IAI Collaborative Research Network (CRN) program.

FINAL REPORT

The Collaborative Research Network (CRN) program was approved in 1998. It began in 1999, as a five-year program (1999–2003) with an initial investment of about US$10 million for 14 grants (14 CRNs) and through no-cost extensions was active until 2006. The CRN program encompasses most of the IAI's main objectives:

- to improve understanding of regional global change phenomena;
- to set up international networks for research into global change issues;
- to produce information for policy- and decision-makers; and
- to expand scientific capacity in the Americas.

The CRN program was not only designed to support research, but also to encourage synergistic networks between scientists in the Americas on global-change problems of importance to the region: scientists and scientific institutions working together in an integrated and collaborative fashion. The highly multidisciplinary networks were designed to enable in-depth investigation of a wide range of global environmental change issues. They have generated significant, high-quality scientific information that can be and has been used by stakeholders and policy- and decision-makers to aid mitigation of and adaptation to harmful environmental changes and their impacts on our societies. The number of scientists and/or institutions affiliated with the CRN program has increased every year as PIs and Co-PIs have added new collaborators. Supplemental and/or parallel funds raised by CRN PIs have also continued to grow to exceed US$ 16 million. The major contributors of additional funds were national science and technology organizations of IAI member countries. Other institutions providing funds for CRN projects included the European Union, France, Germany, the United Nations Development Program, the Global Environmental Facility, the World Bank, and the Red Latino Americana de Botánica. Over 600 students have benefited from participating in CRN research. The growth of both participation and funding for the CRNs shows that the CRN program has been very effective in extending and increasing the number of institutions composing these international research networks.

Several of the research projects in the program investigated terrestrial ecosystems and their use.

CRN 001, **Biogeochemical Cycles under Land Use Change in the Semiarid Americas** (PI: Holm Tiessen) has generated data on land and soil degradation and on resource management options to improve land quality with the participation of the University of Saskatchewan, and partners in Argentina, Brazil, Mexico and Venezuela.

Research on organic matter, nutrient cycling and erosion was combined to solve a paradox of land degradation in northeastern Brazil. In this region of scarce but intense rainfall, evidence of erosion is obvious, but the typical soil quality indicators do not confirm the impact of erosion. The team used measurements of radioactive ^{137}Cs that had labeled the earth's surface evenly during the 1960 hydrogen bomb tests, to calculate top soil loss. Sediment losses since the bomb fallout period 40 years ago were calculated at 220 kg soil m^{-2} from shoulder slopes, equivalent to a 20-cm layer of top soil. Losses from the back slope position were even higher, estimated at 268 kg soil m^{-2}, equivalent to a 24-cm layer. Both levels represent very serious erosion rates. Studies on soil carbon confirmed very rapid soil organic matter turnover in soils of several regions of the Northeast. Turnover rates of less than 50 years were measured, indicating a high potential for degradation and the need for careful

management of land cover. The high carbon turnover and high erosion rates combine to make these soils highly susceptible to degradation, but also obscure the degradative processes. Organic matter turnover, both accretion and mineralization, is so fast that carbon levels are hardly affected by erosion. Unlike in temperate regions, organic matter level is therefore a poor indicator of land degradation by erosion.

Also in NE Brazil, work on water and nutrient cycling in on-farm trials has shown the positive impact of agroforestry and of including succulents (forage cactus) into cropping systems. This has stabilized food and fodder production and improved and stabilized income. An increased use of native legume trees was also proposed based on these studies. The positive impact of increasing "useful" biodiversity on land management were improved water use efficiency and long-term sustainability. This research is ongoing beyond the CRN with European and Brazilian funding.

Isotope studies using $^{14}C14$ dating and natural ^{13}C replacement have shown the much more rapid C turnover in tropical as compared to temperate soils. In the warm temperate soils of La Pampa province, where soil degradation and long-term sustainability are concerns, several sites under different management and vegetation cover showed very fast C turnover with half-lives of only 10 to 12 years. This compares to half-lives of 50 to over 100 years in temperate grasslands of North America. This surprising and alarming result indicates the high susceptibility to land degradation of the semiarid regions of La Pampa. Conservation management is of great importance under these conditions, and that lessons from the well-studied Great Plains can not be applied without careful adaptation. One troubling result was that soils of one region that had suffered severe degradation under conventional arable agriculture were unable to recover original organic matter levels under reclamation attempts with pastures. This is a rare but important evidence of a threshold of irreversibility (or at least considerable hysteresis) in the degradation process. The impacts of land quality and its decline on social and economic well-being of the region were also quantified, work that has now been taken over in a CRN II project under different leadership.

In Yucatan, off-farm income opportunities have caused wide-spread abandonment of traditionally managed shifting cultivation fields. This process was observed during CRN activities, and social and land cover changes were documented. As a follow-up to the research, the team then developed a social accounting matrix and implemented an ecological land-use planning in cooperation with municipalities. Within this program of research, extension and implementation, a number of detailed studies were conducted on aspects of land cover management, such as limitations for tree establishment, the economic viability and appropriate tree management for fruit and timber production, the negative impact of irrigation on insect infestation, and the potential of trees for productivity and reclamation of quarries. Adapting management and land-use decisions to the constraints and opportunities of landscape has become a central concern. Within this, it has become clear that many of the land-use changes are driven by alternative economic opportunities including subsidies and are unrelated to resource quality. A great danger of this process is that land-use decisions (or the lack of conscious decisions) are independent of the needs for resource management or conservation.

CRN 009, **Cattle Ranching, Land Use and Deforestation in Brazil, Ecuador and Peru** (PI: Charles Wood), carried out research in rural Ecuador and Peru, and in three rural sites in the Brazilian Amazon. In-depth interviews were performed with land managers by interdisciplinary teams of researches drawn from the three countries. Data collection and analysis focused on the decision making process by which rural establishments take into account social and biophysical factors in the decision to invest in cattle, in the choice to establish and manage pasture, and in the strategies to clear primary or secondary forest.

The findings showed that deforestation is taking place in all regions, although the pace of land use change varies between sites. The choice of pasture management strategies depends on the internal characteristics of rural households, on price and market structures, and on the historical and cultural

characteristics of the populations involved. While deforestation was an outcome common to nearly all of the research sites, the factors that lead to deforestation varied from one context to another, and by the type of producer involved. An understanding of land use decisions is important because of the environmental consequences of converting forest to pastures. It is widely understood that deforestation is associated with reduced biodiversity, changes in hydrology, increased soil erosion, and alterations in microclimates. Moreover, the burning of biomass releases large quantities of carbon into the atmosphere in the form of carbon dioxide, while cattle are an additional source of methane gas, which is produced in the bovine intestinal tract. An analysis of the expansion of cattle ranching was therefore a way to address a wide range of priority environmental issues. The multi-leveled, interdisciplinary, and comparative approach added to the scholarly understanding of the factors that drive environmentally significant land use decisions. In addition, the approach generated the kind of information required to formulate recommendations to encourage alternative forms of land use and promote sustainable pasture management.

The project generated seven book-length monographs: an edited volume on land use and deforestation in the Amazon; a monograph on each of the five research sites (in Brazil, Ecuador and Peru), and an edited volume that synthesized and compared the results of the regional monographs. Another 6 books, 24 articles, and 12 presentations publication were associated with the CRN project. Young scholars participated in the fieldwork aided by modest research awards to carry out independent research on topics relevant to the CRN's objectives. Direct or in kind support from CRN 009 contributed to the completion of 20 academic degrees at various levels (5 completed Ph.Ds; 9 Ph.D. candidates; 4 MS, 2 BS degrees) in a variety of disciplines (Anthropology, Ecology, Economics, Sociology, Geography, Agrarian Science, Agroforestry, Political Science and Agronomy).

CRN 012, **The Role of Biodiversity and Climate in the Functioning of Ecosystems: A Comparative Study of Grasslands, Savannas, and Forests** (PI: Osvaldo Sala) had significant implications for science, conservation and public policy and management decisions from the local to the global scale. The CRN explored a number of questions related to biodiversity and ecosystem functioning, including the relationship between biodiversity and primary productivity, the effect of plant species diversity on decomposition and carbon turnover, the role of biodiversity in controlling nutrient cycling along climatic gradients, the effect of life-form shifts on nutrient pools, and the importance of microbial diversity in determining ecosystem functioning.

Results from the field experiments in South America have shed new insights on the relationships between biodiversity and ecosystem functioning. In particular, the focus on ecosystems in temperate South America that have received relatively little human impact has provided new information with respect to the importance of biodiversity in intact ecosystems. Vascular plant removal experiments in the Patagonian steppe have shown that biodiversity (species richness) and net primary productivity are positively correlated, as has been shown in a number of experiments with artificially constructed communities. However, in the Patagonian steppe, this relationship is much more pronounced, such that changes in diversity result in more dramatic changes in primary production. This is attributed to the fact that these ecosystems are intact and undisturbed, so that long-term consequences of species interactions and in particular positive species interactions (facilitation) have developed.

Experimental results from the Southern temperate forest have also provided important insights. Research in a forest mosaic has demonstrated a significant relationship between aboveground vascular plant diversity and belowground soil organisms. The abundance of soil functional groups appears to be affected by the input and quality of organic matter entering the soil pool, in particular by differences in litter quality from different species. In addition to the direct effect on soil organisms, these differences in litter quality affect rates of carbon and nitrogen turnover in these sites, both directly through changes in litter input, and indirectly through long-term effects on carbon and nitrogen pools. These results are

novel in that the relationships between above- and belowground diversity have been difficult to establish, in part because it has been extremely difficult to examine these relationships in intact long-lived ecosystems such as forests. Results from both the Patagonian steppe and the Andean temperate forests demonstrate the importance of using intact ecosystems for exploring fundamental ecological relationships, and to accurately assess the importance of biodiversity loss for ecosystem functioning. These results have far-reaching importance since the maintenance and preservation of biodiversity is one of the pressing concerns for the global community in the next century. The prominence of the preservation and maintenance of biodiversity as a world concern affects political agendas, governments, and public policy.

The research of CRN-012 has resulted in 2 edited books, 45 scientific articles published or in press, 19 book chapters, and 4 popular articles. The research and capacity building activities highlight the importance of biodiversity as both an interdisciplinary science, as well as an emerging issue of both local and global significance for public policy.

CRN 040, **Comparative Studies of Global Change Effects on the Vegetation of two Tropical Ecosystems: The High Mountain and the Seasonal Savanna** (PI Juan Silva) had four main research components. Scientists and (a total of 27) students from Argentina, Brazil, Colombia and Venezuela investigated a) water dynamics in mountain forests and grasslands; b) structural and functional responses to environmental and perturbation gradients in mountain ecosystems; c) structural and functional responses to environmental and perturbation gradients in seasonal savannas; and d) climate dynamics.

Water plays a fundamental role in determining the biological diversity and stability of tropical ecosystems and renders essential services to human societies. The influence of global change (the combination of climate and land use change) on the flows of water in tropical ecosystems and how the latter respond to these changes was investigated in two important ecosystems: mountain forests and the seasonal savannas. The research on the water dynamics in mountain forests and associated grasslands was conducted on Andean slopes in three countries, Argentina, Colombia and Venezuela. The water balance in these three ecosystems was affected by floristic composition (especially of the epiphytic community and the grasslands), and (drastically) by the replacement of forests by different types of grasslands. Resulting changes in water flows were particularly important during heavy rainfall, turning these into catastrophic events.

In the seasonal savannas, the annual fluctuations in soil water content at different depths along physiognomic gradients from woody savannas to open grasslands were related water flows. The replacement of native savannas, well known for their high biodiversity, by introduced pastures with higher water use efficiency and greater productivity has deeply affected water circulation in the system. Particularly relevant was the reduction in soil water recharge and in soil available water for plant growth.

Water availability was shown to be a determinant of savanna structure and functioning. The ecology of savanna trees, the response of different species and functional groups to water availability as determined by rainfall, geomorphology and soil texture provided an understanding of the nature of savanna vegetation, the coexistence of exclusive growth forms like trees and graminoids, the role of fire and the responses of savannas to changes in rainfall and land use. These relationships are important at the scale of regional climate, given the extent of seasonal savannas in South America, their biodiversity and the rapid transformation of these ecosystems as a consequence of land use change.

Differences between functional groups and between species at a level of detail such as germination, seedling growth and survival and performance in water, and carbon flows showed a complex picture of species-specific responses. This suggests that oversimplification and gross species classification in major functional types may be misleading and that more detailed analysis is needed to understand savanna responses to global change.

Both, paramos and *Polylepis* (the highest growing tree) forests are experiencing high pressure from land use change. The diversity of functional attributes (which determines a high ecological resilience) found in the different species of *Polylepis* along the latitudinal gradient explained some aspects of their success under different climatic scenarios. The responses of paramo vegetation to environmental gradients and their relations to biodiversity, as well as the behavior of individual species and higher taxa are important since these communities play an important role in the water flows of high tropical mountains at the basin scale. Three major data bases for Venezuela: plants from the paramos, plants from savannas and rainfall data have been made available on the web through IAIDIS. The multi-scale approach of this CRN, from the landscape to the individual plant permitted insights into the processes and mechanisms involved in the responses of ecosystems to global change.

In combination, these terrestrial ecosystem projects provided a comprehensive evaluation of the interactions between landuse, ecosystem function and ecophysiology under global change and climate stress.

Closely linked to the terrestrial ecosystems are inland aquatic systems. This link was explored in CRN 047, **Andean Amazon Rivers Analysis and Management** project (PI: Michael McClain) which aimed at the scientific understanding of Andean Amazon river ecosystems necessary for effective management in light of progressing development and possible climate change.

Landscape analyses centered on classification of terrestrial and aquatic features of the region, examination of biophysical and cultural controls on the configuration of land cover, and an analysis of socioeconomic drivers of land-use change. Innovative aspects of this work included the identification of the best approach to classified mixed terrestrial/aquatic pixels in Landsat images, improved techniques for distinguishing similar land-cover types in western Amazonian settings, the development of techniques to link landuse change to widely available socioeconomic data, and a focus on aspects of the landscape that potentially influence the quantity and quality of water in the region's rivers.

A second major area of activities involved coordinated discharge and water quality sampling campaigns across pilot basins in Peru, Ecuador, and Colombia. Sampling was conducted at nearly 150 sampling stations over the 5-years of the project, and weekly samples were collected over a multi-year period for a subset of approximately 15 stations distributed across all three pilot basins.

Results showed that Andean Amazon rivers generally enjoy high water quality and intact ecosystems, although both degraded water quality and compromised ecosystem integrity were documented in the vicinity of towns discharging raw sewage to rivers and in areas of intense agriculture. Untreated wastes from towns and poor land management in agricultural areas are the most widespread threats, while petroleum development and mining are important in certain regions.

Over the 5 years of the project investigators and students were able to determine relationships between seasonal and sporadic changes in discharge and water quality. Quantitative models of these dynamics were developed to guide continued research and decision making. More than 100,000 km^2 of the Andean Amazon landscapes were examined for land cover, land use, and climate parameters. Four new methods of landscape analysis were developed in student projects: a technique for predicting the rates and patterns of deforestation from widely available socioeconomic data, an end-member mixing technique to identify and map aquatic habitats using Landsat imagery; a technique to distinguish regionally relevant land-use types from Landsat imagery, and a neural network approach to interpolate between climate stations to develop regional precipitation maps.

Modeling activities of precipitation and runoff for pilot basins in Ecuador and Peru involved compilations of existing climate and runoff data and parameterization, calibration, and verification of basin-scale models. These models will be useful beyond the life of the project for water resource planning purposes and evaluations of climate change impacts on existing resources.

More than 200 household surveys yielding information about the ways humans both depend upon and impact river ecosystems: how people use water from rivers, how colonists and indigenous people used riparian areas along rivers. The status of more than 100 river sections was documented and related to nearby threats. Threats include landuse conflict, mostly in Andean and riparian areas where coca is grown. Government fumigation of these areas contributes to degradation. Deforested areas and soil compaction in the Orteguaza and Mocoa basins contributed to the highest yield of suspended solids in the basin with averages of 435 ppm, and 413 ppm respectively. Discrepancies between actual land cover and best land use pose a conflict in the attempt to prevent primary forest degradation with little long-term benefit for activities such as agriculture and cattle ranching.

Facilities and infrastructure created continue to support global-change research in Peru, Ecuador, and Colombia, and continue to be supported with funding from the Moore and MacArthur Foundations. The Andean Amazon Research Station in Oxapampa, Peru, is gaining regional recognition as a center of research.

A historical perspective on climate change was provided based on tree ring analysis along the entire backbone of the Americas by CRN003, **The Assessment of Present, Past and Future Climate Variability in the Americas form Treeline Environments** (PI: Brian Luckman). The project has demonstrated strong linkages between temperature series in Patagonia and Alaska and inverse but statistically significant relationships with coral records from the Central Pacific. Other significant results have been the first reconstructions of streamflow from Mexico and Chile which have major significance in terms of the future potential of tree ring studies to contribute to studies of hydrologic variability and water supply throughout the Americas. In North America, the project was able to reconstruct glacier mass balances using dendrochronologies, and to establish links to the Pacific Decadal Oscillation and ENSO events. Examination of the climatic controls of mass balance through these studies is important for understanding future trajectories for glacier change (i.e. melt and recession) in these regions. The CRN has also reconstructed glacier fluctuations in the Patagonian Andes in Argentina.

Long-term (over 3000 year) chronologies were established for the southern US. Very detailed information was obtained on climate fluctuations in the region. The climate transition around the year 1400 for instance was marked by warmer sea surface temperatures in the Pacific, rainier winters and cooler summers in California and the Great Basin. The Bristlecone Pine records thus point towards a history of low frequency El Niño events.

In Mexico**,** the major achievement of the CRN has been the development of a network of Douglas fir chronologies from which well-verified reconstructions of precipitation, drought and streamflow have been developed. The longest chronology in Mexico (Barranco de Amealco) from a baldcypress stand in Queretaro is over a thousand years (969–2004). This chronology exhibits reduced growth during periods of extensive historical droughts, particularly 1100 to 1160, coinciding with the decline of the Toltec empire, and has significant potential for a long precipitation reconstruction. During the project six winter-spring precipitation reconstructions have been developed, the longest (for Durango) being over 600 years. Water supply is the most important climate-variability-related issue in Mexico, and these reconstructions will be of critical importance for water management in this drought-prone region. This atmospheric phenomenon has strong socioeconomic significance**,** as it is the primary source of water used for livestock, agriculture, industry, and many other activities. In addition, the precipitation and drought reconstructions in Mexico have been used to provide detailed evidence for the causes of the historically significant socioeconomic events (famines, disease outbreaks, changing crop yields) that influenced the development, peak and decline of important prehispanic civilizations that flourished in central Mexico.

In 1999 Cook et al. (J. Climate, 12, 1145-1162) produced a spectacular gridded reconstruction of the Palmer Drought Severity Index (PDSI) for the co-terminous United States for each of the last 300 years (see http://www.ncdc.noaa.gov/paleo/pdsi.html ref). The provision of new moisture sensitive tree-ring chronologies for Mexico and western Canada fuelled by the CRN has been a major contribution to the recently-published expanded reconstruction (Cook et al., Science, 306, 1015-1018) of this network that now includes 286 2.5° grid squares covering most of North America from the Arctic Ocean in western Canada to southern Mexico.

The CRN's work in the tropics has narrowed the latitudinal gap for dendrochronologies by extending the network equatorwards and by investigation of new species in both hemispheres. For the first time, sites in both hemispheres have yielded chronologies and climate reconstructions that extend significantly into the tropics. In addition, dendrochronological studies of semiarid woodland sites have also been carried out in both hemispheres (mesquite in Mexico, *Prosopis* in Argentina) in association with management studies of these forest types for wood and charcoal production.

Pioneer work by the CRN has developed chronologies up to 705 years from small stunted *Polylepis tarapacana* growing on the slopes of Bolivian volcanoes up to 4900m. These are the highest tree-rings sites in the world and results demonstrate a strong relationship between ring-widths and precipitation, which have the potential to provide annually-resolved proxy precipitation reconstructions for the region over several hundred years.

Dendrochronological studies have yielded significant information on the relationship between climate and forest disturbances. Tree mortality episodes have been recognized during the 20th century for *Austrocedrus chilensis* growing along the xeric forest-steppe border in northern Argentinean Patagonia. These regional events of tree mortality are associated with extreme warm-dry climatic conditions occurring either in single or two consecutive summers. Warmer temperatures in the northern Patagonian Andes since the mid 1970s, due to changes in the Pacific Decadal Oscillation (PDO) modes, have increased the occurrence of lighting-induced fires. It is crucial to understand the effect of recent climate variations on both physical and biological systems in order to predict correctly ecosystem responses to future climatic changes across the Patagonian Andes.

A continent-wide synthesis of the results shows coherent relationships between high-latitude climates in both hemispheres and the tropical Pacific over the last 300 years. These relationships are particularly strong at the interdecadal to centennial scale. Reconstructed El Niño sea surface temperatures from the Central Pacific over the last 300 years are positively correlated with tree ring records from the SW United States and from Central Chile, and negatively correlated with ringwidths on the Bolivian Altiplano. These relationships indicate that precipitation variability in low latitudes is primarily forced by the tropics. However, significant correlations between reconstructed Patagonian temperature records and mean sea level pressures in the Southern Ocean indicate that precipitation south of 40°S is mainly influenced by extra tropical forcing. These analyses provide the first examples of many potential large scale regional and global climate linkages that could be examined using the full database being assembled by the CRN.

Links between critical stressors of global change (enhanced UV-B radiation and temperature) ecosystem effects and societal vulnerability were established by CRN 026, **Enhanced ultraviolet-B radiation in natural ecosystems as an added perturbation due to ozone depletion** (PI: Maria Vernet). Based on the hypothesis that the response of organisms and systems to UVR varies along gradients, the CRN linked data collection, ecosystem modeling and socio-economic studies. 25 investigators from18 institutions in 5 countries evaluated the direct and indirect socio-economics impacts of UV-b radiation.

Several experiments showed that other environmental stresses than UV-B confounded the results. The mechanism of chlorophyll-a production in *Salicornia* seemed more affected by the local salinity than the actual UV-B radiation levels. A flavonoid protection mechanism in *Salicornia* plants

seems to have prevented significant damage to the growth and chlorophyll production mechanisms of the plant. Yet, plants excluded from UV were taller and showed a tendency of higher number of internodes and branches than the other treatments.

The Chl-b:Chl-a ratio was increased by UV-B in outdoor mesocosm experiments in Brazil and southern Argentina, indicating a community change favouring green algae. Since changes in phytoplankton biomass were minor in all experiments, even though UV-B enhancement was important, community structure of phytoplankton is probably more important in ecosystem resistance to this stressor. Cell physiological condition was worse under enhanced UV-B. However, this was not reflected in the quantum yield of photochemistry (Fv/Fm), which showed no effect of the treatments for all three sites.

Experiments in freshwater demonstrated for the first time the role of UVR at inducing a vertical avoidance behavior in crustacean zooplankton at whole lake scale, and the role of UVR in the induction of the synthesis of mycosporine-glutaminol-glucoside, a new photoprotective compound from freshwaters, with putative photoprotective function.

A mathematical model was built to represent the results and showed some unexpected results due to indirect trophic effects among bacteria, phytoplankton and heterotrophic flagellates. The most remarkable effect was an increment in bacteria and flagellate populations due to enhanced UVBR. This effect was similar to that observed in experimental mesocosms and is related to the decrease of predation due to the direct damage to predators (ciliates) by UVBR.

Synergy or feedback mechanism between different ecosystem effects on marshes/marine systems, education, tourism, were explored in a model designed with stakeholder participation. The synthesis model indicates for marshes that UV-b on a global scale is not a significant stress relative to potential impacts of sea level rise. While changes in the marine sector due to anthropogenic influences may *affect* global climate change, marshes are expected to primarily be *affected by* climate change.

An in-depth exploration of societal responses to climate stressors was provided by CRN 031, **ENSO Disaster Risk Management in Latin America: proposal for the consolidation of a comparative-regional social study based research, information and training network.** (PI: Eduardo Franco †, Allan Lavell). The project spanning 8 countries (Argentina, Brazil, Ecuador, Mexico, Costa Rica, Colombia, Peru and Florida, USA.), was based within the overall framework of the Latin American Network for the Social Study of Disaster Prevention - LA RED. Comparative research on changing risk patterns associated with ENSO over the last 35 years and the role of social variables in such changes and the explanation of loss and damage was based on the creation of a series of national and a regional data base on damaging events associated with ENSO and climatic variability in the 8 countries. The information was provided at a high spatial scale of resolution (municipalities, districts, etc.) which required advances in the construction of a regional internet based documentation system.

The database (DESINVENTAR) built on all damaging hydrometeorological events over the period 1970 to 2003 in the different project countries, is unique in the region. These data sets, covering ENSO and non-ENSO years, allow analysis at a high scale of spatial resolution which is of use to national and local level decision makers and permits an understanding of changing temporal, spatial and semantic patterns of event occurrence and the attendant impacts at a social level. As such it is an invaluable, public domain source of information for policy makers, researchers and others.

Although most attention has been paid to the physical side of ENSO (and associated hazard disturbances - excessive rainfall, landslides, drought, disease vectors etc.), the most important controllable impact on loss levels, risk and future disaster will be determined by social vulnerability. The resilience and capacity for adjustment and adaptation of society are critical factors. Any consideration of the challenges for policy and practice associated with these phenomena must automatically integrate the discussion of "ENSO risk" with a more wide ranging consideration of such phenomena as annual climatic variability and future Global Climatic Change.

Amongst the major challenges for implementation of risk management practice relating to the Niño and Niña which derive from research results, the following considerations derive from the CRN's output:

For Central American countries, for example, the types of hazards associated with ENSO are also common in the region under normal annual patterns of climatic variability, whereas in the north of Peru or north-west Argentina the ENSO risk patterns are almost unique. These differences have much importance for decision making and the structuring of integral risk management practice.

Comparative national research results showed varying temporal and spatial patterns of loss and damage during different ENSO periods. This changing spatial and social incidence of associated hazards in different Niño periods generated a contradiction between the improving ability to predict the occurrence of the ENSO phenomena at a global or national scale and the increasing difficulty of predicting particular impacts at the local scale. Moreover, local impacts were very much conditioned by human vulnerability patterns and changes such that the hazard side of the equation, which has received far more attention, increasingly assumes a lower predictive power as to loss and damage. This result has important practical implications: the reconciliation of the contradiction between the local nature of risk and centrally, technocratically, controlled intervention decisions and mechanisms that make popular participation difficult and ignore local rationales and needs must be overcome.

The project demonstrated the need to consider the Niño in the light of climate variability and change and not as an independent and autonomous phenomenon. Results showed that ENSO risk must be considered in the light of climatic risk in general. There can be no special ENSO risk management set up but, rather, an integral risk management system for the country or local area which takes into accounts not only ENSO risk but also other more recurrent risks. The patterns of social change and adaptation that occur under annual hazard conditions are part of the changing social matrix in which ENSO risk patterns exist.

Project results have been made available to different decision making sectors through conferences, seminars and publications or have been incorporated into new projects undertaken by team members in the different countries. Training and educational modules developed will permit more widespread impact through such channels.

A broader link between climate variability and human condition was established by CRN- 038, a **Multi-objective Study of Climate Variability for Impact Mitigation in the Trade Convergence Climate Complex** (PI: M. Pilar Cornejo R. De Grunauer). The project was suspended in 2002 for administrative reasons, and the results pertain to two years of operation.

CRN-038 was comprised of two groups, one analyzed physical processes and the second human dimensions of climate variability. Results for the Caribbean suggested that interannual variability in the early season (May–June–July) is influenced strongly by anomalies in the sea surface temperatures of the tropical North Atlantic, with positive anomalies over a narrow latitudinal band (0–20 N) being associated with enhanced Caribbean rainfall. The coincidence of this band with the main development region for tropical waves suggests a modification of the development of the waves by the warmer tropical Atlantic. The strong influence of the tropical North Atlantic wanes in the late season (August–September–October), with the equatorial Pacific and equatorial Atlantic becoming more significant modulators of interannual variability. A significant spatial correlation suggests an influence of the El Niño/La Niña, with a warm Pacific associated with a depressed late season and vice versa. There also seemed to be a robust relationship between late season Caribbean rainfall and an east-west gradient of sea surface temperature (SST) between the two equatorial oceanic basins. Oppositely signed SST anomalies in the NINO3 region and the central equatorial Atlantic (0 –15 W, 5 S–5 N) are well correlated with Caribbean rainfall for this period.

Using 94 daily rain gauge stations, the mean dominant annual cycles in the Central American region were calculated using empirical orthogonal functions analysis. This allowed determination of

some important aspects of this cycle such as the start and end of the rainy season and the mid summer drought. Some latitudinal variations were found in these variables. The region was dominated by one mean annual cycle that captured 72% of the variance. This cycle involved the latitudinal migration of the ITCZ, the seasonal variation of latent heat flux, and low level wind and its interaction with local orography. The second important annual cycle explains only the 8% of the variance, principally in stations located over the Caribbean Coast of Honduras, Costa Rica and Panama. At the interannual scale, the wettest (driest) years in the region were dominated in general by warmer (colder) sea surface temperature in the tropical Atlantic compared with the eastern tropical Pacific.

Monthly data on rice and maize crops was collected and related to meteorological information on air temperature, precipitation and relative humidity for seven stations for the period 1970-1999. Based on these data, risk analysis maps were constructed for rice and maize crops in the Guayas-Los Ríos and Manabí provinces, as a function of geographical position, excess precipitation in each of the highest intense months and the zonation of low lands. The foundations were laid out for yield prediction models, but were not carried out

In Ecuador, the group provided a climate alert system, ACUICLIMA (http://www.cenaim.espol.edu.ec/acuiclim/alerta.htm), which is updated weekly. The system has improved the analysis of data of the oceanographic station "El Pelado" off Ecuador. Another important result of the Ecuadorian studies is that heat balance occurs on ENSO scales and that the fortnightly component of the tides is important in the variability of the depth of the 20°C isotherm which shows evidence of remote and local forcing. The strong relationship between climate, mainly defined by ocean temperature, with shrimp production is a factor of high economic interest.

Human health risks associated with climate change were examined in CRN 048, **Diagnostics and Prediction of Climate Variability and Human Health Impacts in the Tropical Americas** (PI: Ulisses Confalonieri) which identified linkages between climate (temperature, rainfall, humidity), land use/land cover changes and the seasonal and interannual dynamics of malaria and dengue fever.

Peaks of dengue incidence were detected 2 months after peaks in temperature and sometimes were coincident with peaks in precipitation and/or humidity. Application of Simple Linear Models and Transference Function Models to series of dengue data and climatological variables showed that, although the dengue-climate relationship was not linear, it was possible to detect a significant relation between the disease and some climatic variables, usually with a lag time. With the simple linear models it was observed that the monthly incidence was related significantly to the incidence from 1 to 3 months before. The Transference function models have represented the dengue/climate relations very well and it was possible to model the number of cases as well as the incidence simultaneously. However, the high variability in the equation of the effects has shown that only one climate variable did not explain the variability in incidence rates.

The analysis of the influence of rainfall on malaria incidence yielded heterogeneous results, due to non-climatic factors. Positive and negative correlations were obtained, with lag periods ranging from 1 to 6 months; the correlations were strongest at 4-months time delay. Precipitations occurring in the driest months of the year were the most predictive of malaria in Roraima, Brazil. With a log transformation of the disease incidence data the ENSO Index became significant. The project concluded that the transmission of malaria is a complex ecological system. Among the variables affecting malaria incidence are rainfall, temperature and humidity which have a major impact in the life cycle of insect vectors. Other variables modify the impact of climate. Topography, geomorphology, vegetation and human interventions contribute to an epidemiological response with different characteristics in time and space.

Overall, the results demonstrated linkages between ENSO and malaria in Colombia and provided the basis for the development of a Geographical Information System for the study of malaria and climate. In the Caribbean islands and in southern Mexico a link was shown between dengue

epidemiology and climate variability. ENSO-induced drought was shown to reduce malaria transmission in parts of the Brazilian Amazon. But this relationship was modified by social-environmental vulnerability factors to malaria. In Venezuela population dynamics of mosquito vectors of malaria were linked to meteorological variables. Examining life cycles of vectors in more detail, meteorological/hydrological influences were documented on the breeding sites of mosquito populations in both savanna and forest areas in the Amazon.

A mathematical model and simulation were promising tools to analyze the entomological, epidemiological, and climatic interactions related to malaria transmission, and to point towards practical mitigation and human health control interventions. The scientific results were applied to the design of climate-health early warning systems with the aim of optimizing scarce resources from health systems in developing countries in the Americas. Since researchers in this project were frequently based in governmental health departments, these scientific results were very effectively translated into policies and action aiming to protect the health of affected populations.

Several CRNs were primarily concerned with climate and climate change.

Among them was CRN 055, a **regional program for the Study of Regional Climate Variability and Changes, their Prediction and Impact in the MERCOSUR Area** (PI: Mario Nunez), which studied the physical processes of extreme events in the MERCOSUR area, principally in the context of the South American Low Level Jet Field Experiment. Results were fed into models to investigate regional climate variability and changes, and an attempt was made to assess the degree of understanding of these extreme events by stakeholders and population.

Climate over Brazil showed complex rainfall variability over time and space driven by both global and regional phenomena. At interannual and greater scales, El Niño (ENSO) acts mainly over the northeast, Amazonia and south Brazil. The Pacific Decadal Oscillation (PO), the Antarctic Oscillation (AO) and the SST of Atlantic Ocean appear to be the principal forcing at interannual scales of rainfall variability over northeast Brazil, Amazonia and the South Atlantic Convergence Zone (SACZ). Annual rainfall from 1951 to 2000 showed a positive trend over southern Brazil (+180 to +200 mm/ decade) and a negative trend (-180 to -200 mm/decade) over the extreme northwest of Amazonia and some regions of southeast Brazil.

A global vegetation model was used to calculate 12 biome types under 5 climate parameters. The model, coupled to CPTEC AGCM, was used to search for multiple equilibrium states between vegetation and climate for current climate conditions. Two stable states were found for tropical South America: one corresponds to the current biome distribution and the other to a situation in which savannas replace tropical forest in the eastern Amazonia and a semi-desert replaces dry shrub land in parts of NE Brazil. A move from one equilibrium to the other was precipitated by perturbations such as drought, or by radical changes in the biomes of South America as a result of global warming. Under different climate change scenarios for this century there is a probability of profound biome changes in South America with replacement of 30 to 50% of tropical forests in Amazonia by savannas, semi-desert vegetation in NE Brazil and southward expansion of the subtropical Atlantic forest.

Within this project, a multinational and interdisciplinary team from Argentina, Brazil, Paraguay, Uruguay and the United States published more than 40 Journal articles or book chapters and organized 4 workshops. Modeling the research results from the project helped to produce *regional climate change scenarios* for the Second National Communication on Climate Change of Argentina, and a regional climate model has been produced for Uruguay to produce climate scenarios for the Third National Communication of Uruguay. Most of the scientists collaborating in the CRN have participated in the South America low level jet experiment (SALLJEX). As a result of the program, some are now also participating as Principal Investigators in CLARIS, a Europe – South America cooperative research network, supported by the European Commission.

South American climate was linked to oceanic processes in CRN 061, an **International Consortium for the Study of Global and Climate Change in the South Atlantic** (PI: Edmo Campos), based on a network of scientists and institutions in Argentina, Brazil, Uruguay and USA.

Basin scale general circulation and climate studies examined the South Atlantic role on interocean exchanges and global thermohaline circulation, the mechanisms of South Atlantic interannual SST variability and the variability of Southwestern South Atlantic fronts.

The project showed that the migrations of the Brazil – Malvinas Confluence at seasonal time scales pivot from a N-S orientation in winter to a NW-SE orientation in summer, caused by the decoupling of the surface layer from the main flow at depth during the austral summer. This is in contrast with the traditional view of the confluence, which suggested extensive seasonal shifts, of the order of 1000 km, along the continental shelf break of eastern South America. Analysis of ocean color combined with SST in the Argentine Basin has considerably refined previous classifications of SW South Atlantic biophysical provinces. The uneven distribution of SST data in the pre-satellite era (before 1981) in the South Atlantic can create spurious variability patterns when analyzed with empirical orthogonal functions (EOFs) in the space domain. Results based on EOF on the time domain, however, lead to more realistic variability structures. This is particularly important because changes associated to data coverage can be incorrectly associated to climate changes.

Previous knowledge of the southeast South America continental shelf was fragmentary, partly due to the sparse synoptic data coverage across political boundaries. The analysis of *in-situ* hydrographic, remote sensing, and atmospheric reanalysis data, together with regional numerical models and new data collected during this CRN project provided a novel view of the three dimensional water mass distributions, the identification of previously undocumented frontal regions. High resolution regional modeling efforts over the continental shelf, forced by winds, tides, continental runoff and deep ocean circulation, have clearly demonstrated the sensitivity of the simulations to wind forcing. This result suggests that numerical model outputs must be interpreted with great caution, particularly over the continental shelf.

Based on satellite derived ocean color, the continental shelf of the southwest South Atlantic experiences one of the largest increases in primary production in the oceans. The CRN has confirmed this trend and revealed that the growth is limited to the continental shelf off Patagonia and is due, primarily, to increased chlorophyll during the austral spring and summer. Increased primary production is thought to be a consequence of global change. The decrease in SST over the shelf seems to confirm this hypothesis.

Regional Studies evaluated the Plata River impact on the SW Atlantic shelf providing input to SW Atlantic shelf modelling which permitted the evaluation of seasonal and interannual variability of the Shelf break front. Interdisciplinary field work, including oceanographic cruises and airborne surveys were without precedent in Latin America. Training and education activities were directly linked to the research through on-board short courses during the PLATA oceanographic cruises. Four advanced, international short courses, attended by over 80 students from several IAI member countries were organized, and more than 40 young scientists and graduate students were trained.

CRN 062, **Eastern Pacific Consortium for Research on Global Change** (PI: Timothy Baumgartner) was a collaborative network of research and education centers in Chile, Peru, Ecuador, Colombia, Costa Rica, Mexico, the United States and Canada aiming to evaluate and anticipate the impacts of global change on coastal and oceanic ecosystems, along with their social and economic consequences, including the combined effects of natural climate variability, human-induced changes on the natural climate system and direct human intervention on coastal and oceanic marine ecosystems through harvesting and other types of habitat alteration. The project was linked to goals of the IGBP (core projects of GLOBEC and PAGES), CLIVAR of the WCRP, and GOSS program of IOC. The principal

research activities involved retrospective-comparative studies to create knowledge base, modelling diagnostics at basin- and regional scales, regional ocean surveys and coastal monitoring.

The ocean-climate system affects climate over land and therefore the functioning of terrestrial ecosystems. This link, and its impacts on agricultural sustainability was explored by CRN 073, **Climate Variability and its impacts in the Mexico, Central America and Caribbean Region** (PI: Víctor Magaña). Much of the progress in climate prediction systems which has helped to reduce the negative impacts of potentially adverse climate or to take advantage of probable adequate climate conditions has been driven by studies on the impacts of El Niño. This CRN aimed to replicate this progress in the Mexico, Central America and Caribbean region based on research with participants from the US, Mexico, Costa Rica, Colombia, Cuba and Jamaica. It examined the characteristics of the annual cycle of precipitation and temperature in the region, specifically the so-called Mid Summer Drought (MSD), a relative minimum in precipitation in the middle of the rainy season (July and August) characterized by slightly less rain than the other summer months (June and September) in most of Mesoamerica. Farmers in the region have requested information on the intensity of the MSD because it influences the productivity of crops like maize.

The project results provided an improved explanation for the MSD in terms of direct zonal circulations that result in teleconnections between the Northeastern Pacific and the Caribbean warm pools. The Caribbean Low Level Jet appears to play a role in the teleconnection through the exchange of energy with easterly waves that travel from the Caribbean to the Pacific or through the gap flow across the Papagayo Isthmus that cools the NE Pacific warm pool. The complex interactions have spatial scales that are not well resolved by current General Circulation Models used to predict seasonal climate anomalies. Such spatial details will be necessary for decision makers to plan their activities considering climate information.

The CRN therefore constructed a regional climate model that combines the NCAR CCM3 and the mesoscale model known as MM5 to explore the possibility of reproducing such small scale features. In addition, an ensemble prediction system was tested to construct the probability density functions that best represent the probabilities of significant anomalies in climate or those exceeding a threshold value in some climatic parameter that results in negative impacts on a socioeconomic sector. Predicting the annual cycle of precipitation by examining the dynamics of the MSD and the Caribbean Low Level Jet constituted a challenge due to the scarcity of data on the warm pools that surround Mesoamerica.

Effectively using climate information in various societal sectors was found to be not an easy task due to the limited capacity for climate risk management among stakeholders. Consequently, in the final stages of the project mechanisms were developed to communicate climate information in terms more easily handled by decision makers. This goal constituted an important capacity building process in the region and will require several more years for stakeholders of the region to understand the value of a seasonal climate forecasts.

Request from government officials for advice on climate, water, agriculture and forests has made CRN73 a reference point for studies on climate variability and change. Most of the PIs maintain close collaboration and thanks to the improved understanding of the climate in the region, they have been invited to participate in Scientific Advisory Committees for various regional climate projects such as the North American Monsoon Experiment, a regional project financed by GEF on capacity building in the climate change adaptation process and new initiatives such as NOAA's Intra Americas Seas Program.

Activities and Findings – Training & Development

The CRN program contributed significantly to training and development of regional human resources and the improvement of the capacity to deal with global environmental change issues and their socio-economic impacts. Capacity building was an integral part of all projects under CRN and opportunities were provided through various mechanisms:

1. Training students through participation in (thematic) courses or workshops
2. Scholarships at undergraduate, graduate, PhD or PDF level in particular to nationals from Latin American and Caribbean IAI member countries
3. Research fellowships.

In total, CRN supported 619 students and young researchers to complete their degree from 1999 through 2005 (see Table 1).

Most CRNs provided a mixture of the three above mechanisms. CRN 003 (Luckman) took a different approach. The project trained a large number (129) of students, but did not provide any substantial scholarships to individual students, placing emphasis on provision of hands-on training, dendrochronological fieldweeks or attendance of special courses instead.

CRN promoted 177 workshops in the Americas. The program provided opportunities for 1,954 students & young professionals to participate and present their work in conferences, seminars, workshops or training courses (Table 2).

Table 1:

Resume of CRN´s Students

	PDF	**PhD**	**M.Sc**	**Undergrad**	**Others**	**Total**
CRN-001	0	16	54	25	5	100
CRN-003	3	21	33	50	22	129
CRN-009	0	12	3	3	3	21
CRN-012	2	5	1	0	1	9
CRN-026	0	10	9	6	6	31
CRN-031	0	7	9	0	10	26
CRN-040	0	16	13	0	65	94
CRN-047	0	0	19	14	8	41
CRN-048	1	5	12	12	4	34
CRN-055	1	9	4	10	0	24
CRN-061	0	14	14	16	10	54
CRN-062	0	7	3	0	0	10
CRN-073	1	8	17	20	0	46
TOTAL	8	130	191	156	134	619

Table 2:

Resume of CRN´s Workshops

PROJECT	WORKSHOPS	STUDENTS
CRN-001	36	100
CRN-003	17	318
CRN-009	16	85
CRN-026	8	13
CRN-040	14	207
CRN-047	7	564
CRN-061	12	121
CRN-073	7	131
CRN-031	38	312
CRN-048	11	23
CRN-062	11	80
TOTAL	**177**	**1954**

** Information collected from the CRN´s Reports*

Outreach Activities

Projects within the CRN program had varying approaches to outreach. While some developed few outreach activities, others maintained extensive contacts with international programs and fora, communities, civic and producer organizations. Several projects published in popular as well as scientific journals. The projects reported the following specific activities:

CRN 001 had a largely agricultural orientation and offered workshops to train producers on different land management options developed by the project in the different countries. Information on the cultivation and uses of Opuntia in NE Brazil was assembled in a book that has been published for use by producers, students and researchers. A number of "Practical Manuals" that will merge scientific and farmers knowledge brought together with the collaboration of an NGO (ASPTA) and leaders of farmer's associations are being prepared at the end of the project will cover four main themes: 1) Agroecological management of soil fertility within family farms; 2) Introduction, management and uses of trees within family farms; 3) Agroecological control of agricultural pests and diseases within family farms; and 4) Management of stocks of water and forage within family farms. The printing costs of these manuals will be funded by CNPq with an expected publication date late in 2006.
A CD with the Diagnosis for the Forest Development Program of Yucatan has been prepared and distributed to the municipalities that participated in the project, together with Fundacion Produce Yucatan A.C., Secretaria de Recursos Naturales and the Secretaria de Ecologia from the Yucatan Government.

All laboratories involved in CRN 003 have undertaken local and/or regional workshops about dendrochronology and its applications plus demonstration of laboratory facilities to school groups, students etc. The Laboratory in Mendoza has provided Spanish translations of materials for the NOAA web site. This and other specific promotional materials (videos and brochures) were prepared by individual Co-investigators. Since September 2003 group in Valdivia has mounted a traveling exhibit

in Chile entitled "Alerce (Fitzroya cupressoides), millennial witnesses of climate and environmental change in Southern Chile" that was partially sponsored by the CRN. This exhibit has illustrated work on climate and fire reconstruction from alerce tree-rings, and also emphasizes the conservation problems of this species. Sofar it was shown in Puerto Montt, Valdivia, Frutillar, and Osorno and on Chiloé Island.

CRN 009 held numerous meetings, for instance with the town mayors of Xapurí, Uruará, Redenção, with the Union of Rural Workers and producer organizations in Redenção, the Association of Settlement Areas (ASSEMA), the Agroextractive Cooperative of Lago do Junco (COPPALJ), and the Association of Women Producers of Palm Oil (AMTR), all in Maranhão, Brazil.
The CRN's team in Peru shared the project findings with policy makers at the state and national level. The investigator, Muñoz, was interviewed repeatedly concerning the group's conclusion that the promotion of cattle ranching could slow deforestation in the Tingo Maria region because pasture grasses were shown to be well adapted to soils depleted by the cultivation of recently eradicated coca.

The field experiment set up as part of CRN 040 near Brasilia has been used to teach a climate change course "The Ecology behind the Carbon Cycle" aimed at policy makers, NGOs, the private sector, consultants, and teachers with the goal to provide a multidisciplinary understanding of climate change, and to provide a national and international perspective to global environmental change to students. It has been funded by International Institute of Education of Brazil and the Netherland's Embassy in Brazil. 65 students have been trained during 2001- 2003.
Also in Brasilia, there have been outreach activities with Ministry of Science and Technology of Brazil and the "The Large Scale Biosphere- Atmosphere Experiment in Amazonia (LBA)" through the project "The Effects of Rainfall Exclusion on Canopy Phenology, Water Dynamics, Carbon, Nutrients, and Survival of Plants of the Cerrado - Projeto Seca-Cerrado" and the project "The present and future effects of ground fires on forest carbon stocks, metabolism, hydrology and economic value in Amazonia and the Cerrado".
Carlos Klink organized a workshop in Brasilia with UNESCO-MAB and SCOPE "Socioeconomic aspects of emerging ecosystems" in 2003, which was addressed especially to stakeholders, social and natural scientists and government officials. Michele Ataroff co-organized the workshop "Andean Cloud Forests" with Alejandro Brown in the "IV International Symposium on Sustainable Development in The Andes (AMA-Mérida 2001)". AMA is the "Andean Mountain Association", an organization of scientists, institutions, producers and stakeholders.

Outreach activities in CRN 047 mainly took the form of environmental education in local schools and the involvement of Earthwatch volunteers in field sampling activities. Students from nine Peruvian secondary schools became involved in the GLOBE (Global Learning through Observations to Benefit the Environment) Program (www.globe.gov) with local scientists for a hands-on learning experience. Schools were equipped with weather stations, and water and soil test kits to allow the students to participate fully in GLOBE and to interact with similar-age students from over 80 other countries that also participate in GLOBE. The most important innovation of this project from a GLOBE perspective was that it linked scientists already working in the region with school children and their communities to provide support for environmental research and management programs in their own region. Most other schools participating in the GLOBE Program interact only with US-based scientists and then those interactions are exclusively via internet. These activities were a collaborative effort between Florida International University, the University of Miami, and the National Agrarian University of Peru. Students and teachers from the participating schools made environmental measurements and incorporated the monitoring activities into an environmental curriculum tied to the GLOBE program. This curriculum has been designed to facilitate the learning of science by use of the inquiry process. Its

learning activities use data collection as the point of departure to broaden the students' environmental knowledge and perspectives through communication with fellow students around the world and with scientists who utilize the data in their research.
GLOBE activities have been expanded now involving 5 local schools in the area of Oxapampa, 188 students form 4-12th grade, and 11 teachers. Students in the program are involved in water quality measurements, river level readings, mapping, river clean up events, riparian reforestation, and identification of contamination input points. Other activities include; plant identifications, meteorological data collection, herbarium work, and recycling projects. Students in the program participated in Forestry Week and took first place in the 2004 Regional Science Fair in the categories of Earth and Space Sciences, and Technology and Engineering. Other local organizations (ProNaturaleza, INRENA, MBG, DIGESA, Oxapampa Hospital Environmental Health Department) also became involved in the activities.
The CRN project in Oaxpampa, Peru, also co-hosted the local 2004 World Environmental Day celebration. In 2002, 4 teams of Earthwatch volunteers investigated aquatic biodiversity in the region and related this to the resource needs of local people.

CRN 048 on climate effects on dengue and malaria naturally had strong links with local and national health organizations, health ministries, hospitals and practitioners. Training of field and administrative staff personal belonging to the Colobian Ministry of Social Protection (Health Division) and the Colombian National Institute of Health in Bogotá, the Chocó and Antioquia Regional Health Services, focused on malaria entomology and climate-related issues.
Meetings were regularly conducted during 1999-2006 with the personal of the Regional Health Service of Antioquia, regarding to El Niño event, and the establishment of measures to help to develop prevention campaigns for malaria incidence.
Collaborations were also initiated with Fundacion Natura (NGO), CodeChoco (Regional Environmental Agency of Choco), Nuqui Hospital Major of Nuqui, Fundacion para el Desarrollo Humano y Sostenible del Choco (ONG).

CRN061 published a number of its findings in popular journals:
El impacto del Plata sobre el océano Atlántico, Ciencia Hoy, 14, 28-37, Buenos Aires, Argentina, August-September 2004, in Spanish. (http://www.ciencia-hoy.retina.ar/hoy82/index.htm)
El Mar desde adentro, Revista Aventura, May 2005, Buenos Aires, 54-59. Article about experimental oceanography, with emphasis on the Plata and the IAI. (http://www.aventurasur.com/), in Spanish.
O impacto do rio da Prata no oceano Atlântico, Ciencia Hoje, 216, 30-37, Rio de Janeiro, Brazil, June 2005. (http://cienciahoje.uol.com.br/controlPanel/materia/view/209), in Portuguese.

It also provide several outreach presentations to non-scientific audiences
Campos, E.J.D. 2002: The Use of Numerical Models in Oceanic Fishculture. 1o. Encontro Internacional de Agronegocios em Pesca e Aquicultura. Santos, Sao Paulo, 20/05/2002. Invited.
Campos, E.J.D., 2002: O emprego de modelos matemáticos no estudo da dispersão de manchas de óleo em regiões costeiras e oceânicas. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renovaveis (IBAMA). Rio de Janeiro, 20/10/02. Invited
Piola, A.R., 2004, El Atlántico Sur y el Cambio Global, Ciencia Tecnología y Sociedad, Conferencias de Divulgación Científica, Asociación Argentina para el Progreso de la Ciencia and Sociedade Brasileira para o Progresso da Ciéncia, Buenos Aires. Invited
Piola, A.R., 2001, El Océano y el Clima, International Federation of Maritime Associations and Navy Leagues, Buenos Aires, Argentina, noviembre 2001. Invited.
Two videos were prepared:

Proyecto NICOP-LAPLATA, documentary film based on footage taken during the Plata airborne and in-situ experiments. Produced by the Ocean Dynamics Section of Servicio de Hidrografía Naval, Argentina. Presented at several meetings, available at IAI (in Spanish).
Plata Airborne Salinity Survey, documentary film of installation of STARRS airborne salinity mapper on Uruguayan Airforce Aviocar 212. Produced by the Departamento Técnico, Servicio de Sensores Remotos Aeroespaciales, Fuerza Aérea Uruguaya.

Projects within the CRN program had varying approaches to outreach. While some developed few outreach activities, others maintained extensive contacts with international programs and fora, communities, civic and producer organizations. Several projects published in popular as well as scientific journals. The projects reported the following specific activities:

CRN 001 had a largely agricultural orientation and offered workshops to train producers on different land management options developed by the project in the different countries. Information on the cultivation and uses of Opuntia in NE Brazil was assembled in a book that has been published for use by producers, students and researchers. A number of "Practical Manuals" that will merge scientific and farmers knowledge brought together with the collaboration of an NGO (ASPTA) and leaders of farmer's associations are being prepared at the end of the project will cover four main themes: 1) Agroecological management of soil fertility within family farms; 2) Introduction, management and uses of trees within family farms; 3) Agroecological control of agricultural pests and diseases within family farms; and 4) Management of stocks of water and forage within family farms. The printing costs of these manuals will be funded by CNPq with an expected publication date late in 2006.
A CD with the Diagnosis for the Forest Development Program of Yucatan has been prepared and distributed to the municipalities that participated in the project, together with Fundacion Produce Yucatan A.C., Secretaria de Recursos Naturales and the Secretaria de Ecologia from the Yucatan Government.

All laboratories involved in CRN 003 have undertaken local and/or regional workshops about dendrochronology and its applications plus demonstration of laboratory facilities to school groups, students etc. The Laboratory in Mendoza has provided Spanish translations of materials for the NOAA web site. This and other specific promotional materials (videos and brochures) were prepared by individual Co-investigators. Since September 2003 group in Valdivia has mounted a traveling exhibit in Chile entitled "Alerce (Fitzroya cupressoides), millennial witnesses of climate and environmental change in Southern Chile" that was partially sponsored by the CRN. This exhibit has illustrated work on climate and fire reconstruction from alerce tree-rings, and also emphasizes the conservation problems of this species. Sofar it was shown in Puerto Montt, Valdivia, Frutillar, and Osorno and on Chiloé Island.

CRN 009 held numerous meetings, for instance with the town mayors of Xapurí, Uruará, Redenção, with the Union of Rural Workers and producer organizations in Redenção, the Association of Settlement Areas (ASSEMA), the Agroextractive Cooperative of Lago do Junco (COPPALJ), and the Association of Women Producers of Palm Oil (AMTR), all in Maranhão, Brazil.
The CRN's team in Peru shared the project findings with policy makers at the state and national level. The investigator, Muñoz, was interviewed repeatedly concerning the group's conclusion that the promotion of cattle ranching could slow deforestation in the Tingo Maria region because pasture grasses were shown to be well adapted to soils depleted by the cultivation of recently eradicated coca.

The field experiment set up as part of CRN 040 near Brasilia has been used to teach a climate change course "The Ecology behind the Carbon Cycle" aimed at policy makers, NGOs, the private sector,

consultants, and teachers with the goal to provide a multidisciplinary understanding of climate change, and to provide a national and international perspective to global environmental change to students. It has been funded by International Institute of Education of Brazil and the Netherland's Embassy in Brazil. 65 students have been trained during 2001- 2003.
Also in Brasilia, there have been outreach activities with Ministry of Science and Technology of Brazil and the "The Large Scale Biosphere- Atmosphere Experiment in Amazonia (LBA)" through the project "The Effects of Rainfall Exclusion on Canopy Phenology, Water Dynamics, Carbon, Nutrients, and Survival of Plants of the Cerrado - Projeto Seca-Cerrado" and the project "The present and future effects of ground fires on forest carbon stocks, metabolism, hydrology and economic value in Amazonia and the Cerrado".
Carlos Klink organized a workshop in Brasilia with UNESCO-MAB and SCOPE "Socioeconomic aspects of emerging ecosystems" in 2003, which was addressed especially to stakeholders, social and natural scientists and government officials. Michele Ataroff co-organized the workshop "Andean Cloud Forests" with Alejandro Brown in the "IV International Symposium on Sustainable Development in The Andes (AMA-Mérida 2001)". AMA is the "Andean Mountain Association", an organization of scientists, institutions, producers and stakeholders.

Outreach activities in CRN 047 mainly took the form of environmental education in local schools and the involvement of Earthwatch volunteers in field sampling activities. Students from nine Peruvian secondary schools became involved in the GLOBE (Global Learning through Observations to Benefit the Environment) Program (www.globe.gov) with local scientists for a hands-on learning experience. Schools were equipped with weather stations, and water and soil test kits to allow the students to participate fully in GLOBE and to interact with similar-age students from over 80 other countries that also participate in GLOBE. The most important innovation of this project from a GLOBE perspective was that it linked scientists already working in the region with school children and their communities to provide support for environmental research and management programs in their own region. Most other schools participating in the GLOBE Program interact only with US-based scientists and then those interactions are exclusively via internet. These activities were a collaborative effort between Florida International University, the University of Miami, and the National Agrarian University of Peru. Students and teachers from the participating schools made environmental measurements and incorporated the monitoring activities into an environmental curriculum tied to the GLOBE program. This curriculum has been designed to facilitate the learning of science by use of the inquiry process. Its learning activities use data collection as the point of departure to broaden the students' environmental knowledge and perspectives through communication with fellow students around the world and with scientists who utilize the data in their research.
GLOBE activities have been expanded now involving 5 local schools in the area of Oxapampa, 188 students form 4-12th grade, and 11 teachers. Students in the program are involved in water quality measurements, river level readings, mapping, river clean up events, riparian reforestation, and identification of contamination input points. Other activities include; plant identifications, meteorological data collection, herbarium work, and recycling projects. Students in the program participated in Forestry Week and took first place in the 2004 Regional Science Fair in the categories of Earth and Space Sciences, and Technology and Engineering. Other local organizations (ProNaturaleza, INRENA, MBG, DIGESA, Oxapampa Hospital Environmental Health Department) also became involved in the activities.
The CRN project in Oaxpampa, Peru, also co-hosted the local 2004 World Environmental Day celebration. In 2002, 4 teams of Earthwatch volunteers investigated aquatic biodiversity in the region and related this to the resource needs of local people.

CRN 048 on climate effects on dengue and malaria naturally had strong links with local and national health organizations, health ministries, hospitals and practitioners. Training of field and administrative staff personal belonging to the Colobian Ministry of Social Protection (Health Division) and the Colombian National Institute of Health in Bogotá, the Chocó and Antioquia Regional Health Services, focused on malaria entomology and climate-related issues.
Meetings were regularly conducted during 1999-2006 with the personal of the Regional Health Service of Antioquia, regarding to El Niño event, and the establishment of measures to help to develop prevention campaigns for malaria incidence.
Collaborations were also initiated with Fundacion Natura (NGO), CodeChoco (Regional Environmental Agency of Choco), Nuqui Hospital Major of Nuqui, Fundacion para el Desarrollo Humano y Sostenible del Choco (ONG).

CRN061 published a number of its findings in popular journals:
El impacto del Plata sobre el océano Atlántico, Ciencia Hoy, 14, 28-37, Buenos Aires, Argentina, August-September 2004, in Spanish. (http://www.ciencia-hoy.retina.ar/hoy82/index.htm)
El Mar desde adentro, Revista Aventura, May 2005, Buenos Aires, 54-59. Article about experimental oceanography, with emphasis on the Plata and the IAI. (http://www.aventurasur.com/), in Spanish.
O impacto do rio da Prata no oceano Atlântico, Ciencia Hoje, 216, 30-37, Rio de Janeiro, Brazil, June 2005. (http://cienciahoje.uol.com.br/controlPanel/materia/view/209), in Portuguese.

It also provide several outreach presentations to non-scientific audiences
Campos, E.J.D. 2002: The Use of Numerical Models in Oceanic Fishculture. 1o. Encontro Internacional de Agronegocios em Pesca e Aquicultura. Santos, Sao Paulo, 20/05/2002. Invited.
Campos, E.J.D., 2002: O emprego de modelos matemáticos no estudo da dispersão de manchas de óleo em regiões costeiras e oceânicas. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renovaveis (IBAMA). Rio de Janeiro, 20/10/02. Invited
Piola, A.R., 2004, El Atlántico Sur y el Cambio Global, Ciencia Tecnología y Sociedad, Conferencias de Divulgación Científica, Asociación Argentina para el Progreso de la Ciencia and Sociedade Brasileira para o Progresso da Ciéncia, Buenos Aires. Invited
Piola, A.R., 2001, El Océano y el Clima, International Federation of Maritime Associations and Navy Leagues, Buenos Aires, Argentina, noviembre 2001. Invited.
Two videos were prepared:
Proyecto NICOP-LAPLATA, documentary film based on footage taken during the Plata airborne and in-situ experiments. Produced by the Ocean Dynamics Section of Servicio de Hidrografía Naval, Argentina. Presented at several meetings, available at IAI (in Spanish).
Plata Airborne Salinity Survey, documentary film of installation of STARRS airborne salinity mapper on Uruguayan Airforce Aviocar 212. Produced by the Departamento Técnico, Servicio de Sensores Remotos Aeroespaciales, Fuerza Aérea Uruguaya.

Contributions

Contributions within Discipline:
The CRN projects covered a broad range of scientific disciplines in global change research and across the themes of the IAI Science Agenda and are too complex to be categorized into a principal disciplinary field.

The IAI Science Agenda is divided into four major themes. Most of the CRN projects address more than one of the four themes. In the following the CRNs are briefly described placing them into the IAI Science Agenda by the main subject they address. Seven of the projects have strong components in two

subjects: climate variability and human dimensions. Three of them (listed under theme I: *a., b.* and *c.*) are concerned specifically with the near-term climate variability of target regions within the Americas. A fourth project (listed under theme III: *a.*) explored the linkage between surface temperature changes in the Atlantic and climate variability in the Americas. A fifth project, (listed under theme I *d.*) pieced together a 500-year picture of climate variability in the Americas on the basis of the tree-ring record. Finally, two projects (listed under theme VI: *b.* and *c.*) examined in detail the implications of ENSO-related climate variability on disaster management and human health.

Theme I - Understanding Climate Variability in the Americas

The CRNs funded under this theme were:

a. Multi-Objective Study of Climate Variability for Impact Mitigation in the Trade Convergence Climate Complex Region.
b. Development of a Collaborative Research Network for the Study of Regional Climate Variability and Changes, their Prediction and Impact in the MERCOSUR Area.
c. Climate Variability and its Impacts in the Mexican, Central American, and Caribbean Region.
d. The Assessment of Present, Past, and Future Climate Variability in the Americas from Treeline Environments.

Three of these projects (*a., b.* and *c.*) were concerned specifically with the near-term climate variability of target regions within the Americas and the last one project (*d.*), used tree-ring records to understand past climate variability in the Americas.

Theme II - Comparative Studies of Ecosystem, Biodiversity, Land Use and Cover, and Water Resources in the Americas

The CRNs under this theme included studies that compared global change phenomena in various diverse environments, both coastal and terrestrial. The four studies advanced our knowledge of various global changes in terrestrial ecosystems, including those brought about by changes in land use. The subjects were:

a. Biogeochemical Cycles under Land Use Change in the Semiarid Americas.
b. The Role of Biodiversity and Climate in the Functioning of Ecosystems: A Comparative Study of Grasslands, Savannas, and Forests.
c. Effects on Vegetation in High Mountain and Tropical Savannah Ecosystems.
d. Andean Amazon Rivers Analysis and Monitoring (AARAM) Project.

Project *a.*, addressed the fundamental problem of measuring sustainability and ecosystem resilience in semiarid regions. In project *b.*, explicit connections between ecosystem health and biodiversity were examined. Project *c.*, was about building a functional cooperative scientific network to study the global effects of changes in vegetation in high-mountain and tropical savannah ecosystems. Project *d.*, was about developing a quantitative understanding of the effects of land use and climate variability on Andean Amazon river systems.

Theme III - Changes in the Composition of the Atmosphere, **Oceans and Fresh Waters**

The projects under theme III dealt with issues related to documenting and understanding processes that modify the chemical composition of the atmosphere, inland waters, and oceans in a manner that affects productivity and human welfare. CRNs under this theme were:

a. South Atlantic Climate Changes (SACC): An International Consortium for the Study of Global and Climate Changes in the Western South Atlantic.
b. Enhanced Ultraviolet-B Radiation in Natural Ecosystems as an Added Perturbation due to Ozone Depletion.
c. An Eastern Pacific Consortium for Research on Global Change in Coastal and Oceanic Regions (EPCOR).

Project *a.,* studied continental shelf impacts, seasonal climate, and South Atlantic sea-surface temperature variability and their effects on South American climate. Project *b*., developed a research network for assessing the ecological impact of increased ultraviolet-B radiation to South American ecosystems. Project *c.* employed several teams of scientists working to understand the implications of global change for the coastal resources of the Eastern Pacific.

Theme IV - Integrated Assessment, Human Dimensions and Applications

The human dimension element is an essential component of global-change research. Most CRN projects included this component, but—as mentioned earlier—three of them were especially strong in this regard. They were:

a. Cattle Ranching, Land Use, and Deforestation in Brazil, Peru, and Ecuador.
b. ENSO Disaster Risk Management in Latin America: A Proposal for the Consolidation of a Regional Network for Comparative Research, Information, and Training from a Social Perspective.
c. Diagnostics and Prediction of Climate Variability and Human Health Impacts in the Tropical Americas.

Project *a.* focused on understanding the social factors behind modifications in land use and land cover. These modifications are now recognized as major drivers of global change, especially in the Amazon. Project *b*. formed a team of social and natural scientists in an effort to improve the management of ENSO-related disasters in the South American countries; Project *c*. looked into the close linkages between human health and climate variability in impoverished communities in South America.

One measure for the impact of IAI research are publications in scientific journals, and the large number of presentations on IAI funded projects at scientific meetings, e.g. the American Meteorological Society, the Latin American Studies Association, the Open Science Conferences of International Geosphere Biosphere Program (IGBP) or the International Human Dimensions Program (IHDP). CRN has produced 283 publications in peer-reviewed scientific and technical journals (including such high impact journals as Nature, Science, Ecology or Journal of Climate) and 87 books/book-chapters across the various disciplines. Many more are expected to be published following the evaluation of the final results of the individual projects. More than 250 CRN related papers have been presented in symposia, congresses or seminars or as books or book chapters. The results of all projects are outlined in the Activities and Findings section of this report and in detail in the Final Technical Reports of the individual projects.

Beside the scientific contribution to the various disciplines, a major impact of CRN has been through its unique approach. CRN was not designed simply to support research, but to encourage synergistic efforts on the part of scientists working throughout the Americas on global-change problems of importance to the region.

- to improve understanding of regional global change phenomena;
- to set up international networks for research into global change issues;
- to produce information for policy- and decision-makers; and
- to expand scientific capacity in the Americas.

Effectively addressing *regional* global-change issues required an active scientific network that crosses international boundaries: scientists and scientific institutions working together in an integrated and collaborative fashion. The networks were designed to enable in-depth investigation of a broad range of pressing topics concerning global environmental change, they are highly multinational, multidisciplinary and involving both the natural and social sciences.

CRN has pioneered a new way of doing global change science, unique for the region and beyond. CRN is a combination of top science and regional networking. The approach started with a cycle of smaller scale programs preceding CRN and allowing for the systematic development of the final CRN networks. Each program was competitive and independently peer-reviewed, ensuring that only excellent science will succeed. The final projects approved under CRN represent a multi-layered and complex network of networks with collaborations at various levels:

- Within the individual projects across the institutions and the (natural and social sciences) disciplines involved;

- Between the individual projects dealing with different interlinked topics (e.g. land-use and ecosystem function under global change and climate stress);

- Between the CRN projects and other regional or global programs/institutions (e.g., APN, DIVERSITAS, IGBP, IHDP, PAHO, WCRP)

As an example of this complexity, CRN 048 "Diagnostics and Prediction of Climate Variability and Human Health Impacts in the Tropical Americas" involved institutions from Brazil, Colombia, Jamaica, Mexico, USA and Venezuela. The project had technical support from the Pan-American Health Organization (PAHO) and the participation of epidemiologists, ecologists, entomologists, climatologists, hydrologists, mathematicians and social scientists. It formed the largest network of institutions dealing with climate/health issues in the Americas.

The linkage between CRN and the global programs was specifically enhanced during the "Building Global Change Networks in the Americas" meeting in Mendoza, Argentina in January 2003. The meeting was organized jointly by the IAI and IGBP and brought together the CRN Principal Investigators and representatives from APN, DIVERSITAS, GCTE, GLOBEC, IAI, IGBP, IHDP, LOICZ, NSF, PAGES, START, WCRP. Through this meeting, the CRN science (and approach) received global recognition, new collaborations were created and existing collaborations further developed. Although the CRN approach is regional across the Americas, it was crucial to make the regional–global linkage. No region is isolated, they are teleconnected around the world and the meeting provided a platform for this connection within the CRN framework. (The meeting also resulted in a Memorandum of Understanding between IAI and IGBP). CRN scientists are now part of Scientific Committees of several core projects and CRN science is presented during major meetings of the global programs. The global recognition has not only led to enhanced dialogue with the global programs, but also with the international conventions. IAI has received observer status at the UNFCCC and UNCBD and is participating in their SBSTA meetings. The scientific results of several CRNs (e.g. Tiessen,

Sala) have also contributed to the creation of chapters for Intergovernmental Panel for Climate Change (IPCC) or the Millennium Ecosystem Assessment (MA).

The networks have not only advanced the regional knowledge of global change phenomena and their socioeconomic impacts, but simultaneously helped build a stronger and more cohesive global change science community across the IAI region with specific emphasis on the involvement of regional developing countries. The networks have forced the often isolated operating scientists to work and interact with each other, South-South and North-South. The resulting scientific interchange represents a major contribution to the enhancement of the regional capacity to deal with global change phenomena.

Contributions to Human Resource Development:

CRN made a substantial contribution to the development of human resources in the Americas mainly through 1) new approaches to global change research in the Americas and 2) capacity building of students and (young/early career) professionals under each CRN project.

The new network approach has forced scientists who often operated rather isolated to work and interact with each other, both in North-South and South-South linkages. Specifically the latter has received a substantial thrust under CRN. While in earlier programs the majority of proposals were led by North Americans, CRN developed many truly equal partnerships South - South and North – South, and has greatly increased Southern leadership. To quote Mike Brklacich, Chairman of the IAI Scientific Advisory Committee: "To me this has been one of the biggest success stories of the IAI: truly building capacity and fostering high quality science in Latin America".

Capacity building has been an integral part of all CRN projects. As outlined in the "Training & Development" section of this report, under CRN, opportunities have been provided for close to 2000 students who have been exposed to networking across national and disciplinary boundaries and to the international global change community through participation in conferences, seminars, workshops or training events. This is expected to feedback into the way global change research is done and the way research results are utilized in decision and policy making when those young professionals develop their careers and may take key positions in their governments or educational system. Some CRN efforts already bear fruit, e.g. the SACC short courses conducted under CRN 061 (PI Edmo Campos) will continue under CRN II (PI Alberto Piola) and the coordinator, Carolina Parada, University of Washington, is a former student of the 2nd SACC short course in 2001. "Looking across the CRN projects, I am struck by the incorporation of capacity building as an integral part of most projects and by the very large number of students involved. This is research-driven capacity building at its best, and a model that we hope to pursue in other regions" – Roland Fuchs, Director International START Secretariat.

The CRN networking approach has built a substantially stronger and more cohesive global change science community across the IAI region with specific emphasis on Latin America and the Caribbean. The scientific interchange represents a major contribution to the enhancement of the regional capacity to deal with global change phenomena and their socioeconomic impacts. The CRN contribution to institutional capacity building is incorporated in section "Contributions beyond Science & Engineering".

Contributions to Resources for Research and Education:

The CRN program has created multiple resources for Research and Education.

Numerous research infrastructure improvements occurred in cooperating laboratories and institutions. Beyond these "normal" improvements there are a number of major legacies.

The CRN and its researchers together with the IAI Directorate have developed and made operational the IAI DIS. The DIS is an Internet-based data and information system with the following objectives in focus: 1) Dissemination of data created within the IAI scientific projects by using a metadata creation and management process; 2) Data discovery; and 3) Contribute for the standardization and exchange of scientific data between investigators and institutions. The DIS Search Tool facilitates the identification of articles, presentations, posters and other information produced by the IAI Researchers. The DIS Harvest Process collects metadata that are marked as "searchable" by the Researcher and specially keep the metadata list up-to-date, and consequently the data list. A number of projects have contributed and are still contributing to the metadata stock in the DIS.

CRN 003 has created a number of new dendro laboratories, greatly improving regional capacities. Dendrochronology is labour- rather than capital-intensive. For this reason, a primary goal of the project has been to expand the availability and use of facilities and provide training in basic techniques. New laboratories were established in Durango (Mexico) and La Paz (Bolivia) in October 2000. The IAI funded a CRN-linked PESCA proposal (PESCA 018) to establish a similar laboratory at the University of Piura, Peru. This lab became operational in January 2001 and subsequently secured one year of funding from the IAI Small Grants Program.
These three laboratories serve regions with little or no prior expertise in tree-ring studies.
Dedicated IAI-funded staff were associated with the each facility and have undergone training at one of the senior laboratories in the CRN (Mendoza, Tucson, Lamont, or Arkansas). In 2004 IAI SGP II funds were awarded to Fidel Roig, Brazilian and Canadian colleagues to establish a dendrochronological laboratory at the Universidade Federal do Rio Grande do Sul, in Porto Allegre, Brazil. The technical components of this proposal utilized the model established by CRN03 for the new laboratories in Mexico, Bolivia and Peru. During the project the Mendoza Lab in Argentina has expanded and consolidated its role as the major tree-ring laboratory in the Southern Hemisphere. It has provided considerable training for Latin American scientists both in house and by short courses delivered at other facilities

The Amazonian River project established facilities and infrastructure that continue to support global-change research in Peru, Ecuador, and Colombia. The Andean Amazon Research Station in Oxapampa, Peru, is gaining regional recognition as a center of research and continues to be supported with funding from the Moore and MacArthur Foundations. The CRN has also left behind important infrastructure in the form of new and refurbished meteorological and river gauging stations: two new climate stations in Peru and a refurbished one in Ecuador. In Peru the station in the national park is being turned over to INRENA, and in Ecuador the station is operated by INAMHI. Five new permanent river gauging stations and two refurbished stations in Ecuador are being monitored by staff of the Andean Amazon Research Station in Peru. Colombian stations have been turned over to the Universidad de al Amazonia, and in Ecuador they are being operated by INAMHI.

The disaster management CRN had as its primary purpose the creation of disaster data bases for public and institutional consultation. DesInventar databases for Ecuador, Mexico, Peru, Costa Rica and Argentina were established and in combination with DesConsultar query modules provide a significant new base for research and extension in disaster management and monitoring. Several educational modules for post graduate teaching purposes were derived from the databases.

Contributions beyond Science and Engineering:

Impact on Societies and their Institutions:

Global change science is increasingly called upon to respond to societies concerns. Projects of the CRN program, responding to these concerns, have achieved numerous results beyond the science output. The proximity of scientists to practitioners and policy makers in environmental change issues has allowed policy makers to incorporate scientific knowledge into their decision making process, and scientists to guide their research towards problem-solving. This was analyzed in a workshop co-organized by IAI and SCOPE in November 2005. The workshop has resulted in a book "Making Global Change Research relevant to Policy Makers – Experience gained from 10 years of Research Networks in the Americas" that is currently under review and expected to be published under the SCOPE series in late 2006/early 2007. The following provides a brief synopsis of the CRN experience from this volume which concentrates on lasting and sometimes institutionalized relationships between science and different sectors of society.

Most research institutions in Latin America have relegated extension efforts largely to the level of secondary activities, although extension may well be an important link between universities and societies. Meanwhile, NGOs in developing countries have taken on extension roles and support the development of rural communities. Several CRNs have established lasting linkages to NGOs.

In NE Brazil, a regional network was developed between two universities (UFPE and UFPB), an NGO (ASPTA – Assessoria e Serviços a Projetos em Agricultura Alternativa), farmers' associations and local leaders which has been successful in linking stakeholders. In Central Argentina, collaboration between the University of La Pampa (UNLP) and INTA (Instituto Nacional de Tecnología Agropecuaria) agricultural cooperatives and NGOs such as AAPRESID (Asociación Argentina de Productores en Siembra Directa) and AACREA (Asociación Argentina de Consorcios Regionales de Experimentación Agropecuaria) developed the opportunity for activities directly relevant to the production sector and generated lasting networks.

Research conducted in Yucatan has been evaluated by State and Federal governments and used by the Secretaria de Medio Ambiente Recursos Naturales y Pesca (SEMARNAT) to develop a permanent system of corn production. The "Ecological Planning of the State of Yucatan"; and the "Forest Development Program of Yucatan State" funded by the Mexican government, Fundacion Produce Yucatan, A.C., and the Mesoamerican Corridor Project and are being coordinated by the CRN partners (PROTROPICO). This work continues and the plans will have a direct impact on landuse in the region for the coming decades.

The local engagement of NGOs has been important for immediate impact and application of research and capacity building. In the Andean Amazon national policies are largely irrelevant to the day to day realities of rural natural resource management. Local economies, authorities, institutions, and cultural practices exert the greatest controls over resource management and extraction (including water, wood, land, and wildlife). In this context, the strategy of an Amazonian CRN was to build partnerships with local governments and NGOs in the immediate vicinity of its field activities. The CRN also implemented an environmental education program in the local elementary schools which developed into an annual "Día del Río" event in which local school children host a mini fair in the town square, presenting drawings, models, and posters of their studies on river processes and good management practices. The most productive local partnerships were forged with development NGOs, whose staff proved to be excellent complements to the scientific technical teams. NGOs often make long term

commitments to working with individual communities, and they therefore enjoy a level of community trust that a 3-5 year research program could not hope to achieve. They understand community needs and are able to see linkages between technical studies and community development that our team members would not. The ideal NGO partner is linked to larger international actors and activities, such that they understand better the context of the research themes emphasized by the IAI. For example, the CRN's most effective NGO partners were ProNaturaleza (Peru), which is closely associated with The Nature Conservancy, the Instituto del Bien Común (Peru), which has close ties to the Woods Hole Research Center, and EcoCiencia (Ecuador), which has acted as the local implementer of several international initiatives.

Links to local communities and institutions and engagement of land users in data collection involved stakeholders as Participants, resulting in lasting capacity improvements.

Local actors were also involved in linking the results of a UV-B research projects to the perception of impacts in communities in Southern Argentina. Mediated modeling was used as a bridge between local stakeholders and investigators to extend the research to the general public. The model was built with STELLA (High Performance Systems Inc.) which uses four basic iconic building blocks: stocks, flows, auxiliary variables and connectors. The resulting conceptual model structure integrated both science and community thinking and discussion. As a component of the model "Ecosystem Services" provided a link between ecosystems and human welfare.

Beyond the local impacts, at a national level, information from a CRN on tree growth has been incorporated into Chilean forest law. And beyond national levels, several meteorological projects linked to Climate Outlook Fora in Central America, Mexico and Ecuador, and developed better ways of transmitting climate information to the public. Improved weather and climate forecasting was translated into capacity building for adaptation to climate change. Another CRN provided a lasting legacy to monitoring efforts. The PIRATA Project, a cooperative project between Brazil, the United States and France, was launched in 1997 to monitor ocean variability at selected tropical locations.

One CRN's central concern was to generate a territorially disaggregated disaster data base (known as DESINVENTAR: see www.desenredando.org for details on this data base) in order to provide information with which to analyze the changing spatial, social and semantic patterns of disaster risk, loss and damage associated with ENSO and non ENSO generated hydro-meteorological hazards. This information and the ensuing analysis offer a basis for the publication and dissemination of scientific results (including the development of an interactive regional ENSO documentation system open to all interested parties), and the development of training and educational modules on ENSO risk and risk management, directly affected different social actors and decision makers.

Capacity Building in Scientific Institutions

Many of the co-investigators and their institutions had no experience with international cooperations. Communication, project administration, accounting and monitoring capabilities frequently were developed as part of the CRN efforts. Both North-South and South-South collaborations contributed to this process. At the end of the program there is a noticeable improvement in the institutional capacity of the region to conduct multilateral, effective, auditable research and training. In this way, the IAI has built a constituency of researches that not only maintain the scientific excellence required in the peer-reviewed research process, but who are increasingly supported by institutions and administrators capable of handling international tasks. This improved capacity is seen not only in Southern but also in the institutions of the US and Canada.

Publications:

Journal Publications

Acuna- Soto, R., Stahle, D.W., Cleaveland, M.K. and Therrell, M.D., "Megadrought and Megadeath in 16th. Century Mexico", Emerging Infectious Diseases, p. 360, vol. 8, (2002).

Aguiar, R.L.F., Maia, L.C., Salcedo, I.H., Sampaio, E.V.S.B., "Integraçao entre fungos microrrizicos arbusculares e fosforo no desenvolvimento da algaroba", Revista Arvore, p. 583-592, vol. 28, (2004).

Aguirre-Hernández, E., G. Gaxiola-Castro, S. Nájera-Martínez, T. Baumgartner, M. Kahru, and G. Mitchell, "Phytoplankton absorption, photosynthetic parameters, and primary production off Baja California: summer and autumn, 1998", Deep Sea Research Part II, p. 799, vol. 51, (2004).

Ake Gomez, A., M. Avila, J.J. Jimenez-Osornio, "Valor de los productos directos del agroecosistema solar: el caso de Hocaba, Yucatan, Mexico", Sociedades Rurales, Produccion y Medio Ambiente, p. 7, vol. 3, (2002).

Alemanni, M. E., M. Lozada, and H. E. Zagarese, "Assessing sublethal effects of ultraviolet radiation in juvenile rainbow trout (Oncorhynchus mykiss).", Photochemical and Photobiological Sciences, p. 867, vol. 2, (2003).

Alheit, J. and M. Niquen, "Regime shifts in the Humboldt Current ecosystem", Progress in Oceanography, p. 201, vol. 60, (2004).

Alonso, C., V Rocco, J. P. Barriga, M. A. Battini, and H. E. Zagarese, "Surface avoidance by freshwater zooplankton: Field evidence on the role of ultraviolet radiation.", Limnology and Oceanography, p. 225, vol. 49(1), (2004).

Altesor, A, G Piñeiro, F Lezama, RB Jackson, M Sarasola, JM Paruelo, "Ecosystem changes associated with grazing in subhumid South American grasslands", Journal of Vegetation Science, p. 323, vol. 17, (2006).

Alvarez, C., L. Goycochea, A. Quiroga, G. Botta , E. Noellemeyer., "Soil penetration resistance and water content ratio intwo soils of the semiarid Pampa region.", INIA, p. 00, vol. 00, (2006).

Amador, J. A., Alfaro, E. J., Lizano, O. G., & Magaña, V. O, "Atmospheric forcing of the eastern tropical Pacific: A review", Progress in Oceanography., (2006).

Ambrizzi, T, and V. Magaña, "Experimento Climático Nas Aguas Quentes da America Central", Boletim da Sociedade Brasileira de Meteorologia (SBMET), p. 6, vol. 22, (2002).

Amorim, I. L., Sampaio, E.V.S.B., Araujo, E.L., "Flora e estrutura da vegetaçao arbustivo-arborea de uma area de caatinga do Serido, RN, Brasil.", Acta Botanica Brasilica, p. 615, vol. 19, (2005).

Aparicio, L.M., Llerena, C.A. and McClain, M.E., "Usos del agua en la cuenca del río Pachitea, Perú (publicación aceptada en la Revista Forestal del Perú", AARAM Special Issue, p. 1, vol. 24, (2001).

Araújo, M.S.B., Salcedo, I.H., Sampaio, E.V.S.B., "Proposta de modificação do método de cálculo do fósforo na biomassa microbiana aplicada a solos de Pernambuco.", Revista Brasileira de Ciência de Solo.

Aravena J. C., Carmona M., Pérez C. and Armesto J. J., "Changes in tree species richness, stand structure and soil properties in a successional chronosequence of forest fragments in northern Chiloé Island, Chile.", Revista Chilena de Historia Natural, p. 339, vol. 75, (2002).

Aravena, J.C., Lara, A., Wolodarsky-Franke, A., Villalba, R., and Cuq, E., "Tree-ring growth patterns and temperature reconstruction from Nothofagus pumilio (Fagaceae) forests at the upper tree line of southern Chilean Patagonia.", Revista Chilena de Historia Natural, p. 361, vol. 75, (2002).

Ataroff, M., "Precipitación e Intercepción en ecosistemas boscosos de Los Andes venezolanos", Ecotropicos, p. 195, vol. 15, (2002).

Auad, G., A. Miller, and M. DiLorenzo, "Long-term forecasts of oceanic conditions off California and their biological implication", Geophys. Res., (2006).

Austin, A. T. and L. Vivanco, "Plant litter decomposition in a semi-arid ecosystem controlled by photodegradation", Nature, (2006).

Austin, A. T., "The human footprint in ecology - past, present and future", New Phytologist, p. 419, vol. 164, (2004).

Austin, A. T., G. Piñiero, and M. Gonzalez Polo, "More is less: agricultural impacts on the N cycle in Argentina", Biogeochemistry, vol. 10, (2006).

Austin, A. T., L. Yahdjian, J. M. Stark, J. Belnap, U. Norton, A. Porporato, D. A. Ravetta, and S. M. Schaeffer, "Water pulses and biogeochemical cycles in arid and semiarid ecosystems", Oecologia, p. 221, vol. 141, (2004).

Austin, AT, O. E Sala and R.B Jackson, "Inhibition of nitrification alters carbon turnover in the Patagonian steppe", Ecosystems, (2006).

Ayon, P., S. Purca, and R. Guevara-Carrasco, "Zooplankton volume trends off Peru between 1964 and 2001", ICES Journal of Marine Science, (2004).

Ballance, L. T., Pitman, R. L., Fiedler, P. C., Gerrodette, T., & Reilly, S. B, "Seabirds, cetaceans and the oceanography of the eastern tropical Pacific: A review. ", Progress in Oceanography, (2006).

Ballestero, D. and J.E. Coen, "Generation and propagation of anticyclonic rings in the Gulf of Papagayo", Int. Jour. Remote Sensing, p. 2217, vol. 25, (2004).

Barger N.N., D'Antonio, C.M, Ghneim T, Cuenvas E., "Controls over colonization of an African pasture grass (Melinis minutiflora) in a Venezuelan savanna.", Plant Ecology, p. 31, vol. 163, (2003).

Barros, F.S.M.; Vasconcelos, S.D., Arruda, M.E. & Confalonieri, U.E.C, "Tetrahymenidae infection in mosquito populations in a malaria-endemic region of the Amazon", J. Invertebr. Pathol, p. 199, vol. 91, (2006).

Barros, F.S.M; Arruda, M.E; Vasconcelos, S.D.; Luitgards-Moura J.F.; Honório, N.A. & Confalonieri, U.E.C., "Breeding Sites of a Riverine Malaria Vector in the Amazon: seasonal variation and relation to human activity", Journal of Medical Entomology, (2006).

Barros, F.S.M; Tadei, W.P.; Arruda, M.E; Vasconcelos, S.D.; Luitgards-Moura J.F.; Honório, N.A. & Confalonieri, U.E.C, "Seasonal variation of malaria vectors, with notes on their Plasmodium Infectivity: a model for areas with diverging drainage patterns in the Amazon.", Transactions of the Royal Society of Tropical Medicine and Hygiene, (2006).

Bartolomé, M., Caputo, M.G., Celis, A., Herzer, H.M., Rodríguez,C, "El clima y otros factores de riesgo productivo en la Pampa Húmeda, Argentina", Realidad Económica, p. 00, vol. 202, (2004).

Bartolomé, Mara, "La construcción social de la inundación en Pergamino. Ñas versiones de la inundación y su incidencia en la gestión", Etnografías Contemporáneas, p. 232, vol. 1, (2005).

Baruch, Z., and R. B. Jackson, "Responses of tropical native and invader C4 grasses to clipping, fire and increased atmospheric CO2 concentration", Oecologia, p. 522, vol. 145, (2005).

Baruch, Z., R. R. Pattison, and G. Goldstein, "Responses to light and water availability of four invasive Melastomaceae in the Hawaiian Islands", International Journal of Plant Science, p. 107, vol. 161, (2000).

Baumgartner, T.R., A. Soutar and V. Ferreira and J. Field, "Fish scale deposition in the Santa Barbara Basin, southern California", Fishery Bulletin, p. 00, vol. 00, (2005). In preparation for submission in 2006 Baumgartner, T.R., A. Soutar, V. Ferreira, "Anchoveta scale-deposition off central Perú, ", Fisheries Oceanography, (2005).

Baumgartner, T.R., G. Auad, and A. Miller, "Simulation of a basin-wide climate regime shift and regional response of the California sardine habitat", Progress in Oceanography., (2005).

Bazzino, G., R. Quiñones, W. Norris, "Environmental associations of shortfin squid Illex Argentenus (Cephalapoda: Ommastrephidae) on the Northern Patagonian Shelf.", Fisheries Research. (2006).

Benjamin, T., P. Montanez, J.Jimenez-Osornio, A. Gillespie, "Carbon, water and nutrient flux in Mayan homegardens in the Yucatan Península of Mexico.", Agroforestry Systems., p. 103, vol. 53, (2001).

Berbery, E. H., E. A. Collini, V. Silva, M. Peña, D. L. Lettenmaier, V. Barros, M.Pyle, "The water cycle of La Plata basin at regional scales", GEWEX News, (2004).

Biondi, F., "Treeline Dendroclimatology in the North American Tropics.", Pages News, p. 9, vol. 10(1), (2002).

Boninsegna, J.A., "Progress in South American Dendrochronology", Pages News, p. 11, vol. 10, (2002).

Boulanger, J. P., Julie Leloup, Olga Penalba, Matilde Rusticucci, Florence Lafon and Walter Vargas, "Observed precipitation in the Parana -Plata hydrological basin: long-term trends, extreme conditions and ENSO teleconnections. ", Climate Dynamics, p. 393, vol. 24, (2005).

Brenes, C., M.F. Lavín, A.S. Mascarenhas Jr, "Geostrophic currents off the Pacific coast of Central America in September-October, 1993", Geophysical Research Letters., (2005).

Brunini, O., P. L. Silva Dias, A. M. Grimm, E. D. Assad e V. K. Boken, "Agrictural drought phenomenon in Latin America with focus on Brazil. In V. K. Boken, A. P. Cracknell e R. L. Heathcote: Monitoring and Predicting Agricultural Drought: A Global Study", Oxford University Press, New York, p. 00, vol. 156, (2005).

Bustamante, M., L. Martinelli, D.A. Silva, P. Camargo, C.A. Klink, T. Domingues & R. Santos, "15N natural abundance in woody plants and soils of the savannas in Central Brazil (Cerrado)", Ecological Applications, p. 200, vol. 14, (2004).

Caamal, A. J.J. Jiménez-Osornio, A. Torres-Barragan y A.L. Anaya., "The use of some allelopathic plants for weed control in agricultural management", Journal of Agronomy, p. 27, vol. 93, (2001).

Caceres, M. and A. Valle-Levinson, "Transverse structure of flow at either side of a sill/contraction combination", Estuarine and Coastal Shelf Science. Estuarine and Coastal Shelf Science., p. 00, vol. 00, (2006).

Campos, E.J.D., D. Velhote and I.C.A. da Silveira, "Shelf break upwelling driven by Brazil Current cyclonic meanders", Geophys. Res. Letters, p. 751, vol. 27, (2000).

Carmona, M., Aravena J. C., Pérez C. and Armesto J.J., "Coarse-woody debris biomass in successional and primary temperate forests in Chiloé Island, Chile.", Forest Ecology and Management, p. 265, vol. 164, (2002).

Casagrande, G., Vergara, G., Suarez, A., Perez, S., Sierra, E.y Cony P, "Caracterización agroclimática de las heladas en el este de la provincia de La Pampa (Argentina).", Revista de la Facultad de Agronomía de la Universidad Nacional de La Pampa, p. 31, vol. 12, (2001).

Castillo-Caamal, J.B., J.J. Jiménez-Osornio, A. López-Pérez, W. Aguilar Cordero and A. M. Castillo-Caamal, "Feeding Mucuna Beans to Small Ruminants of Mayan farmers in the Yucatán, Península, México", Tropical and Subtropical Agroecosystems, p. 113, vol. 2003, (1).

Celis, A., Caputo, G., Bartolomé, M., Kisilevsky, G., Herzer, H. Rodríguez, C., "Primeros pasos hacia una política local que gestiones el riesgo de inundación", Medio Ambiente y Urbanización, p. 00, vol. 62/63, (2005).

Chapin, F. S., E. S. Zavaleta, V. T. Eviner, R. L. Naylor, P. M. Vitousek, H. L. Reynolds, D. U. Hooper, S. Lavorel, O. E. Sala, S. E. Hobbie, M. C. Mack, and S. Díaz, "Consequences of Changing Biodiversity", Nature, p. 234, vol. 405, (2000).

Cipriotti, P., and M. R. Aguiar, "Effects of grazing on patch structure in a semi-arid two-phase vegetation mosaic", Journal of Vegetation Science, p. 57, vol. 16, (2005).

Collini, E. A., E. H. Berbery and V. Barros, "Soil moisture effects in the onset and development of the South American monsoon precipitation", Mon. Wea. Rev., (2006).

Colmenares, M., Rada, F. & Luque, R., "Anatomía foliar de Polylepis sericea Wedd, (Rosaceae) a dos altitudes en el Estado Mérida", Plántula, p. 141, vol. 3, (2005).

Confalonieri, U.E.C, "Variabilidade Climática, Vulnerabilidade Social e Saúde no Brasil.", Terra Livre, S. Paulo, p. 193, vol. 19-I, (2003).

Cony, P., Casagrande, G. y Vergara, G., "Cuantificación de un índice de estrés calórico para vacas lecheras en Anguil, provincia de La Pampa (Argentina)", Revista de la Facultad de Agronomía de la Universidad Nacional de La Pampa., p. 1, vol. 15, (2004).

Corredor, J., A.W. Bruckner, F. Muszynski, R.A. Armstrong, and J.M. Morell., "UV-absorbing compounds in three species of Caribbean zooxanthellate corals: depth distribution and spectral response", Bulletin of Marine Science, p. 821, vol. 67, (2000).

Cunningham, CC; IFA Cavalcanti, "Intraseasonal modes of variability affecting the South Atlantic Convergence Zone", Intern. Journ.Climat, (2006).

D'Arrigo, R.D., Villalba, R., and Wiles, G., "Tree-ring estimates of Pacific decadal climate variability ", Climate Dynamics, p. 219, vol. 18, (2001).

Davy, A.J., Bishop, G.F. & Costa, C.S.B., "Salicornia L. Biological Flora of British Isles,", Journal of Ecology, p. 681, vol. 89(4), (2001).

Detrés, Y., R.A. Armstrong, and X. Connelly, "Ultraviolet-induced responses in two species of climax tropical marine macrophytes.", J. of Photochemistry and Photobiology, p. 55, vol. 62(1-2), (2001). Published

Díaz Susana, Don Nelson, Guillermo Deferrari, Carolina Camilión., "Estimated and Measured DNA, Plant-Chromosphere and Erythemal-Weighted Irradiances at Barrow and South Pole (1979-2000)", Journal of Agronomy and Forest Meteorology (former name: Agronomy and Forest Meteorology), p. 69, vol. 120, (2003).

Diaz, S.C., D.W. Stahle, M.D. Therrell, and M.K. Cleaveland, "Chihuahua winter-spring precipitation reconstructed from tree rings: 1644-1992", Climate Research, p. 237, vol. 22, (2002).

Drumond, A.R.M. & Ambrizzi, "Inter-ENSO variability and its influence over the South American monsoon system", Advances in Geosciences, p. 167, vol. 6, (2006).

Drumond, A.R.M. & Ambrizzi, T, "The role of SST on the South American atmospheric circulation during the January, February and March 2001", Climate Dynamics, p. 781, vol. 24, (2005).

Durazo R. and T.R. Baumgartner, "Evolution of oceanographic conditions off Baja California, 1997-1999", Progress in Oceanography, p. 7, vol. 54, (2002).

Engel, V, EG Jobbágy, M Stieglitz, M Williams, RB Jackson, "The hydrological consequences of Eucalyptus afforestation in the Argentine Pampas", Water Resources Research, p. 00, vol. 41, (2005).

Erazo M.C. & Fariñas MR., "Relaciones Fitogeográficas de la Flora Vascular de los páramos andinos venezolanos", Pittieria, p. 00, vol. 00, (2004).

Escobar, G., Walter Vargas and Susana Bischoff, "Wind Tides in the Rio de la Plata Estuary: Meteorological Conditions", International Journal of Climatology, p. 1159, vol. 24, (2004).

Espinosa-Carreon, T. L., P. T. Strub, G. Gaxiola-Castro, E. Beier, and L. Soto-Mardones, "Mesoscale process influence on the chlorophyll in the southern California Current region during 2000", J. Geophysical Research., p. 00, vol. 00, (2005).

Espinosa-Carreon, T. L., Strub, P. T., Beier, E., Ocampo-Torres, F. and Gaxiola-Castro, G, "Seasonal and interannual variability of satellite-derived chlorophyll pigment,surface height, and temperature off Baja California", Jour. Geophysical Research, p. 00, vol. 109, (2004).

Evans, M.N., Cane, M.A., Schrag, D.P., Kaplan, A., Linsley, B.K., Villalba, R., and Wellington, G.M., "2001. Support for tropically-driven Pacific decadal variability based on paleoproxy evidence", Geophysical Research Letters, p. 3869, vol. 28, (2001).

Farber, J. & Fernández, M. A., "Zooplankton and the oceanography of the eastern tropical Pacific: A review", Progress in Oceanography, (2006).

Farley, KA, EG Jobbágy, RB Jackson, "Effects of afforestation on water yield: a global synthesis with implications for policy", Global Change Biology, p. 1565, vol. 11, (2005).

Fiedler, P. C. & Talley, L. D, "Hydrography of the eastern tropical Pacific: A review", Progress in Oceanography, (2006).

Fiedler, P. C., & Lavín, M, "Introduction: A review of eastern tropical Pacific oceanography", Progress in Oceanography (2006).

Field, D.B., T.R. Baumgartner, C.D. Charles, V.Ferreira-Bartrina, M.D. Ohman, "Planktonic foraminifera of the California Current reflect 20th-Century Warming", Science, p. 00, vol. 311, (2006).

Foy B., E. Caetano, V. Magaña, A. Zitácuaro, B. Cárdenas, A. P. Martínez, A. Retama, R. Ramos, R. Reyes, G. Sosa, L. T. Molina, M. J.Molina, "Meteorological and Photochemical Conditions during the MCMA-2003 Field Campaign ", Atmospheric Chemistry and Physics Discussions, p. 2503, vol. 5, (2005).

Fraga, V.S., Salcedo, I.H. 2004. Declines of Organic Nutrient Pools in Tropical Semi-Arid Soils under Subsistence Farming., "Soil Science Society of America Journal", Soil Science Society of America Journal, p. 215, vol. 68, (2004).

Franco A. C., Bustamante, M., Caldas, L. S., Goldstein, G., , Meinzer, F. C., Kozovits, A. R., P. Rundel, and Coradin, Vera T. R. , "Leaf functional traits of Neotropical savanna trees in relation to seasonal water deficit", Trees, p. 326, vol. 19, (2005).

Frank, D. A., R. D. Evans, and B. F. Tracy, "The role of ammonia volatilization in controlling the natural 15N abundance of a grazed grassland", Biogeochemistry, p. 169, vol. 68, (2004).

Frank, D.A., "The interactive effects of grazing ungulates and aboveground production on grassland diversity", Oecologia, (2005).

Freitas S.R., K.M. Longo, M.A.F.Silva Dias, P.L. Silva Dias, F.S. Recuero, R. Chatfield, E. Prins, P. Artaxo, "Monitoring the Transport of Biomass Burning Emissions in South America.", Environmental Fluid Mechanics, p. 00, vol. 00, (2004).

Galárraga Remigio y María Cristina Torres., "Water Quality on the Napo River Basin (Ecuadorian Andean Amazonia)", Mountain Research and Development, p. 295, vol. 21, (2001).

Gallardo, M., González, J.A., Prado, F.E., "Light modulation of betalains synthesis in Chenopodium quinoa Willd. seedlings Phochem", Photobiology, p. 80, vol. 69, (1999).

Galvão, S.R., Salcedo, I. H., Santos, A.C., "Frações de carbono e nitrogênio em função da textura, do relevo e do uso do solo na microbacia do Agreste em Vaca Brava (PB).", Revista Brasileira de Ciência do Solo, p. 955, vol. 29, (2005).

García-Núñez C & Azócar A., "Ecofisiología de la regeneración de las especies leñosas de la sabana", Ecotrópicos, p. 00, vol. 17, (2004).

García-Núñez C, Rada F, Boero C, González J, Gallardo M, Azócar A, Liberman-Cruz M, Hilal M & Prado F. , "Carbon and water relations in Polylepis tarapacana Phil., a tropical treeline species at extreme altitudes", Photosynthetica, p. 133, vol. 42, (2004).

García-Núñez, C., Azócar, A.& Silva, J. F., "Fruit, seed production and soil seed bank in three evergreen woody species from a Neotropical savanna", Journal of Tropical Ecology, p. 563, vol. 17, (2001).

Gartner, B.L., Aloni R., Funada R., Lichtfuss-Gautier A.N., and Roig F.A., "Clues for dendrochronology from studies of wood structure and function", Dendrochronologia, p. 53, vol. 20, (2001).

Gay-García,C.; Hernández-Vázquez,M.; Jiménez-López,J.; Lezama Gutiérrez, J.; Magaña-Rueda, V.O.; Morales-Acoltzi, T. y Orozco-Flores, S, "Evaluation of climatic forecasts of rainfall for the Tlaxcala State (México)1998-2002", Atmósfera, p. 127, vol. 3, (2004).

Gómez, D. y Reynel, C., "Composición florística del bosque ribereño en dos microcuencas del río San Alberto, Oxapampa, Peru", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Gómez, Z.., Llerena. C.A. y McClain, M.E., "Variabilidad espacio-temporal del nitrógeno e iones mayores en la cuenca del río Pachitea, Peru", Revista Forestal del Perú, p. 1, vol. 24, (2001).

González, JA, M. Liberman Cruz; C. Boero; M. Gallardo & F.E. Prado, "Leaf thickness, protective and photosynthetic pigments and carbohydrate content in leaves of the world's highest elevation tree, Polylepis tarapacana (Rosaceae). ", Phyton, p. 41, vol. 00, (2002).

Grimm, A. M., A. K. Sahai e C. F. Ropelewski, "Interdecadal Variations in AGCM Simulation Skills", Journal of Climate, p. 3406, vol. 19, (2006).

Gutierrez, D., A. Sifeddine, J.L. Reyss, G. Vargas, F. Velazco, R. Salvatecci, V. Ferreira,L. Ortlieb, T. Baumgartner, M. Boussafir, H. Boucher, J. Valdés, L. Valdés, L.Marinovic, P. Soler, D. Field, and P. Tapia, "Anoxic sediments off central Perú record interannual to multidecadal changes of climate and upwelling ecosystem functioning during the past few centuries", Advances in Geosciences, p. 119, vol. 6, (2006).

Halpin, P.M., P. T. Strub, W. Peterson, and T. Baumgartner, "An overview of interactions among oceanography, marine ecosystems, climatic and human disruptions along the eastern margins of the Pacific Ocean.", Revista Chilena de Historia Natural, p. 371, vol. 77, (2004).

Hamman, A., Momo, F., Duhour, A., Falco, L., Sagario, C., Cuadrado, M., "Effect of UV radiation on Eisenia fetida populations", Pedobiologia, p. 842, vol. 47, (2003).

Haylock, M. R., T. C. Peterson, L. M. Alves, T. Ambrizzi, Y. M. T. Anunciação, J. Baez, V. R. Barros, M. A. Berlato, M. Bidegain, G. Coronel,V. Corradi, V. J. Garcia,A. M. Grimm, D. Karoly, , "Trends in total and extreme South American rainfall 1960-2000 and links with sea surface temperature.", Journal of Climate, p. 1490, vol. 19, (2006).

Herrera, F.F. and E. Cuevas., "Soil arthropods as bioindicators of land restoration.", Venesuelos.

Herrera, F.F., Alceste, C., Armenise, A., Flores, S., Cuevas, E., "Microbial variables and chemical soil properties as indicators of fire effect on secondary savannas.", Suelos Ecuatoriales.

Herzer, H.M., Caputo, M.G., Celis, A., Bartolomé, M., Rodríguez,C., y Weber, E, "El clima en la región pampeana y su importancia en la toma de decisión agrícola", Suplemento especial : Uso de la información climática para la toma de decisiones en la producción agrícola de la Revista CREA, p. 00, vol. 269, (2003).

Herzer, Hilda; Caputo, María Graciela; Celis, Alejandra; Gurevich, Raquel; Petit, Hernán; Bartolomé, Mara y Rodríguez, Carla, "Grandes inundaciones en la ciudad de Pergamino: extraordinarias, pero recurrentes", Realidad Económica, vol. 175, (2000).

Higgins R. Wayne, Art Douglas, Andrea Hahmann, E. Hugo Berbery , Dave Gutzler, Jim Shuttleworth, David Stensrud, Jorge A. Amador, Rit Carbone, Miguel Cortez, Michael Douglas, Rene Lobato, Jose Meitin, "Progress 72 in Pan American CLIVAR Research: The North American Monsoon System.", Atmósfera, p. 29, vol. 16, (2003).

Hilal, M., Parrado M.F, M. Rosa, M.Gallardo, E. M. Massa, J. A. González and F. E. Prado. "Epidermal lignin deposition in quinoa cotyledons in response to UV-B radiation", Photochemistry and Photobiology, p. 205, vol. 79, (2004).

Hoffman, W. A., and R. B. Jackson, "Vegetation-climate feedbacks in the conversion of tropical savanna to grassland", Journal of Climate, p. 1593, vol. 13, (2000).

Hoffmann, WA, W Schroeder, RB Jackson, "Regional feedbacks among fire, climate, and tropical deforestation.", Journal of Geophysical Research, p. 4721, vol. 108, (2003).

Hutyra L. J. W. Munger, C. A. Nobre, S. R. Saleska, S. A. Vieira, and S. C. Wofsy, "Climatic variability and vegetation vulnerability in Amazonia", Geophysical Research Letters, p. 00, vol. 32, (2005). Published

Huxman, T. E., M. D. Smith, P. A. Fay, A. K. Knapp, M. R. Shaw, M. E. Loik, S. D. Smith, D. T. Tissue, J. C. Zak, J. F. Weltzin, W. T. Pockman, O. E. Sala, B. Haddad, J. Harte, G. W. Koch, S. Schwinning, E. E. Small, and D. G. Williams, "Convergence across biomes to a common rain-use efficiency", Nature, p. 651, vol. 429, (2004).

I.C. A. da Silveira, A.K. Schmidt, E.J.D. Campos and Y. Ikeda, "A Corrente do Brasil ao largo da costa leste brasileira", Braz. Jour. Oceanogr, p. 171, vol. 48, (2000).

Inbar, M., Llerena, C.A., "Erosion Processes in High Mountain Agricultural Terraces in Peru." Mountain Research and Development, p. 72, vol. 20, (2000).

Jackson, R. B., H. J. Schenk, E. G. Jobbágy, J. Canadell, G. D. Colello, R. E. Dickinson, C. B. Field, P. Friedlingstein, M. Heimann, K. Hibbard, D. W. Kicklighter, A. Kleidon, R. P. Neilson, W. J. Parton, O. E. Sala, and M. T. Sykes, "Belowground consequences of vegetation change and their treatment in models", Ecological Applications, p. 470, vol. 10, (2000).

Jackson, RB, EG Jobbágy, R Avissar, S Baidya Roy, D Barrett, CW Cook, KA Farley, DC le Maitre, BA McCarl, BC Murray, "Trading water for carbon with biological carbon sequestration", Science, p. 1944, vol. 310, (2005).

Jazcilevich A., A. Reynoso Garcia y E. Caetano, "Locally Induced Surface Air Confluence by Complex Terrain and its Effects on Air Pollution in the Valley of Mexico", Atmospheric Environment, p. 5481, vol. 39, (2005).

Jiménez-Peréz, L.C., and B.E. Lavaniegos, "Changes in dominante of copepods off Baja California during the 1997-1999 El Niño and La Niña", Marine Ecology Progress Series , p. 147, vol. 277, (2004). Published

Jobbágy, E. G., and R. B. Jackson, "Global controls of forest line elevation in the northern and southern hemisphere", Global Ecology and Biogeography, p. 253, vol. 9, (2000).

Jobbágy, E. G., and R. B. Jackson, "The distribution of soil nutrients with depth: global patterns and the imprint of plants", Biogeochemistry, (2001).

Jobbágy, E. G., and R. B. Jackson, "The vertical distribution of soil organic carbon and its relation to climate and vegetation.", Ecological Applications, p. 423, vol. 10, (2000).

Jobbágy, E., and R. B. Jackson, "Groundwater use and salinization with grassland afforestation", Global Change Biology, p. 1299, vol. 10, (2004).

Jobbágy, E., and R. B. Jackson, "The uplift of soil nutrients by plants: biogeochemical consequences across scales", Ecology, p. 2380, vol. 85, (2004).

Kessler, W. S., "The circulation of the eastern tropical Pacific: A review", Progress in Oceanography, (2006).

Klink, C.A. & R. B. Machado, "Conservation of the Brazilian Cerrado", Conservation Biology, p. 707, vol. 19, (2005).

Kuwahara, V. S., Mahoney, K., Strutton, P. & Chavez, F. P, "Primary productivity and biogeochemical cycling in the eastern tropical Pacific: A review", Progress in Oceanography, (2006).

Labraga J. C., O. Frumento y M. López, "The atmospheric water vapor cycle in South America and the tropospheric circulation", Journal of Climate, p. 1899, vol. 13, (2000).

Ladah, L.B., and J.A. Zertuche, "Giant kelp survival in deep water (25 - 40 m) during El Niño of 1997-1998 in Baja California, Mexico", Botanica Marina, p. 367, vol. 47, (2004).

Ladah, L.B., F.J. Tapia, J. Pineda, and M. Lopez, "Spatially heterogeneous synchronous settlement of Chthamalus spp. larvae in northern Baja California ", Marine Ecology Progress Series, p. 177, vol. 302, (2005).

Lara, A., Aravena, J.C., Villalba, R., Wolodarsky-Franke, A., Luckman, B.H., and Wilson, R., "Dendroclimatology of high-elevation Nothofagus pumilio forests at their northern distribution limit in the central Andes of Chile.", Canadian Journal of Forest Research, p. 925, vol. 31, (2001).

Lauenroth, W. K., I. C. Burke, and J. M. Paruelo, "Patterns of production and precipitation-use efficiency of winter wheat and native grasslands in the Central Great Plains of the United States", Ecosystems, p. 344, vol. 3, (2000).

Lavaniegos B.E., L.C. Jiménez-Pérez, G. Gaxiola-Castro, "Plankton response to El Niño 1997-98 and La Niña 1999 in the southern region of the California Current", Progress in Oceanography, p. 33, vol. 54, (2002).

Lavin, M.F., E. Beier, J. Gómez-Valdéz, V.M. Godínez and J. Garcia, "On the summer poleward coastal current off SW México", Geophysical Research Letters, p. 00, vol. 33, (2006).

Lentini, C.A.D., E.J.D. Campos and G. Podesta, "The annual cycle of satellite-derived SST on the Subtropical South American Continental Shelf", Oceanogr, p. 93, vol. 48, (2000).

Lentini, C.A.D., G. Podesta, E.J.D. Campos and D.B. Olson, "SST Anomalies in the Western South Atlantic Ocean - 1982 to 1984", Cont. Shelf Res, p. 90, vol. 21, (2001).

Lenza, E. & Ferreira, J. N., "Biologia floral de Serjania erecta Radlk.(Sapindaceae): um caso de diocia temporal", Boletim do Herbário Ezechias Paulo Heringer , p. 23, vol. 6, (2000).

LeQuesne, C. and Sandoval L., "New southern limit for Nothofagus glauca (Phil.) Krasser.", Gayana Botánica, p. 139, vol. 58, (2001).

Libkind, D., Pérez. A. P., R. Sommaruga, M. C. Diéguez, M. Ferraro, S. Brizzio, H. Zagarese, and M. R. Rosa Giraudo, "Constitutive and UV-inducible synthesis of photoprotective compounds (carotenoids and mycosporines) by freshwater yeasts.", Photochemical and Photobioological Sciences, p. 281, vol. 3, (2004).

Liebmann, Brant, and Dave Allured, "Daily Precipitation Grids for South America", Bulletin of the American Meteorological Society, p. 1567, vol. 86, (2005).

Liebmann, Brant, Carolina S. Vera, Leila M.V. Carvalho, Inés A. Camilloni, Martin P. Hoerling, Dave Allured, Vicente R. Barros, Julián Báez, and Mario Bidegain, "An Observed Trend in Central South American Precipitation", Journal of Climate, p. 4357, vol. 17, (2004).

Liebmann, Brant, George N. Kiladis, Carolina S. Vera, A. Celeste Saulo, and Leila M.V.Carvalho, "Subseasonal Variations of Rainfall in South America in the Vicinity of the Low-Level Jet East of the Andes and Comparison to Those in the South Atlantic Convergence Zone", Journal of Climate, p. 3829, vol. 17, (2004).

Lima, R.L.F.A., Salcedo, I.H., Fraga, V.S., "Propágulos de micorrizas arbusculares em solos deficientes em fósforo, sob diferentes usos, da região semi-árida no NE do Brasil.", Revista Brasileira de Ciência de Solo.

Llerena, C.A. y McClain, M.E., "Importancia del conocimiento hidrometeorológico y biogeoquímico de las cuencas de la Amazonia andina y su influencia en la cuenca baja", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Lovengreeen, C. y H. Fuenzalida, "Radiación ultravioleta productora de eritema en Valdivia: comparación entre inferencias satelitales, modelo de transferencia radiativa y mediciones desde tierra", Revista Médica de Chile, p. 17, vol. 130, (2002).

Luckman, B. H. and Boninsegna, J. A., "The Assessment of Present, Past and Future Climatic Variability in the Americas from Tree-Line Environments.", PAGES News, p. 17, vol. 9(3), (2001). Published

Magaña, V. & Ambrizzi, T, "Dynamics of subtropical vertical motions over the Americas during El Niño boreal winters", Atmosfera, p. 211, vol. 18, (2005).

Magaña, V. and E. Caetano, "Temporal evolution of summer convective activity over the Americas Warm Pools", Geophysical Research Letters, p. 00, vol. 32, (2005).

Magaña, V. J. L. Vázquez, J. L. Pérez and J. B. Pérez, "Impact of El Niño on precipitation in México", Geofísica Internacional, p. 313, vol. 42, (2003).

Magaña, V., J. Pérez and M. Méndez, "Diagnostic and prognostic of extreme precipitation events in the Mexico basin", Geofísica Internacional., p. 247, vol. 41, (2003).

Markewitz, D., J. Resende, L. Parron, M. Bustamante, C.A. Klink, R. Figueiredo & E. Davidson. "Stream water chemical fluxes in an undisturbed watershed of the Brazilian Cerrado", Hydrological Processes, (2004).

Markgraf, V., Baumgartner, T.R., Bradbury, J.P., Diaz, H.F., Dunbar, R.B., Luckman, B.H., Seltzer, G.O., Swetnam, T.W., and Villalba, R., "Paleoclimate reconstruction along the Pole-Equator-Pole transect of the America (PEP 1).", Quaternary Sciences Reviews, p. 125, vol. 19, (2000).

Márquez, E., Fariñas, M., Briceño, B. & Rada, F., "Distribution of grasses along an altitudinal gradient in a Venezuelan paramo", Revista Chilena de Historia Natural, p. 649, vol. 77, (2004).

Martinelli, L. A., R. W. Howarth, E. Cuevas, S. Filoso, A. T. Austin , L. Donoso, V. Huzsar, D. Keeney, L. L. Lara, C. Llerena, G. McIssac, E. Medina, J. Ortiz-Zayas, D. Scavia, D. W. Schindler, D. Soto, and A. Townsend, "The origin and fate of reactive nitrogen in Latin America and the Caribbean", Biogeochemistry, (2006).

Martinez-Arroyo A., A Benitez-Macias, E Caetano, V. Magaña, "Distribution on the Northeast Pacific Warm Pool and its Possible Role on dms Production and Release", World Resources, (2005).

McClain ME and Cossio RE., "The use and conservation of riparian zones in the rural Peruvian Amazon.", Environmental Conservation, p.242, vol. 30, (2003).

McClain, M.E., Aparicio, L.M., Llerena, C.A., "Water Use and Protection in Rural Communities of the Peruvian Amazon Basin.", Water Internacional, p. 400, vol. 26, (2001).

McCulley, RL, EG Jobbágy, WT Pockman, RB Jackson, "Nutrient uptake as a contributing explanation for deep rooting in arid and semi-arid ecosystems", Oecologia, p. 620, vol. 141, (2004).

Mechoso, C. R., A. W. Robertson, A. M. Grimm e C. S. Vera, "South American Monsoon System", GEWEX News, p. 12, vol. 15, (2005).

Menezes, R.S.C. and Salcedo, I.H., "Mineralização de N após incorporação de adubos orgânicos em um Neossolo Regolítico cultivado com milho.", Revista Brasileira de Engenharia Agrícola e Ambiental.

Mestas-Nuñez, A. M. and A. Miller, "Interdecadal variability and climate change in the eastern tropical Pacific: A review", Progress in Oceanography. (2006).

Meyerson, L.A; Baron, J; Melillo, J.M; Naiman, R.J; O'Malley, RI; Orians, G; Palmer, MA; Pfaff, AS; Running, SW; Sala, OE, "Aggregate measures of ecosystem services: can we take the pulse of nature?", Frontiers in Ecology and the Environment, p. 56, vol. 3, (2005).

Minetti, J.L., Vargas, W.M., Poblete, A.G., Acuña, L.R. y Casagrande, G., "Non-linear trends and low frequency oscillations in annual precipitation over Argentina and Chile", Atmósfera, p. 199, vol. 16, (2003).

Molina, J. y Llerena, C.A., "Caracterización hidrologico-forestal de dos microcuencas, una con cobertura vegetal y otra con uso agrícola previo, en San Alberto, Oxapampa, Peru", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Moll, M.E. y Llerena, C. A., "Estudio de la infiltracion en las microcuencas experiementales Wara y Killa, San Alberto, Oxapampa", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Montañez-Escalante, P., L. García-Barrios y J.J. Jiménez-Osornio, "Quarry Reclamation in Mérida, Yucatán, México: A Review on Achievements and Current Limitations", Tropical and Subtropical Agroecosystems, p. 101, vol. 5, (2005).

Morales M. S., R. Villalba, H. R. Grau, P. Villagra, J. A. Boninsegna, A. Ripalta And L. Paolini., "Potential of Prosopis ferox Griseb (Leguminosae, subfamily: Mimosoideae) for dendrochronological studies in high-montane subtropical deserts.", Revista Chilena de Historia Natural.

Morales, M.S., Villalba, R., Grau, H.R., Villagra, P.E., Boninsegna, J.A., Ripalta, A., y Paolini, L., "Potencialidad de Prosopis ferox Griseb (Leguminosae, subfamilia: Mimosoideae) para estudios dendrocronológicos en los desiertos subtropicales de alta montaña.", Revista Chilena de Historia Natural, p. 865, vol. 74, (2001).

Müller, G.; Ambrizzi, T. & Nuñez, M. N, "Mean atmospheric circulation leading to generalized frosts in Central Southern South America.", Theoretical and Applied Climatology, p. 95, vol. 82, (2005). Published

NOBRE, A.A; SCHMIDT, A.M. & LOPES, H.F., "Spatio-temporal models for the mapping of the incidence of malaria in Pará", Environmetrics, p. 291, vol. 16:, (2005).

Noellemeyer, E., D. Estelrich, A. Quiroga., "Soil quality in three range soils of the semiarid Pampa of Argentina.", Journal of Arid Environments., p. 142, vol. 65, (2006).

Obregón, G. O., Nobre, C. A, "Rainfall trend in Brazil", Bulletin of the American Meteorological Society, p. 1008, vol. 84, (2004).

Ordóñez, J., Llerena, C.A. y Obregón, E., "Analisis hidrometeorologico y aplicacion del modelo de simulacion IPH-MEN en la cuena del Pachitea", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Oyama Marcos Daisuke and C. A. Nobre, "A new climate-vegetation equilibrium state for Tropical South America", Geophysical research letters, p. 00, vol. 30, (2003).

Oyama Marcos Daisuke and C. A. Nobre, "Climatic Consequences of a Large-Scale Desertification in Northeast Brazil: A GCM Simulation Study", Journal of Climate, p. 3203, vol. 17, (2004). Published

Pancotto, V. A., O. E. Sala, T. M. Robson, M. M. Caldwell, and A. L. Scopel, "Direct and indirect effects of solar ultraviolet-B radiation on long-term decomposition", Global Change Biology, p. 1982, vol. 11, (2005).

Paruelo, J. M., I. C. Burke, and W. K. Lauenroth, "Land use impact on ecosystem functioning in eastern Colorado (USA)", Global Change Biology, (2001).

Paruelo, J. M., O. E. Sala, and A. B. Beltrán, "Long-term dynamics of water and carbon in semi-arid ecosystems: a gradient analysis in the Patagonian steppe", Plant Ecology, p. 133, vol. 150, (2000). Published

Penalba, O, and Walter M. Vargas., "Interdecadal and Interannual Variations of Annual and Extreme Precipitation over Central-Northeastern Argentina. ", International Journal of Climatology, p. 1565, vol. 24, (2004).

Pereira, I.M., Andrade, L.A., Barbosa, M.R.V., Sampaio, E.V.S.B., "Composição florística e análise fitossociológica do componente lenhoso de um remanescente de caatinga no Agreste Paraíbano", Acta Botanica Brasilica, p. 357, vol. 16, (2002).

Perez M., A.M., Menezes, R.S.C., Silva, E.D., "Nutrientes do Solo, Microclima e Produtividade do Milho em Sistema Agroflorestal com Gliricidia Sepium no Agreste Paraibano", Revista Brasileira de Ciência do Solo., (2006).

Pérez, A. Patricia, Mónica M. Díaz, Marcela A. Ferraro, Gagriela C. Cusminsky, and Horacio E. Zagarese, "Replicated mesocosm study on the role of natural ultraviolet radiation in high CDOM, shallow lakes", Photochemical and Photobioological Sciences, p. 118, vol. 2, (2003).

Pérez, C. A., M. R. Carmona, J. C. Aravena, and J. J. Armesto, "Successional changes in soil nutrient availability, non-symbiotic nitrogen fixation, and carbon:nitrogen ratios in southern Chilean forest ecosystems", Oecologia, p. 617, vol. 140, (2004).

Perez, S., Sierra, E., Casagrande, G., Vergara, G. y Bernal, F., "Comportamiento de las precipitaciones (1918/2000) en el centro oeste de la provincia de Buenos Aires (Argentina).", Revista de la Facultad de Agronomía de la Universidad Nacional de La Pampa., p. 39, vol. 14, (2003).

Pezza, A.B, e T. Ambrizzi, "Cyclone and Anticyclone tracks and large scale circulation associated with polar outbreaks in South America: Synoptic Climatology", International Journal of Climatology, p. 215, vol. , 25, (2005).

Pezza, A.B., e T. Ambrizzi, "Cold waves in South America and freezing temperatures in Sao Paulo: Historical background (1888 - 2003) and case studies of cyclone and anticyclone tracks", Revista Brasileira de Meteorologia, p. 22, vol. 20, (2005).

Phoenix, G. K., W. K. Hicks, P. Ineson, S. Cinderby, J. C. I. Kuylenstierna, W. D. Stock, F. J. Dentener, K. E. Giller, A. T. Austin , R. Lefroy, and B. S. Gimeno, "World biodiversity hotspots threatened by atmospheric nitrogen deposition: highlighting the need for a greater global perspective", Global Change Biology, p. 470, vol. 12, (2006).

Piola, A.R., E.J.D. Campos, O.O. Möller Jr., J. Charo and C. Martinez, "Subtropical Shelf Front off eastern South America", Geophys. Research, p. 6565, vol. 105, (2000).

Quiroga, A., A. Bono, A. Corro Molas. 2002. Aspectos nutricionales del Girasol en la región semiárida y subhúmeda pampeana, "Rev. De Inform. Investigac. Agric.", Rev. de Inform. Investigac. Agric., p. 128, vol. XXI, (2002).

Quiroga, A., D. Funaro, R. Fernández, E. Noellemeyer, "Factores edáficos y de manejo que condicionan la eficiencia del barbecho en la región pampeana.", Ciencia del Suelo, p. 86, vol. 79, (2005).

Quiroga, A., Diaz Zorita, M., Buschiazzo, D., "Safflower productivity as related to soil water storage and management practice in semiarid regions", Comm.Soil Sci.Plant Anal., p. 2851, vol. 32, (2005).

Quiroga,A., D. Funaro, E. Noellemeyer, D. Peinemann., "Soil quality indicators and barley fertilization response.", Soil & Tillage Res., (2006).

Rada, F., García-Nuñez, C., Boero, C., Gallardo, M., Hilal, M., González, J., Prado, F.E., Liberman-Cruz, M. & Azocar, A. , "Low temperature resistance in Polylepis tarapacana, a tree growing at the highest altitudes in the world", Plant Cell and Environment , p. 377, vol. 24, (2001).

Ramos O, C Llerena, M McClain & J Quintanilla, "Perdidas de nitrógeno del bosque de neblina en la sub-cuenca de San Alberto, Oxapampa, Perú.", Revista Boliviana de Quimica, p. 86, vol. 20, (2003).

Ramos, J., Villa, J., Ruiz, A., Armstrong, R., and J. L. Matta, "UV dose determines key characteristics of non-melanoma skin cancer.", Cancer Epidemiology, Biomarkers & Prevention, p. 2006, vol. 13, (2004).

Reboita, M.S.; Rocha, R.P. & Ambrizzi, T, "Evaluation of the latent and sensible heat fluxes simulated by RegCM3 over the South Atlantic from 1990 to 1994", Clivar Exchanges, p. 58, vol. 10, (2005). Published

Rivera A., Acuña, C. Casassa, G. and Bown, F., "Use of remotely-sensed and field data to estimate the contribution of Chilean glaciers to eustatic sea-level rise.", Annals of Glaciology, p. 367, vol. 34, (2002).

Rocco, V. E. , O. Oppezzo, R. Pizarro, R Sommaruga, M. A. Ferraro, and H. E. Zagarese, "Ultraviolet damage and counteracting mechanisms in the freshwater copepod Boeckella poppei from the Antarctic Peninsula", Limnology and Oceanography, p. 829, vol. 47, (2002).

Rodrigues, D.A., IFA Cavalcanti, "Simulations of the Hydrologic Cycle over Southern South America using the CPTEC/COLA AGCM", Journal of Hydrometeorology, p. 00, vol. 00, (2006).

Rodrigues, R.R. and J.A. Lorenzzetti, "A Numerical study of the effects of bottom topography and coastline geometry on the Southeast Brazilian coastal upwelling", Cont. Shelf Res, p. 371, vol. 21, (2001).

Roig, F, Carlos Le-Quesne, José A. Boninsegna, Keith R. Briffa, Antonio Lara, Håkan Grudd, Philip D. Jones & Carolina Villagrán., "Climate variability 50,000 years ago in mid-latitude Chile as reconstructed from tree rings", Nature, p. 567, vol. 410, (2001).

Roig, F., J.J. Jiménez Osorio, J. Villanueva Diaz, B. Luckman, H. Tiessen, A. Medina, E. Noellemeyer, "Anatomy of growth rings at the Yucatan peninsula", Dendrochronologia, p. 187, vol. 22, (2005).

Roig, F.A., Fernandez M., Gareca E., Altamirano S. & Monge S., "Dendrochronological studies in the humid Puna environments of Bolivia.", Ecología y Conservación Ambiental, p. 3, vol. 9, (2001).

Rosa, M., Mirna Hilal, Juan A. González & Fernando E. Prado, "Changes in soluble carbohydrates and related enzymes induced by low temperature during early developmental stages of quinoa (Chenopodium quinoa Willd.) seedlings", Journal of Plant Physiology, p. 683, vol. 161, (2004).

Rossi, B.E. y P.E. Villagra, "Prosopis flexuosa effects on the spatial pattern of understory species and soil properties in the Monte desert (Argentina)", Journal of Vegetation Science, p. 543, vol. 14, (2003).

Sala, O. E., F. S. Chapin III, J. J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L. F. Huenneke, R. B. Jackson, A. Kinzig, R. Leemans, D. M. Lodge, H. A. Mooney, M. Oesterheld, "Global Biodiversity Scenarios for the Year 2100", Science, p. 1770, vol. 287, (2000).

Salio, P.V., M. Nicolini and E.J. Zipser, "Mesoscale Convective Systems over Southeastern South America and their relationship with the South American Low Level Jet", Monthly Weather Review., p. 00, vol. 00, (2005).

Sampaio, E.V.S.B., Silva, G.C., "Biomass equations for Brazilian semiarid caatinga plants.", Acta Botanica Brasilica, p. 935, vol. 19(4), (2005).

Sampaio, E.V.S.B., Tiessen, H., Antonino, A.C.D., Salcedo, I.H., "Residual N and P fertilizer effect and fertilizer recovery on intercropped and sole-cropped corn and bean in semiarid northeast Brazil", Nutrient Cycling in Agroecosystems, p. 1, vol. 70, (2004).

Sánez, J. y De Ruyter, E., "Evaluación de la calidad del agua del río San Alberto (Oxapampa), por medio del método BMWP de monitoreo biológico", Revista Forestal del Perú, p. 1, vol. 24, (2001).

Santos, A.C., Salcedo, I.H., Candeias, A.L.B., "Relação entre o relevo e as classes texturais do solo na microbacia hidrográfica de Vaca Brava, PB.", Revista Brasileira de Cartografia, p. 94, vol. 54, (2002).

Santos, Maria Aurora, and C. A. Nobre, "Relationship between CAPE, precipitation and Bolivian high during Wet-AMC/LBA.", Revista Brasileira de Meteorologia., p. 00, vol. 00, (2006).

Sastre, M.P., M. Vernet and S. Steiner, "Single-cell Gel Electrophoresis Applied to the Analysis of Ultraviolet Damage and Repair Phytoplankton Cells.", Photochemistry and Photobiology, (2000).

Schwinning, S., and O. E. Sala, "Hierarchy of responses to resource pulses in arid and semi-arid ecosystems", Oecologia, p. 211, vol. 141, (2004).

Seeliger, U. and Costa, C.S.B., "The Patos-Mirim basins, lagoons and estuary: Natural and human forcing factors.", Loicz Reports Studies, p. 105, vol. 21, (2002).

Shang, C., Tiessen, H., "Carbon Turnover and Carbon-13 Natural Abundance in Organomineral Fractions of a Tropical Dry Forest Soil Under Cultivation.", Soil Science Society of America Journal, p. 2149, vol. 64, (2000).

Shang, C., Tiessen, H., "Soil Organic C Sequestration and Stabilization in Karstic Soils of Yucatan", Biogeochemistry, p. 177, vol. 62, (2003).

Sierra, E., Perez, S., Casagrande, G.y Vergara, G., "Efectos del ENSO sobre las precipitaciones del trimestre noviembre-enero (1921/1998) en el centro-este de la provincia de La Pampa (Argentina)", Revista Argentina de Agrometeorología.(RADA), p. 83, vol. 1, (2001).

Silva J. F., Zambrano A. & Fariñas M. R., "Increase in the woody component of seasonal savannas under different fire regimes in Calabozo, Venezuela.", Journal of Biogeography, p. 977, vol. 28, (2001). Published

Silva, D.A. & Klink, C.A., "Dinâmica da foliação de duas gramíneas C4 e uma C3 nativas do Cerrado. ", Revista Brasileira de Botânica, p. 441, vol. 24, (2001).

Silva, G.A.M. & Ambrizzi, T., "Inter-El Niño variability and its impact on the South American low level jet east of the Andes during austral summer: Two case studies", Advances in Geosciences, p. 283, vol. 6, (2006).

Silva, T.O., Menezes, R.S.C., "Adubação Orgânica da Batata com Esterco e/ou Crotalária Juncea: II - Disponibilidade de N, P e K no Solo ao Longo do Ciclo de Cultivo.", Revista Brasileira de Ciência do Solo.

Silva, T.O., Menezes, R.S.C., Sampaio, E.V.S.B., Salcedo, I.H., "Adubação Orgânica da Batata com Esterco e/ou Crotalaria Juncea: I - Produtividade Vegetal e Estoque de Nutrientes no Solo em Longo Prazo.", Revista Brasileira de Ciência do Solo.

Silveira, Luciano Marçal da, Tiessen, H., Tonneau, J.P., "Organic matter management in family agriculture of semiarid Paraiba, Brazil.", Nutrient Cycling in Agroecosystems, p. 215, vol. 61, (2001).

Silveira, M.M.L.; Araújo, M.S.B.; Sampaio, E.V.S.B., "Fracionamento de fósforo em solos do semiárido brasileiro.", Revista Brasileira de Ciência do Solo, p. 02, vol. 60, (2006).

Silvestri, G. E., and C. S. Vera, "Antarctic Oscillation signal on precipitation anomalies over southeastern South America ", Geophys. Res. Lett, p. 00, vol. 30, (2003).

Simionato, C., C. S. Vera and F. Siegismund, "Surface wind variability on seasonal and interannual scales over Río de la Plata area", Journal of Coastal Research, p. 770, vol. 21, (2005).

Sircelj, M. R., Rosa, M. D., Parrado M.F., González, J.A., Hilal, M. y Prado, F.E., "Ultraestructural and metabolic changes induced by UV-B radiation in cotyledons of quinoa (Chenopodium quinoa Willd.)", Biocell, p. 180, vol. 26, (2002).

Solman, S., M. Nuñez and M. F. Cabré, "Regional climate change experiments over southern South America. I: Present Climate", Climate Dynamics, (2006).

Sosa-Ávalos, R., G. Gaxiola-Castro, R. Durazo, "Effect of Santa Ana winds on bio-optical properties off Baja California", Ciencias Marinas, p.:339, vol. 31, (2005).

Sosa-Avalos, R.G., G. Gaxiola-Castro, B.G. Mitchell, "Particles and phyoplankton light absorption coefficients determined off Baja California", Geophysical Research, (2005).

Sosa-Nishizaki, O., Lluch-Cota, S., Dreyfus, M., Galvan, F., Ortega, S. & Castillo, L., "Fisheries oceanography of the eastern tropical Pacific: A review.", Progress in Oceanography. Progress in Oceanography. Progress in Oceanography., (2006).

Souza, E. B.; Kayano, M.T. & Ambrizzi, T, "Intraseasonal and submonthly variability within over Amazon and Northeast Brazil during the autumn rainy season", Theoretical and Applied Climatology, p. 177, vol. 81, (2005).

Souza, E.B., M. T. Kayano, e T. Ambrizzi, "The Eastern Amazon/Northeast Brazil regional precipitation in a weekly timescale modulated by tropical Pacific and Atlantic SST anomalies during austral autumn", Revista Brasileira de Meteorologia, p. 325, vol. 19, (2004).

Souza, E.B., T. Ambrizzi, e C.A.S. Coelho, "Two ENSO episodes with reversed impacts on the regional precipitation of the Northeastern South America", Revista Meteorologica, Argentina. (2005).

Tartarotti, B., G Baffico, P. Temporetti, and H. E. Zagarese., "Mycosporine-like amino acids in planktonic organisms living under different UV exposure conditions in Patagonian lakes.", Journal of Plankton Research, p. 753, vol. 26, (2004).

Thomas, A.C., P.Brickley, P.T. Strub, and C. James, "). Chlorophyll interannual variability in four major eastern boundary currents.", Geophysical Research Letters., (2005).

Tiessen, H., Menezes, R.S.C., Salcedo, I.H., Wick, B., "Tree effects, soil fertility and organic matter turnover in a silvo-pastoral system in semiarid NE Brazil.", Plant and Soil, p. 195, vol. 252, (2003).

Tiessen, H., Sampaio, E.V.S.B. , Salcedo, I.H., "Organic matter turnover and management in low input agriculture of NE Brazil", Nutrient Cycling in Agroecosystems, p. 99, vol. 61, (2001).

Tiessen, H., Weisbach, C., Menezes, R.S.C., "Estimating the Contribution of Trees to Available P.", Agroforestry Forum, p. 1, vol. 9, (1999).

Townsend-Small A, ME McClain & JA Brandes., "Contributions of carbon and nitrogen from the Andes mountains to the Amazon River: Evidence from an elevational gradient of soils, plants, and river material.", Limnology and Oceanography, p. 672, vol. 50, (2005).

Valle-Levinson, A. and J.L. Blanco, "Observations of wind influence on exchange flows in a strait of the Chilean inland sea", J. Marine Research, (2006).

Valle-Levinson, A. et al.,, "Observations of wind-induced exchange at the entrance to an equatorward facing embayment", Deep Sea Research., p. 00, vol. 00, (2006).

Vera, C. S., G. E. Silvestri, V. R. Barros, and A. F. Carril, "Differences in El Niño response over the Southern Hemisphere.", J. Climate, p. 1741, vol. 17, (2004).

Vera, C., G. Silvestri, B. Liebmann, P. Gonzalez, "Climate change scenarios for seasonal precipitation in South America from IPCC-AR4 models", Geophys. Res. Lett, p. 00, vol. 00, (2006).

Vera, C.; J. Baez; M. Douglas; C. B. Emmanuel; J. Marengo; J. Meitin; M. Nicolini; J.Nogues-Paegle; J. Paegle; O. Penalba; P. Salio; C. Saulo; M. A. Silva Dias; P. Silva Dias; and E. Zipser, "The South American Low-Level Jet Experiment (SALLJEX", Bull. Amer. Meteor. Soc, p. 63, vol. 87, (2006).

Vergara, G. y Casagrande, G., "Estadísticas agroclimáticas de la Facultad de Agronomia, Santa Rosa, La Pampa, Argentina", Revista de la Facultad de Agronomía de la Universidad Nacional de La Pampa., p. 1, vol. 13, (2002).

Vigliarolo, P., C. Vera, and S. Diaz, "Synoptic-scale variability and its relationship with Ozone and Antarctic Vortex Displacements", Mon. Wea. Rev., p. 2374, vol. 133, (2005).

Villagra, P.E. & Roig, F.A., "Distribución geográfica y fitosociología de Prosopis argentina y P. alpataco (Fabaceae, Mimosoidea)", Bol. Soc. Argent. Bot., p. 99, vol. 37(1-2), (2002).

Villagra, P.E., Marone, L. & Cony, M.A., "Mechanism affecting the fate of Prosopis flexuosa seeds during secondary dispersal en the Monte desert.", Austral Ecol., p. 416, vol. 27, (2002).

Vincent, L.A., T.C. Peterson, V.R. Barros, M.B. Marino, M. Rusticucci, G. Carrasco, E.Ramirez, L.M. Alves, T. Ambrizzi, M.A. Berlato, A.M.Grimm, J.A. Marengo, L.Molion, D.F. Moncunill, E. Rebello, Y.M.T. Anunciação, J. Quintana, J.L. Santos, J.Baez, , "Observed trends in indices of daily temperature extremes in South America 1960-2000", Journal of Climate, p. 5011, vol. 18,, (2005).

Vivanco, L., and A. T. Austin, "Intrinsic species' effects on leaf litter and root decomposition: a comparison of temperate grasses from North and South America", Oecologia, (2006).

Walker, R. & Ataroff, M., "Biomasa epífita y su contenido de nutrientes en una selva nublada de Los Andes venezolanos", Ecotropicos, p. 203, vol. 15, (2002).

Walker, R. & Ataroff, M., "Nutrientes en el dosel", Lyona, p. 7, vol. 7, (2004).

Wang, C. & Fiedler, P. C, "ENSO variability in the eastern tropical Pacific: A review.", Progress in Oceanography, (2006).

Watson E. and Luckman B.H., "The dendroclimatic signal in Douglas-fir and ponderosa pine tree-ring chronologies from the Southern Canadian Cordillera", Canadian Journal of Forest Research, p. 1858, vol. 32, (2002).

Wayne Higgins, Jorge Amador, Anna Barros, E. Hugo Berbery, Ernesto Caetano, Rob Cifelli, Rit Carbone, Miguel Cortez-Vazquez, Art Douglas, Michael Douglas, Gus Emmanuel, Dave Gochis, Dave Gutzler, Richard Johnson,, "The North American Monsoon Experiment (NAME) 2004 field campaign.", Bull.Amer.Met Soc, (2005).

Weisbach, C., H. Tiessen y J.J. Jiménez-Osornio., "Soil fertility during shifting cultivation in the tropical karst soils of Yucatan", Agronomie, p. 253, vol. 22, (2002).

Whitehead, K. and M. Vernet., "Influence of mycosporine-like amino acids (MAAs) on UV absorption by particulate and dissolved organic matter in La Jolla Bay.", Limnology and Oceanography, p. 8, vol. 45, (2000).

Wick, B., Tiessen, H., Menezes, R.S.C., "Land quality changes following the conversion of natural vegetation into silvo-pastoral systems in semiarid NE Brazil.", Plant and Soil, p. 59, vol. 222, (2000).

Wiles, G.C., Jacoby, G.C., Davi, N., and McAllister, R., "Late Holocene glacial fluctuations in the Wrangell Mountains, Alaska. ", GSA Bulletin, p. 896, vol. 114, (2002).

Willett, C. S. & Leben, R, "Eddies and mesoscale processes in the eastern tropical Pacific: A review", Progress in Oceanography, (2006).

Williams, D. G., and Z. Baruch, "African grass invasion in the Americas: ecosystem consequences and the role of ecophysiology", Biological Invasions, p. 123, vol. 2, (2000).

Wolodarsky, A., Ripalta, A., "Large-scale temperature changes across the southern Andes: 20th-century variations in the context of the past 400 years.", Climatic Change, p. 177, vol. 59, (2003).

Wütherich D, Azócar A, García-Núñez C & Silva JF., "Seed dispersal in Palicourea rigida H.B.K, a common treelet species from a Neotropical savanna ", Journal of Tropical Ecology, p. 449, vol. 17, (2001).

Xue YongKang, F. De Sales, W.-P. Li, C. R. Mechoso, C. A. Nobre and H.-M. Juang, "Role of Land Surface Processes in South American Monsoon Development", Journal of Climate, p. 741, vol. 19, (2006). Published

Yahdjian, L. and O.E. Sala, "Vegetation structure constrains primary production response to increased water availability in the Patagonian steppe of Argentina", Ecology, p. 952, vol. 87, (2006).

Yahdjian, L., O. E. Sala, and A. T. Austin, "Differential controls of water input on litter decomposition and nitrogen dynamics in the Patagonian steppe", Ecosystems, p. 128, vol. 9, (2006).

Zach, A., H. Tiessen, E. Noellemeyer., "Carbon turnover and 13C natural abundance under landuse change in the semiarid La Pampa, Argentina.", Soil Sci. Soc. Amer. J., p. 00, vol. 00, (2006).

Zanabria, P. y Llerena, C. A., "Los bosques nublados de la Amazonia andina de Torohuaca, San Ignacio, Cajamarca; y su influencia en la precipitación neta", Revista Forestal del Perú, p. 1, vol. 24, (2001). Published

Zavialov, P., O.O. Möller Jr. and E.J.D. Campos, "First direct measurements of currents on the shelf of Southern Brazil", Cont. Shelf Res, (2000).

Books or Other One-time Publications

Alaback, P., Veblen, T.T. Whitlock, C. Lara, A., Kitzberger, T., Villalba R., "Climatic and Human Influences on Fire Regimes in Temperate Forest ecosystems in North and South America", (2003). Chapter, Published. Editor(s): Springer-Verlag Heidelberg. Collection: In: How Landscapes Change, G.A. Bradshaw and P.A.Marquet (Eds.) Ecological Studies

Alcamo, J., D. Van Vuuren, C. Ringler, J. Alder, E. Bennett, D. Lodge, T. Masui, T. Morita, M. Rosegrant, O. E. Sala , K. Schulze, M. Zurek, B. Eickhout and M. Maerker, K. Kok, "Methodology for Devoloping the MA Scenarios", (2005). Chapter. Editor(s): Island Press, Washington, DC. Collection: in S. R. Carpenter, P. Pingali, E. M. Bennett, and M. Zurek, editors. Ecosystems and Human Well-Being: Scenarios

Amador, J.A., R. Chacón and S. Laporte, "Climate and Climate Variability in the Arenal River Basin of Costa Rica", (2003). Book. Editor(s): Kluwer Publishing. Holland. Collection: Advances in Global Change Research: Climate and Water.

Ataroff, M., "Estudios de dinámica hídrica en la selva nublada de La Mucuy, estado Mérida, Venezuela", (2005). Book. Editor(s): ICAE, Mérida, Venezuela. Collection: In M. Ataroff y J.F. Silva (eds) Dinámica hídrica em sistemas neotropicales. Pp:, Investigaciones en Dinámica Hídrica de la red RICAS Azócar, A. & Fariñas, M., "Páramos", (2003). Book. Editor(s): Ediciones Fundación Polar y Fonacit. Venezuela. Collection: En: Aguilera M., Azócar, A., González- Jimenez, E. (Eds.) Biodiversidad en Venezuela

Ataroff, M., "Selvas y bosques de montaña", (2003). Chapter. Editor(s): CONICIT-Fundación Polar, Caracas. Collection: In M. Aguilera, A. Azócar, E. González-Jiménez (Eds.): Biodiversidad en Venezuela

Barbosa, M.R.; Agra, M.F.; Sampaio, E.V.S.B.; Cunha, J.P.; Andrade, L.A., "Diversidade florística na Mata do Pau-Ferro, Areia, Paraíba.", (2004). Editor(s): In: Porto, K.C.; Cabral, J.J.P.; Tabarelli, M. (ed.). Brejos de Altitude em Pernambuco e Paraíba: história natural, ecologia e conservação. MMA, Brasília Collection: MMA, Brasilia

Bezerra, L. Euzebio M Silva & Carlos A Klink, "Disponibilidade de água e evapotranspiração em ecossistemas do Cerrado brasileiro", (2005). Book. Editor(s): ICAE, Mérida, Venezuela. Collection: In: M. Ataroff y J.F. Silva, eds. Dinamica hidrica en sistemas neotropicales. Investigaciones em Dinámica Hidrica de la Red RICAS

Boninsegna, J.A. and Delgado S., "Atuel River streamflow variations from 1575 to present reconstructed by tree rings, their relationships to the Southern Oscillation", (2002). Chapter. Editor(s): In: Trombotto, D. and R. Villalba (eds.)

Boninsegna, J.A. and M. Hughes, "Volcanic signals in Temperature Reconstructions based on tree-ring records for North and South America", (2001). Chapter. Editor(s): Vera Markgraf (ed.), Academic Press. Collection: In: Inter-Hemispheric Climate Linkages

Campos, E.J.D, A. Busalacchi, A. Piola, C. Tanajura, D. Olson, I. Wainer, J. Lutjeharms, P.Nobre, R. Matano and S. Garzoli, "Important Aspects of the South Atlantic to the Understanding of the Global Climate", (2001). Book. Editor(s): BMRC, Melbourne, Australia. Collection: Observing the Ocean in the 21st Century. Koblinksy, C.J, N.R. Smith, editors

Chapin, F. S., O. E. Sala, and E. Huber Sannwald, "Future Scenarios of Global Biodiversity", (2001). Book. Editor(s): Springer Verlag, New York. Chapin, F. S., O. E. Sala, E. Huber Sannwald, and R. Leemans, "The future of biodiversity in a changing world", (2001). Chapter. Editor(s): Springer-Verlag, New York. Collection: in: F. S. Chapin, O. E. Sala, and E. Huber Sannwald, editors. Future Scenarios of Global Biodiversity

Delgado, S., Masiokas, M., Villalba, R., Trombotto, D., Ripalta, A., Hernández, J., and Calí, S., "Historical and dendrochronological evidences for glacier fluctuations in Patagonia during the past 1000 years (PATAGON-

1000)", (2002). Chapters. Editor(s): In: Trombotto, D. and R. Villalba (eds.) ZetaEditores, Mendoza, Argentina. Collection: IANIGLA, 30 Years of Basic and Applied Research on Environmental Sciences

Dirzo, R., "Ecosystems of Central America", (2001). Book. Editor(s): Academic Press, San Diego. Collection: S. A. Levin, editor. Encyclopedia of Biodiversity

Dirzo, R., "Plant-mammal interactions: lessons for our understanding of nature and implications for biodiversity conservation", (2001). Chapter. Editor(s): Blackwell, London. Collection: in: N. Huntley and M. C. Press, editors. Ecology: Challenges and Achievements

Dirzo, R., and R. Sussman, "Tropical rain forests: human impact and extinction", (2001). Chapter. Editor(s): Chicago University Press, Chicago. Collection: in: R. Chazdon and T. C. Whitmore, editors. Classics in Tropical Ecology

Ebi, Kristie ; Chan, Nathan ; Milne, A ; Confalonieri, U. E. C. "MALARIA", (2005). Book. Editor(s): Harvard University. Collection: Paul R. Epstein; Evan Mills. (Org.). Climate Change Futures: Health, Ecological and Economic Dimensions. Boston

Evans, M.N., Kaplan, A., Cane, M.A., and Villalba, R., "Globality and optimality in climate field reconstructions from proxy data", (2001). Chapter. Editor(s): Vera Markgraf (ed.), Academic Press. Collection: In: Inter-Hemispheric Climate Linkages

Galindo, I.C.L., Sampaio, E.V.S.B., Menezes, R.S.C., "Uso da Palma no manejo e conservação de solos.", (2005). Chapter, Published Editor(s): Editora Universitária Collection: n: Menezes, R.S.C.; Simões, D.A.; Sampaio, E.V.S.B.. (Org.). A palma no Nordeste do Brasil: conhecimento atual e novas perspectivas de uso.

García-Cuesta S, Sanez F, Delgado L, Martínez N, Rubio-Palis Y, "Caracterización de la vegetación a través de percepción remota y su relación con los criaderos del vector de malaria en la península de Paria. Estado Sucre-Venezuela", (2004). Book. Editor(s): SELPER

Giulietti, A.M.; Boccage Neta, A.L.; Castro, A.A.J.F.; Gamarra-Rojas, C.F.L.; Sampaio, E.V.S.B.; Virginio, J.F.; Queiroz, L.P.; Figueiredo, M.A.; Rodal, M.J.N.; Barbosa, M.R.V.; Harley, R.., "Diagnóstico da vegetação nativa do bioma caatinga", (2004). Chapter Editor(s): MMA. UFPE Conservation International Biodiversitas Embrapa Semiárido, Brasília Collection: In: Silva, J.M.C.; Tabarelli, M.; Fonseca, M.T.; Lins, L.V. (org.) Biodiversidade da Caatinga: áreas e ações prioritárias para a conservação

Helbling, E. W., and H. E. Zagarese, "UV effects in aquatic organisms and ecosystems", (2003). Book. Editor(s): Cambridge: The Royal Society of Chemistry Collection: Edited by D.-P. Häder and G. Jori, European Society for Photobiology, Comprehensive Series in Photosciences

Inbar, M., Llerena, C.A, "Procesos Erosivos y Abandono de Andenes", (2001). Book. Editor(s): La Molina Collection: Conservación y Abandono de Andenes, UNALM-Universidad de Haifa

Jackson, R. B., M. J. Lechowicz, X. Li, and H. A. Mooney, "The roles of phenology, growth, and allocation in global terrestrial productivity", (2001). Chapter. Editor(s): Academic Press, San Diego. Collection: in H. A. Mooney, B. Saugier, and J. Roy, editors. Terrestrial Global Productivity: Past, Present, and Future

Kareiva, P., J. B. R. Agard, J. Alder, E. M. Bennett, C. Butler, S. R. Carpenter, W. Cheung, "State of the Art in Simulating Future Changes in Ecosystem Services", (2005). Chapter. Editor(s): Island Press, Washington DC. Collection: in S. R. Carpenter, P. Pingali, E. M. Bennett, and M. Zurek, editors. Ecosystems and Human Well-Being: Scenarios

Klink, C. A, "O papel da pesquisa ecológica na gestão ambiental e manejo de ecossistemas.", (2001). Book. Editor(s): Garamond Universitária, Rio de Janeiro. Collection: Bursztyn, M. (org.). A Difícil Sustentabilidade

Klink, C.A. & Moreira, A. G, "Past and current human occupation and landuse", (2002). Book, Published. Editor(s): Columbia University Press, New York. Collection: Oliveira, P.S. & Marquis, R.J., (eds.): The Cerrado of Brazil: Ecology and Natural History of a Neotropical Savanna.

Knapp, A. K., J. M. Briggs, D. L. Childers, and O. E. Sala, "Estimating Aboveground Net Primary Production in Grassland and Herbaceous Dominated Ecosystems", (2006). Chapter. Editor(s): Oxford University Press,

Oxford. Collection: in T. J. Fahey and A. K. Knapp, editors. Principles and Standards for Measuring Net Primary Production in Long-Term Ecological Studies

Le Quesne, C., "Bioecología del bosque nativo chileno", (2002). Chapter. Editor(s): Editorial Universitaria, Santiago, Chile Collection: In: Baldini A. and Pancel, L. (eds), Agentes de daño en el bosque nativo

Llerena, C.A., Inbar, M, "Caracterización de Andenes en la Cuenca de Santa Eulalia.", (2001). Book. Editor(s): La Molina Collection: Conservación y Abandono de Andenes, UNALM-Universidad de Haifa

Luckman B.H. and Smith, D.J., "Developing a Proxy Climate Database for the Last 300 Years in the Canadian Cordillera", (2002). Book, Editor(s): Canadian Foundation for Climate and Atmospheric Sciences. Collection: Interim Status Report GR 242

Luckman, B.H., and Villalba, R., "Assessing the synchroneity of glacier fluctuations in the Western Cordillera of the Americas during the last millennium", (2001). Chapter. Editor(s): Vera Markgraf (ed.), Academic Press. Collection: In: Inter-Hemispheric Climate Linkages

Magaña et al, "Consecuencias presentes y futuras de la variabilidad y el Cambio climático en México", (2003). Book. Editor(s): Instituto Nacional de Ecología. México

Magaña, V, "El Cambio climático Global: Comprender el problema", (2003). Book. Editor(s): Instituto Nacional de Ecología. México

Magaña, V. and C. Conde, "Transboundary water resources in northern Mexico: Sonora, a case study.", (2003). Chapter. Editor(s): Kluwer Publishing. Holland. Collection: In: Advances in Global Change Research: Climate and Water.

McClain M.E, "The relevance of biogeochemistry to Amazon development and conservation.", (2001). Book. Editor(s): Oxford University Press. Collection: McClain ME, Victoria, RL & Richey JE (eds.) The Biogeochemistry of the Amazon

McClain M.E. and Elsenbeer H, "Terrestrial inputs to Amazon streams and internal biogeochemical processing.", (2001). Book. Editor(s): Oxford University Press. Collection: In McClain ME, Victoria, RL & Richey JE (eds.) The biogeochemistry of the Amazon.

McClain M.E., Victoria, R.L. & Richey J., "The Biogeochemistry of the Amazon Basin.", (2001). Book. Editor(s): Oxford University Press

Menezes, R.S.C., Sampaio, E.V.S.B., "Agricultura sustentável no semi-árido nordestino.", (2000). Chapter, Published Editor(s): In: Oliveira, T.S., Romero, R.E., R.N., Assis Jr., Silva, J.R.C.S. (Org.). Agricultura, sustentabilidade e o semi-árido.

Menezes, R.S.C., Sampaio, E.V.S.B., "Simulação dos fluxos e balanços de fósforo em uma unidade de produção agrícola familiar no semi-árido paraibano", (2002). Chapter. Editor(s): Silveira, L.M., Petersen, P., Sabourin, E. Agricultura familiar e agroecologia no semi-árido: avanços a partir do Agreste da Paraíba

Menezes, R.S.C., Sampaio, E.V.S.B., Porto, I., Souza, F.J., "Avaliação da produtividade de palma forrageira em unidades de produção agrícola familiar no Agreste e Curimataú da Paraíba.", (2002). Chapter. Editor(s): In: Silveira, L.M., Petersen, P., Sabourin, E. (Org.). Agricultura familiar e agroecologia no semi-árido: avanços a partir do Agreste da Paraíba.

Menezes, R.S.C., Sampaio, E.V.S.B., Salcedo, I.H., Souza, F.J., "Produtividade de palma em propriedades rurais.", (2005). Chapter. Editor(s): Editora Universitária Collection: In: Menezes, R.S.C.; Simões, D.A.; Sampaio, E.V.S.B.. (Org.). A palma no Nordeste do Brasil: conhecimento atual e novas perspectivas de uso.

Menezes, R.S.C., Sampaio, E.V.S.B., Tiessen, H., Silveira, L.M. and Salcedo, I.H, "Produção de batatinha com incorporação de esterco e/ou crotalária no Agreste paraibano", (2002). Chapter. Collection: Silveira, L.M., Petersen, P., Sabourin, E. Agricultura familiar e agroecologia no semi-árido: avanços a partir do Agreste da Paraíba

Menezes, R.S.C., Simões, D.A., Sampaio, E.V.S.B., "A Palma no Nordeste do Brasil: conhecimento atual e novas perspectivas de uso.", (2005). Book, Published. Editor(s): Editora Universitária UFPE

Menezes, R.S.C., Tiessen, H., Silveira, L.M., Andrade, L., Sampaio, E.V.S.B., Salcedo, I.H., Sabourin, E., Porto, I., and Sarmento, C., "Balanços de nutrientes em unidades de produção agrícola familiar no Agreste e Curimataú da Paraíba: avaliação e resultados preliminares.", (2002). Chapter. Collection: Silveira, L.M., Petersen, P., Sabourin, E. Agricultura familiar e agroecologia no semi-árido: avanços a partir do Agreste da Paraíba

Miranda, H.S., Bustamante, M. M. C. & Miranda, A.C, "The fire factor", (2002). Book, Published. Editor(s): Columbia University Press, New York. Collection: Oliveira, P.S. & Marquis, R.J., eds. The Cerrado of Brazil: Ecology and Natural History of a Neotropical Savanna

Moreno J, Rubio-Palis Y, "Primer registro de Anopheles nuneztovari Gabaldon, 1940 em el estado Bolívar e implicaciones eco-epidemiológicas en la transmisión de malaria.", (2004). Book. Editor(s): Entomotropica

Neale, P. J., E. W. Helbling, and H. E. Zagarese, "Modulation of UV exposure and effects by vertical mixing and advection", (2003). Chapter. Editor(s): Cambridge: Royal Society of Chemistry. Collection: In: UV effects on aquatic organisms and ecosystems, edited by W. E. Helbling and H. E. Zagarese

Neves, L.S. & Costa, C.S.B., "Crescimento de Salicornia gaudichaudiana Mog. em diferentes condições de salinidade", (2001). Chapter. Editor(s): Rio Grande: Editora da FURG. Collection: In: Anais da XIV Semana Nacional de Oceanografia, XIV Semana Nacional de Oceanografia, Rio Grande, 2001

Pacheco, E., Ataroff, M. 2005, "Dinámica ecohidrológica en una selva nublada andina venezolana.", (2005). Book. Editor(s): ICAE, Mérida, Venezuela. Collection: M. Ataroff y J.F. Silva (eds) Dinámica hídrica em sistemas neotropicales. nvestigaciones en Dinámica Hídrica de la red RICAS

Rincón Y.A., Ataroff M & F.Rada, "Dinámica hídrica de un pastizal de Pennisetum clandestinum Hochst ex cliov (pasto kikuyo) bajo distintos niveles de corte", (2005). Book. Editor(s): ICAE, Mérida, Venezuela. Collection: M. Ataroff y J.F. Silva (eds) Dinámica hídrica en sistemas neotropicales. nvestigaciones en Dinámica Hídrica de la red RICAS

Rodríguez AJ, Cárdenas R, Sandoval C, Baptista G, Pham D, Jaimes E, Mendoza JG, Delgado L, Córdova K, "Médio ambiente y protozoosis sistêmicas", (2004). Book. Editor(s): Academia. Collection: Variabilidad Climática y su Incidencia en la Malaria.

Ruiz, D., G. Poveda, M. L. Quiñones, I. D. Vélez, G. Rúa, W. Rojas, and J. S. Zuluaga, "Modelación sistémica para el diagnóstico de la interacción clima-malaria en Colombia. Aplicación durante El Niño 1997-1998 y La Niña 1998-2000.", (2004). Book. Editor(s): Meteorología Colombiana

Sala, O. E., "Aboveground productivity in temperate grassland ecosystems", (2001). Chapter, Published. Editor(s): Academic Press, San Diego. Collection: in H. A. Mooney, J. Roy, and B. Saugier, editors. Terrestrial Global Productivity: Past, Present, and Future

Sala, O. E., "Grasslands", (2001). Book. Editor(s): Springer Verlag, New York. Collection: in F. S. Chapin, O. E. Sala, and E. Huber Sannwald, editors. Future Scenarios of Global Biodiversity

Sala, O. E., A. T. Austin, and L. Vivanco, "Biodiversity in grassland ecosystems", (2001). Book. Editor(s): Academic Press, San Diego. Collection: in: S. Levin, editor. Encyclopedia of Biodiversity

Sala, O. E., and A. T. Austin, "Methods of estimating aboveground net primary production", (2000). Chapter. Editor(s): Springer Verlag, New York. Collection: in: O. E. Sala, R. B. Jackson, H. A. Mooney, and R. W. Howarth, editors. Methods in Ecosystem Science

Sala, O. E., D. van Vuuren, H. Pereira, D. Lodge, J. Alder, G. S. Cumming, A. Dobson, W. Volters, and M. Xenopoulos, "Biodiversity across Scenarios", (2005). Chapter. Editor(s): Island Press, Washington DC. Collection: in: S. R. Carpenter and P. Pingali, editors. The Global Scenarios Assessment

Sala, O. E., F. S. Chapin, and E. Huber Sannwald, "Conclusion and synthesis", (2001). Chapter. Editor(s): Springer Verlag, New York. Collection: in: F. S. Chapin, O. E. Sala, and E. Huber Sannwald, editors. Future Scenarios of Global Biodiversity

Sala, O. E., R. B. Jackson, H. A. Mooney, and R. W. Howarth, "Methods in Ecosystem Science", (2000). Book. Editor(s): Springer, New York

Sala, O. E., R. B. Jackson, H. A. Mooney, and R. W. Howarth, "Methods in Ecosystem Science: Progress, tradeoffs, and limitations", (2000). Chapter. Editor(s): Springer Verlag, New York. Collection: in: O. E. Sala, R. B. Jackson, H. A. Mooney, and R. W. Howarth, editors. Methods in Ecosystem Science

Sampaio, E.V.S.B, Sampaio, Y., "Ensaios sobre a economia da agricultura irrigada", (2004). Book. Editor(s): BNB

Sampaio, E.V.S.B. & Araújo, M.S.B., "Desertificação no Nordeste semi-árido", (2005). Chapter, Published. Editor(s): UFRPE, Recife, Collection: In: Nogueira, R.J.M.C.; Araújo, E.L..; Willadino, L.G., Cavalcante, U.M.T. (ed.). Estresses ambientais: danos e benefícios em plantas.

Sampaio, E.V.S.B. & Gamarra-Rojas, C.F.L., "A vegetação lenhosa das ecorregiões de caatinga", (2003). Chapter. Editor(s): MPEG, UFRA, Embrapa. Collection: . In: Jardim, M.A.G.; Bastos, M.N.C; Santos, J.U.M. Desafios da botânica brasileira no novo milênio: inventário, sistematização e conservação da diversidade vegetal

Sampaio, E.V.S.B., "Caracterização da caatinga e fatores ambientais que afetam a ecologia das plantas lenhosas", (2003). Chapter. Editor(s): Expressão Gráfica e Editora Collection: In: Sales, V.C. (org.) Ecossistemas brasileiros: manejo e conservação. Fortaleza,

Sampaio, E.V.S.B., Menezes, R.S.C., "Perspectivas de uso do solo no semi-árido nordestino.", (2002). Chapter. Collection: In: Araújo, Quintino Reis de. (Org.). 500 anos de uso do solo no Brasil

Sampaio, E.V.S.B., Menezes, R.S.C., "Sustainable Soil Use in Tropical South America with Emphasis on Brazil", (2003). Book. Collection: In: Tiessen, Holm. (Org.). Capacity of Soils for Sustaining Production -A Global Overview, in Encyclopedia of Life Support Systems, UNESCO-EOLSS

Sampaio, E.V.S.B.; Sampaio, Y.; Vital, T.; Araújo, S.B.; Sampaio, G.R., "Desertificação no Brasil.", (2003). Book. Editor(s): Editora Universitária UFPE

Sampaio, Y. & Sampaio, E.V.S.B., "A economia do semi-árido pernambucano e seu potencial de crescimento.", (2002). Chapter. Collection: In: Teuchler, H. & Moura, A.S. Quanto Vale a Caatinga Fortaleza, Fundação Konrad Adenauer

Sarukhan, J., and R. Dirzo, "Biodiversity-rich countries", (2001). Chapter. Editor(s): Academic Press, San Diego. Collection: in: Encyclopedia of Biodiversity

Sayago D., Tourrand J.F. ; Bursztyn M., "Cenas e cenários na Amazônia brasileira", (2003). Book. Editor(s): Ed. Universidade de Brasília

Silva, J.F, "Sabanas", (2003). Chapter. Editor(s): Fundación Polar y FONACIT. Caracas, Venezuela. Collection: in: Aguilera, M., Azócar, A. and Gonzalez-Jimenez, E. (editors). Biodiversidad de Venezuela.

Veiga J.B., Tourrand J.F., "A produção leiteira na Amazônia - Situação atual e perspectivas", (2000). Book. Editor(s): Coll. Embrapa Amazônia Oriental, Embrapa, Belém, Brasil

Veiga J.B.; Tourrand J.F., "Caracterização da viabilidade dos sistemas agropecuários da agricultura familiar na Amazônia Oriental brasileira", (2002). Book. Editor(s): Coll. Embrapa Amazônia Oriental, Embrapa, Belém, Brasil

Villagra, P.E., Morales, M.S., Villalba, R. and Boninsegna, J.A., "Dendroecología de los algarrobales de la zona árida Argentina", (2002). Chapter. Collection: In: D. Trombotto & Villalba, R. (Ed.). IANIGLA, 30 años de investigación básica y aplicada en ciencias ambientales

Villagra, P.E., y Villalba,R., "Estructura poblacional del algarrobal de la Reserva de Ñacuñan", (2001). Chapter. Editor(s): Triunfar. Collection: In: El desierto del Monte: La reserva de la biosfera de Ñacuñan, Claver, S. y Roig-Juñent, S. (eds.)

Villalba, R., "Climatic influences on forest dynamics along the forest-steppe ecotone in Northern Patagonia", (2002). Chapter. Editor(s): ZetaEditores, Mendoza, Argentina. Collection: In: Trombotto, D. and R. Villalba (eds.), 2002. IANIGLA, 30 Years of Basic and Applied Research on Environmental Sciences

Villalba, R., "Dendroclimatology: a Southern Hemisphere Perspective", (2000). Chapter, Published. Editor(s): P. Smolka and W. Volkheimer (eds.) Collection: In: Paleo- and Neoclimates of the Southern Hemisphere: the state of the arts.

Villalba,R., Arrigo, R.D., Cook, E.R., Wiles, G, and Jacoby G.C., "Decadal-scale climatic variability along the extratropical western coast of the Americas: Evidences from tree-ring records", (2000). Chapter. Editor(s): P. Smolka and W. Volkheimer (eds.). Collection: In: Paleo- and Neoclimates of the Southern Hemisphere: the state of the arts.

Walker, R., & Ataroff, M, "El papel de las epífitas en la dinámica hídrica de una selva nublada andina.", (. 20). Book. Editor(s): CAE, Mérida, Venezuela. Collection: M. Ataroff y J.F. Silva (eds) Dinámica hídrica em sistemas neotropicales. nvestigaciones en Dinámica Hídrica de la red RICAS

Williamson, C. E., and H. E. Zagarese, "UV effects on aquatic ecosystems: A changing climate perspective", (2003). Chapter. Editor(s): Cambridge: Royal Society of Chemistry. Collection: In UV effects on aquatic organisms and ecosystems, edited by W. E. Helbling and H. E. Zagarese

Wood C.H. ; Porro R., "Deforestation and land use in the Amazon", (2002). Book. Editor(s): University Press of Florida, Gainesville, FL, USA

Web/Internet Site URL(s):

CRN project home websites and sites related to CRN projects

http://www.cricyt.edu.ar/iai
http://www.latam.ufl.edu/iai
http://www.desenredando.org
http://amazonrivers.org/aaram
http://chiex.net/
http://glaucus.fcien.edu.uy/pcmya/sacc/
http://www.cicese.mx/~iaiepcor/
http://pembu.atmosfcu.unam.mx
www.mediatedmodeling.com.
http://webs.advance.com.ar/subediaz
www.monamb.furg.br
www.grec.iag.usp.br
www.prosur.cima.fcen.uba.ar
www.atmos.umd.edu/~berbery/lpb/
www.atmos.umd.edu/~berbery/etasam