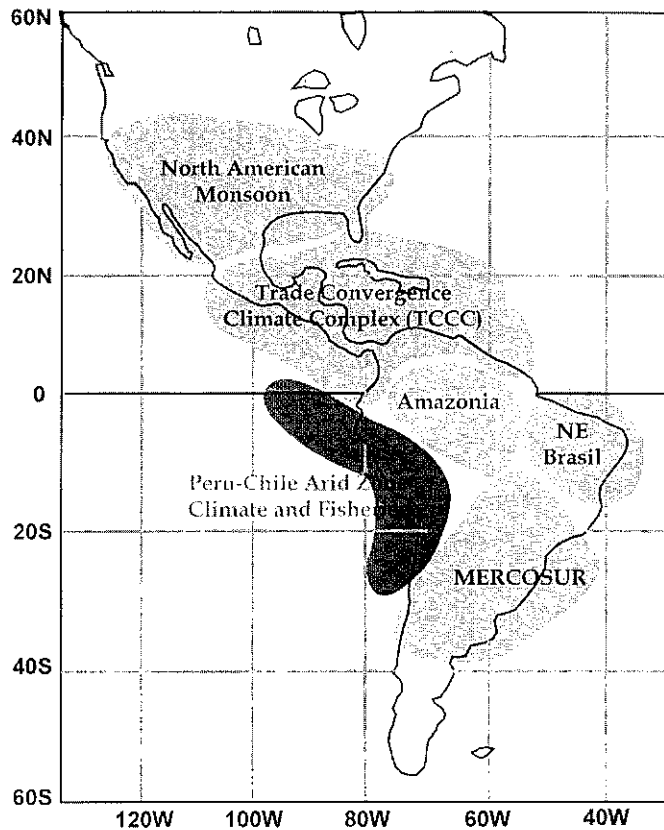


Fig. 3 Schematic showing climatic domains that enclose a common set of interannual climate processes and impacts.

northwestern extreme of the Peru coastal region. The northeastern trades portion of the complex affects the climate in analogous fashion from southern Mexico to Panama. Most of the climatic variations and resulting impacts on human populations in the TC³ region derive from non-seasonal changes that accompany interannual and interdecadal changes in the tropical Atlantic and Pacific Oceans and their interactions with the overlying troposphere. The nature of climatic teleconnections from remote oceanic regions is quite different for the TC³ region than for the midlatitude zones such as the southern USA/northern Mexico and the southern cone of South America (Fig. 3).

Significant impacts occur for tropical agriculture, energy and hydrological resources, fishing/aquaculture and health, most of which are heavily dependent on, and vulnerable to the timing and intensity of wet and dry seasons (CATHALAC, 1995a). During the first months of 1996, the Inter-American Institute for Global Change Research (IAI), approved a start-up grant for the initial phase of the TC³. This start-up grant is used to develop an efficient and effective research programme to study the interannual climate variability in the TC³ region.

HISTORICAL DATA RESCUE

Scattered throughout the region many useful data are stored at institutes, companies, agricultural cooperatives or monasteries. These data include log books with direct or indirect information on the frequency and magnitude of the extremes that have taken place. These databanks could help to detect climate changes and occurrences of the strongly characterized air-sea-land interactions in the region such as ENSOs, hurricanes, droughts, floods, etc.

These data have been collected for short-term practical reference. The holders/owners of the data did/will not profit directly from processing them nor by making them available to a wide public. In most cases, the data are stored in badly maintained archives. The loss of these data is an irreversible process that leaves gaps which might have been filled by means of a "data rescue programme".

One institute in the region that has been collecting data for almost a century is the Panama Canal Commission (PCC). Precipitation, temperature, wind direction/velocity and humidity have been essential data for managing the Panama Canal but no need existed for the analysis of long term data series. In cooperation with the PCC, the University of Miami and the Atlantic Oceanographic and Meteorological Laboratory/National Oceanic and Atmospheric Administration (NOAA/AOML) of the United States Department of Commerce, CATHALAC has started a programme to save the data of the PCC: "Historical Data for Latin American Climate". With the necessary hardware available, the data will be copied from paper archives and more recent microfilm records and will be stored in secure but easily accessible electronic media. These data will be made available to all potential users (University of Miami, 1995a, 1995b).

PROBLEM ORIENTED EXCHANGE AND SHARING OF KNOWLEDGE

Basically, islands in the humid tropics have the same water problems as those encountered in continental areas (Griesinger & Gladwell, 1993). Excess or shortage of rain, erosion, over-exploitation of aquifers and contamination problems have similar roots, although substantial differences exist. Because of their small buffer zones, small islands, defined as smaller than 1000 km², are especially vulnerable to water resources problems. Mismanagement of water as a natural resource in the form of over-exploitation or pollution has a more direct impact on these areas.

Much work has been done to counter this problem, especially to obtain a scientifically better understanding of the different processes. At least as much attention has to be given to training and education of personnel at all levels in the island water sector including the policy/decision makers. At present, in most cases, especially in small island states, training is marginal and some of these nations have very few qualified scientists and engineers to undertake basic hydrological studies. However, in response to the scarcity of freshwater, the majority of the islands are applying an extensive variety of techniques to increase the availability of water. These techniques include capture of runoff water and rain, desalination, water recycling and separate distribution systems for potable water and salt water for sanitary purposes. Hence, techniques to counter water shortages, including techniques to decrease the demand, exist but they should be studied, developed and discussed; but most of all they should be transferred to other potential users.

CATHALAC is supporting research on the hydrological processes that are especially important at these small scales. Close cooperation exists with the Eastern Caribbean Center of the University of the Virgin Islands to initiate an itinerant expert programme providing an excellent means of knowledge and experience transfer. Through this programme, training documents will be developed and meetings will be organized to make knowledge available to those involved (University of the Virgin Islands/Eastern Caribbean Center & CATHALAC, 1995).

DEVELOPING DECISION SUPPORT SYSTEMS FOR REGIONAL POLICY MAKING

The humid tropics are especially challenging for water resources assessment, management and conservation because of the extreme conditions encountered. High temperatures and rainfall, often occurring as severe storms, along with high rates of erosion, cause flooding and sedimentation of streams, lakes, reservoirs, and estuaries. Management problems are compounded by high population densities and increasing urbanization. The special problems and challenges of the humid tropics add to environmental, social and/or economic management difficulties commonly encountered in many developing countries, regardless of climate. There is a need to determine realistic water development policies for efficient integrated and environmentally sound water resource utilization. Water resources assessment, management and conservation has to address such diverse issues as comprehensive national and drainage basin planning, competing demands of water users, international agreements on water uses, the implementation and operation of water development schemes, and increasing needs for training and support systems. Because of the accelerating technological development, population growth, and the urgent task to develop and use water resources more efficiently, it is necessary to broaden traditional planning, to consider the particular aspects of policy and decision making, the process of implementation, and operation and maintenance issues. The challenging social and technological conditions and the widening range of alternatives require more comprehensive, and at the same time more flexible, planning and implementation strategies. But to ensure successful implementation of water management and conservation schemes, policy making and decision making should be well founded by intensive water resources assessment studies. To tackle the problems of water resources assessment, management and conservation in the humid tropics of the LAC region, very specific strategies based on these local circumstances should be developed.

In addressing the most common water resources management problems of the humid tropics there is a need to blend scientific and technological facts and knowledge with societal developmental goals and objectives. Planning management strategies, such as integrated river basin planning, multiple objective planning, demand management, and international cooperation have proven to be successful. A developed and, in the private sector, widely accepted way to address these types of problems is to use a computer system as a "consultant" in the process of decision making. The approach is referred to as the Decision Support System (DSS). CATHALAC and scientists from Case Western University are carrying out joint efforts to promote the use of DSS in the region. The implementation of DSS will be an activity coordinated with the

Instituto de Recursos Naturales Renovables (INRENARE) of Panama, the Fundacion para la Ciencia y Tecnologia (FUNDACYT) of Ecuador, and the Ministry of Sustainable Development and the Environment of Bolivia. Using the DSS approach, information is provided to middle- as well as high-level executives in a manner that is understandable to them and, furthermore, allows them to get insight into the complex situations by an easy to use "if-then" type of dialogue. As the basic language of the computer programme will be the same in all countries, introducing this system on a regional scale will have the advantage of "learning to speak a uniform language" in policy making on an international level. Another foreseeable advantage of the introduction of the DSS is the increasing exchangeability of information and data (CATHALAC, 1996).

BIOLOGICAL, CHEMICAL AND PHYSICAL FUNCTIONS OF AMAZONIA

In order to predict global change caused by the increase of concentrations of greenhouse gases or by significant changes in the use of land, it is necessary to obtain a better understanding of the hydrological cycle using coupled hydrological/atmospheric models. Although predictions show that the major changes will be taking place at higher latitudes, an adequate knowledge of the processes in the tropics is also required, especially because of the vulnerability of the hydrological cycle in the humid tropics to anthropogenic influences.

The humid tropics play a pivotal role in the maintenance of the global hydrological cycle which, to a great extent, determines the actual food producing capacity of the world. Changes within these hydrological processes will increase or decrease this capacity. Hydrological modelling technologies are essential to provide the inputs for global change impact studies constituting a basis for the construction and enforcement of policies. Process studies within reference drainage basins should contribute to the development and refinement of empirical and deterministic models, stressing domains of applicability.

CATHALAC is participating in the identification and organization of an extensive multidisciplinary international research programme to study the hydrological, biochemical, climatological, and ecological processes of the complete drainage basin of the Amazon River and its interaction with the Earth system. The Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA), under the scientific coordination of the Brazilian Centro de Previsao de Tempo y Estudos Climaticos of the Instituto Nacional de Pesquisas Espaciais (CPTEC/INPE), is the most extensive experiment to take place in this region to date. The programme is centred around two key questions that will be addressed through multidisciplinary research, integrating studies in the physical, biological, chemical and human sciences:

- How does Amazonia currently function as a regional entity?
- How will changes in land use and climate affect the biological, chemical and physical functions of Amazonia, including the sustainability of development in the region and the influence of Amazonia on global climate?

The hydrological component of the study will consider issues related to both the quantity and the chemistry of water in the Amazon Basin. The stores and fluxes of water, and the controls on movement of water in soils and in streams, and the

associated transport of constituents, will be determined for a nested suite of drainage basins representing a range of land use intensities (IGBP, 1996; Kabat *et al.*, 1995).

FINAL REMARKS

By executing the above mentioned activities, amongst others, CATHALAC is assisting in the regional establishment of a body of water management experts, trained in both theory and application of sound principles. The resulting network will constitute a strong and well founded group of people, institutes, universities, and international and regional organizations and governmental authorities that will facilitate the highly needed coordination of the planning and execution of research programmes and sharing of knowledge to enhance, directly or indirectly, the level of development of the humid tropics of the LAC region. Special attention is given to sharing information between technical experts, policy makers and decision makers. With the establishment of a regional network the available funds to finance research projects can be used more effectively and efficiently.

REFERENCES

- Bonell, M., Hufschmidt, M. M. & Gladwell, J. S. (eds) (1993) *Hydrology and Water Management in the Humid Tropics*. Cambridge University Press, Cambridge, UK.
- CATHALAC (1995a) A proposal for the planning of the Trade Convergence Climax Complex. *Project Proposal to the Inter-American Institute for Global Change Research Start-Up Grants*.
- CATHALAC (1995b) Final Report II. *Meeting of the Governing Board, 13–15 November 1995, Panama, Republic of Panama*.
- CATHALAC (1995c) I. Foro Nacional sobre El Fenomeno de El Niño y su Impacto en Panama (First Conference on the El Niño phenomenon and its impact on Panama) (16–17 November 1995), Panama, Republic of Panama.
- CATHALAC (1996) Policymaking and negotiation support: technology transfer and training. *Project Proposal to the Inter-American Development Bank, Panama, Republic of Panama*.
- Chang, J. H. & Lau, L. S. (1983) Definition of the humid tropics. In: *Hydrology and Water Management in the Humid Tropics* (ed. by M. Bonell, M. M. Hufschmidt & J. S. Gladwell), 571–575. Cambridge University Press, Cambridge, UK.
- Griesinger, B. & Gladwell, J. S. (1993) Hydrology and water resources of tropical Latin America and the Caribbean. In: *Hydrology and Water Management in the Humid Tropics* (ed. by M. Bonell, M. M. Hufschmidt & J. S. Gladwell), 84–99. Cambridge University Press, Cambridge, UK.
- Hufschmidt, M. M. & Tejwani, K. G. (1993) Integrated water resource management: meeting the sustainable challenge. *IHP Humid Tropics Programme Series 5*. UNESCO, Paris, France.
- IGBP (International Geosphere-Biosphere Programme) (1996) Where does LBA stand? The large scale biosphere-atmosphere experiment in Amazonia. *BAHC News 4*.
- Kabat, P., Dolman, A. J. & Hutjes, R. W. A. (1995) *The Large Scale Biosphere–Atmosphere Experiment in Amazonia: European Contribution II*. Wageningen, The Netherlands.
- Szollosi-Nagy, A. (1993) Preface. In: *Hydrology and Water Management in the Humid Tropics* (ed. by M. Bonell, M. M. Hufschmidt & J. S. Gladwell), xvii–xix. Cambridge University Press, Cambridge, UK.
- UNESCO (1994) International Hydrological Programme, Eleventh Session of the Intergovernmental Council. *Draft Plan of the Fifth Phase (1995–2001) of the IHP: Hydrology and Water Resources Development in a Vulnerable Environment*. UNESCO, Paris, France.
- University of Miami (1995a) Climate historical data for Latin American climate. *Project Proposal to the Inter-American Institute for Global Change Research Initial Science Program. Rosenstiel School of Marine and Atmospheric Science, University of Miami, USA*.
- University of Miami (1995b) Historical data on Latin American climate: a search for variations in spatial and temporal precipitation patterns in the trade convergence region. *Project Proposal to the Inter-American Institute for Global Change Research Initial Science Program. Rosenstiel School of Marine and Atmospheric Science, University of Miami, USA*.
- University of the Virgin islands & CATHALAC (1995) Itinerary Expert Programme, Extending Regional Hydrological Capability Through the Sharing of Expertise. Panama, Republic of Panama.