Nitrogen management policies urgently needed

Nitrogen cycling in Latin America: Drivers,impacts and vulnerabilities

Budget:	US$ 996,100
Lead Agency:	Instituto Nacional de Pesquisas Espaciais, INPE
PI:	Jean Pierre Ometto
Countries:	Brazil, Argentina, Bolivia, Chile, Mexico, USA, Venezuela

Abstract:

Balanced use of nitrogen for sustainable agriculture requires appropriate management and public policies that ensure that the amount of nitrogen in the environment is maintained at adequate levels, not only for food production but also for the health of ecosystems, soils and living organisms, including human beings. The Inter-American Institute for Global Change Research (IAI) supports collaborative work that provides scientific evidence to achieve it.

Scientists of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) claim that by 2050, soil degradation and climate change will reduce crop yields by 10 percent globally. As a result, the drop in food production is anticipated to force migration of some 50 to 700 million people, mainly in Central America, South America, Sub-Saharan Africa, and Asia.

Soils are essential to agriculture and therefore to food security. Soils undergo degradation as a result of deforestation, erosion, and food production on lands that are not managed under sustainable agriculture or service crops.

Global calls to action include Sustainable Development Goal 15 which appeals to 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss', while Aichi Biodiversity target 8 states that 'by 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity'.

Nitrogen is one of the most widely used nutrients to accelerate plant growth; however, when applied in excess, disregarding agronomic and environmental knowledge, nitrogen fertilizers lead to soil degradation and water pollution.

The research project *Nitrogen cycling in Latin America: Drivers, impacts and vulnerabilities* of the Inter-American Institute for Global Change Research (IAI) led by Brazilian agronomist Jean Pierre Ometto, indicates that specific and immediate policies in Latin

America are urgently needed to ensure “the health of soils and an adequate nutrient balance”, so to achieve uniform food production and reduce negative impacts.

Ometto highlights the importance of nitrogen in food production, but alerts “bad agricultural practices may lead to the release of this nutrient to the environment and cause pollution and affect human health.”

In response to its mission to bring together scientists from countries in the Americas to work jointly in seeking solutions to common problems, the IAI is supporting the network on nitrogen cycling (Nnet) which involves researchers from Argentina, Bolivia, Brazil, Chile, Mexico, United States, and Venezuela. The goal of Nnet is to monitor the release of this nutrient into the atmosphere, its incidence on soil erosion and the consequences on food security.

With this project, the IAI, which is composed of 19 countries in the Americas, aims at enhancing the understanding of the nitrogen cycling and promote management options for this nutrient, as for instance establishing threshold levels –dose and frequency– to prevent them from becoming potentially toxic to nature.

Another major aspect of environmental pollution in Latin America is the poor treatment of wastewater, particularly domestic sewage. When not treated, wastewater affects not only water resources, but also biodiversity, and compromises environmental health and the ecosystem services those environments provide, such as fishing and recreation.

Ometto and his colleagues from the Brazilian National Institute for Space Research (INPE), suggest that an immediate measure could be increasing the number of wastewater treatment plants –in South America only 20 per cent is treated– and improving existing plants in order to reduce the impact of the nitrogen load on watersheds and coastal areas. Otherwise, coastal amounts of nitrogen will triple by 2050.

The current lack of information about the real impacts of human activity on the nitrogen cycle, as well as the variety of natural ecosystems and socio-economic situations in the region have led to fall behind implementation of guidelines.

In view of the above, this IAI project has created a set of useful tools to improve the understanding and management of the nitrogen cycle, impact models and quantification of nitrogen fluxes as well as regional maps of nitrogen emissions, among others.

For instance, the project made direct measurements of biological nitrogen fixation in different ecosystems in Mexico, Chile, Bolivia, Brazil, and Argentina and modeled the different cases. Such fixation occurs when bacteria transform nitrogen into ammonium for uptake by plant roots.

The results reveal the effects of nitrogen excess and deficits in the different ecosystems under study, as well as the likely impacts on the people and the natural resources in the region.

The findings of this project set the basis for the support of policy frameworks aimed at managing the nitrogen cycle, promoting best agricultural practices with reduced use of fertilizers, and developing long-term strategies for an efficient use of nitrogen in Latin America.

The importance of studying tropical dry forests

Tropi--Dry: Enhancing knowledge exchange for conservation and management of tropical dry forests in the Americas

Budget: US$ 882,500
Lead agency: University of Alberta
PI: Arturo Sánchez--Azofeifa
Countries: Brazil, Canada, Chile, Costa Rica, United States

Abstract:

Because of the importance of tropical dry forests, and the little information that can be found in scientific literature, the Inter -American Institute for Global Change Research (IAI) has supported the Tropi- Dry network to fill this information gap and propose options for the implementation of public policies.

Tropical dry forests have been globally under-studied: for every 300 scientific papers on tropical rainforest, only one was related to tropical dry forests, says researcher Arturo Sanchez-Azofeifa, director of Tropi-Dry, a collaborative research network supported by the Inter- American Institute for Global Change Research (IAI) that has been working since 2005 to improve the understanding of these ecosystems.

Their balmy climate and fertile soils make tropical dry forests one of the most preferred ecosystems for human settlement, agricultural and livestock activities, and urban development. This is precisely why tropical dry forests are one of the most threatened ecosystems in the world, and subject of enquiry to Sánchez-Azofeifa and researchers in the Americas, mainly Brazil, Canada, Chile, and the United States of America.

With over one hundred papers published in prestigious scientific journals and two books, Tropi- Dry researchers' results have been used by decision makers in Costa Rica and Brazil to understand these ecosystems and propose conservation and land use strategies.

Focusing on three major components - ecology, remote sensors and the human dimension-Tropi-Dry developed a tool to predict drought in Guanacaste, Costa Rica. The province receives many visits from national and foreign tourists not only for its beautiful beaches on the Pacific Ocean but also because it hosts the Santa Rosa National Park, home to a large tropical dry forest. Additionally, wireless network technology developed by Tropi-Dry is used throughout the world. At present, wireless technology to measure environmental variables is used in Germany, the United Kingdom, Brazil, Costa Rica, Canada, Singapore, and Australia.

From the ecological perspective, studying young (less than 10 years), middle-aged (10 - 50 years) and mature (older than 50 years) tropical dry forests, Tropi-Dry has developed a protocol that provides information on the evolution of forest composition and the way it defends from and recovers from extreme events such as drought and hurricanes. For instance, the network found that one of the impacts of climate change is the increase in the amount of lianas, which by strangling host trees contribute largely to forest destruction.

Besides Costa Rica, the network has detected this kind of deforestation on the Pacific coast, Yucatan peninsula, northwest Guatemala, Honduras and around the Nicaragua Lake.

Scientists have also been able to establish the benefits of what they call secondary tropical dry forests, i.e., those that are able to re-grow after being used for cattle ranching or agriculture for some time. Ecosystem services provided by tropical dry forests include carbon sequestration, the conservation of biodiversity, nutrient cycle regulation and water production.

Using modern satellite monitoring techniques, such as hyperspectral and laser (LiDAR) sensors, Tropi-Dry researchers conclude that the evolution of dry forests depends on the ecological conditions of the environment, soil composition and use, the origin of seeds (brought by wind or vertebrate dispersal), and meteorological characteristics.

Tropical dry forests cover about 40 percent of the tropical ecosystems worldwide; large part is being monitored using satellite imagery periodically to determine deforestation rates and the degree of fragmentation due to human activity. The group supported by the Inter-American Institute for Global Change Research (IAI) has advanced field-trip observations, as for instance in Minas Gerais, Brazil, where they measured the diameter of trees in young, intermediate and mature forests, confirming that tree growth depends of the forest species and the biophysical factors that regulate forest development and structure.

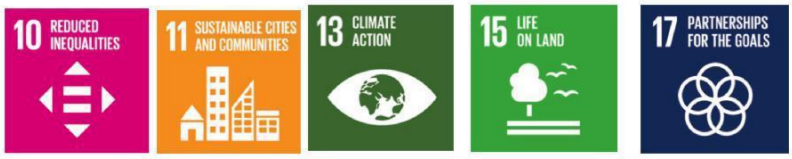
Tropi-Dry has also had major participation in two meetings of the UN Climate Change Convention (Lima and Morocco) where some of the researchers of the network actively worked during the UN Research Dialogues.

Aware of the close relationship between tropical dry forests and human settlements, Tropi-Dry has included in its research the social component in support of management and conservation policies for these ecosystems. “The challenge”, says Sánchez -Azofeifa, “is to develop reference frameworks [in human and ecological systems], to help maintain ecosystem health while recognizing and improving human well-being”.

From climate knowledge to action

Towards usable climate science: Informing decisions and provision of climate services to the agriculture and water sectors of southeastern South America

Budget: US$ 765,499
Lead agency: Universidad de Buenos Aires
PI: Cecilia Hidalgo
Countries: Argentina, Brazil, Paraguay, Uruguay, Bolivia, Chile, and United States



Url: http://serviciosclimaticos.blogspot.com.ar/

Abstract:

By means of cutting edge technologies, though mainly with the users of climate information in mind, a research project co-funded by the IAI focuses on the co-production of knowledge to provide climate services involving both scientists and sectorial stakeholders.

When a project is able to make scientific information accessible for decision making by policy makers and citizens, the society at large benefits and the project becomes successful. Scientific research that not only deliver new knowledge but also involve potential users and strive to make their outcomes available to those who need them, definitely make a difference in terms of their societal relevance.

Climate information is key to decision makers as it helps them analyze and anticipate effects on a wide range of activities, in particular food production, energy and water supply systems that sustain populations. Under climate change and smaller-scale climate variability, the frequency and intensity of extreme events and natural disasters such as floods and drought are also changing, with great human and material losses. Applying scientific evidence to decision making makes it possible to prepare for these events and reduce costs.

This is why, since its inception, the interdisciplinary team of the project *Towards usable climate science: Informing decisions and provision of climate services to the agriculture and water sectors of southeastern South America*, involved researchers from the natural and social sciences: meteorologists, hydrologists, agronomists, engineers, ecologists joined anthropologists, communicators, and economists to respond to the global need for useful climate services and products that are reliable, easy to access and timely.

As a result, a database is available for societal sectors in southern South America that are sensitive to climate –i.e., energy, water, agriculture and livestock, health. To achieve this, countries in the region have joined forces for the first time ever to develop a consolidated set of meteorological data that is subject to rigorous quality control. The database is continuously updated; it provides information on the duration and/or intensity of drought or

water excess, and makes it possible to draw conclusions about vulnerability and the impacts of drought on agriculture and human health, among others.

An innovative method

The project funded by the Inter-American Institute for Global Change Research (IAI) is a multinational, interdisciplinary, inclusive network that includes Argentina, Brazil, Paraguay and the United States. The network develops its activities in close relation with the Regional Climate Center Network for Southern South America (CRC -SSA) and is consequently related with Uruguay, Bolivia and Chile, as members of CRC-SSA. It promotes the recent concept of 'climate services', in order for "scientific achievements to articulate with the planning and decision-making related to environmental and economy policies", according to anthropologist and project leader, Cecilia Hidalgo, from the University of Buenos Aires.

The Collaborative Research Network IAI-CRN3035 has adopted the following definition of ´climate services´: the production and timely delivery of climate data, information and knowledge that is useful for decision-making by users in climate-sensitive sectors and general population.

The project compiled regional meteorological records from 329 weather stations in south of Brazil, east of Paraguay and central-eastern Argentina, Chile, Bolivia and Uruguay from 1961 to date. Data were checked and information-sharing tools were updated, applying the strictest quality controls. Moreover, a regional drought monitoring system was implemented, with special emphasis on the assessment of soil moisture, as a major component of the water balance. It also implemented yield prediction software for the major crops in the region, which include soybean, maize and wheat, from sowing to harvest.

Scientific outcomes are the result of the interaction between researchers and key users from governments and non-governmental organizations "who managed to maintain dialogue and joint work over time, a central aspect for a successful provision of climate services", Cecilia Hidalgo emphasizes.

By relating the database with yield simulation models for the mentioned crops, accurate yield predictions were achieved for 14 localities in the Argentine Pampas region. "The relationship between moisture accumulated in the soil, the number of consecutive days without rain and the yields in specific areas provides information for estimating insurance indices; it also reveals the need for an improved weather station network", the researcher added.

Actionable scientific information

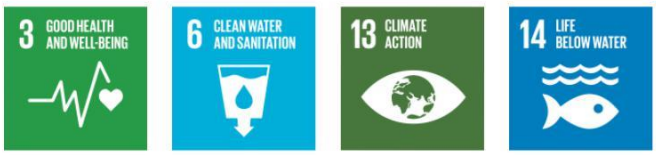
The social context possess pressing scientific and democratic challenges in moving towards the strategic goal of achieving sustainable development. The Inter-American Development Bank (IDB), the University of Buenos Aires (UBA) and the National Council for Science and Technology (Conicet) of Argentina joined the IAI to sponsor this project for its innovative and practical approach. The project combines the achievements of cutting edge climate science with the social perspective of those who are affected by climate changes. Consequently, it generates evidence-based information for decision-making.

Producing climate information to improve decision-making processes is a major challenge. Facing those challenges requires assuring the quality of knowledge and the legitimacy of

decision-making procedures. An important success of this project is having settled collaboration among scientists and practitioners working in government offices and relevant social sectors to share, understand, assess, and co-produce sound knowledge. The academia, government and stakeholders interact in support of collective action.

The state of American lakes and lagoons

Sensing the Americas' Freshwater Ecosystem Risk (SAFER) from climate change
Budget: US$ 902,100
Main agency: Argentine Institute of Oceanography.
PI: Gerardo M. E. Perillo
Countries: Argentina, Canada, Chile, Colombia, United States and Uruguay



https://www.facebook.com/SAFER.IAI/

Abstract:

A project developed by an interdisciplinary group of natural and social scientists that studies the state of river basins, lakes and lagoons on the American continent has delivered advice and guidance on the management of these bodies of water to aid policymaking, and has generated awareness among other groups, such as children and young people.

Because they want children to value water, two researchers from different countries, supported by the Inter-American Institute for Global Change Research (IAI), asked their daughters to write a novel for high school students and a story for younger children. The first one, *Water thieves*, tells of the adventures of two sisters who steal water to survive, after bacteria contaminated all the fresh water of South America. Their adventures take them into the past where they must escape the bacteria. The second one, *The pink brush*, recounts the search of little Alejandra for her lost brush, found by another girl, Luisa, pressed between the algae of a big wetland. Luisa's determination to find Ale, and the support of her sister to succeed, conclude in a rich conversation between the two families about the value of preserving precious water.

The messages of the two publications also reached decision-makers and inhabitants of the towns and villages surrounding the lakes and lagoons that were studied.

How are lakes and their basins related to the settlers who use them? The La Salada lake and Senguer river in Argentina; lakes Muskoka in Canada and La Paloma in Chile; the big swamp of Santa Marta in Colombia; San Joaquin River in the United States, and Rocha lagoon in Uruguay, were the guinea pigs in a study on the effects of climate variability and anthropic activities. Global changes and human activities lead to floods or droughts, damage flora and fauna, increase pollution and acidify waters, promote the arrival of invasive species and, in general, destroy the original ecosystem. They affect what scientists call "ecosystem services", which are benefits offered to communities by nature such as fishing, water consumption or tourism.

What do these water bodies “feel” when they are affected by climate or human action? This was the question that the team from the project *Sensing the America's Freshwater Ecosystem Risk (SAFER) from climate change*, supported by IAI, studied for six years.

Using new scientific methods, researchers took samples, measured and calculated the state of each basin. Through social methods, anthropologists, economists and sociologists involved the users as well as the decision makers of the populations to help them understand the situation and generate solutions.

The inclusion of paleolimnologists who studied historical changes in the evolution of the environments helped “set the thresholds and the resilience pattern of each hydrological system”, according to oceanographer Gerardo Perillo, the main researcher of the project. He helped to show how these environments have changed over time and how they have responded to natural pressures, such as rising sea levels.

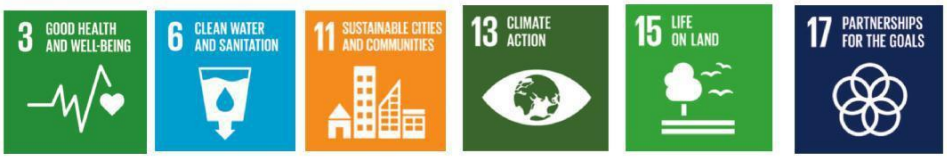
The results? The studies in the six countries supported decision-making based on scientific evidence, designing management strategies and mitigation policies for each particular case which were “technically and economically feasible, as well as culturally acceptable”, according to the project website.

The case of La Salada lagoon, a tourist attraction, is symbolic, according to Perillo. “We took samples and saw that it had pollution problems,” he says. “And with them we worked on the idea of establishing green filters in the lagoon.”

The novel and the story have reached children and young people, there are almost 120 scientific publications, and the advice to decision makers is relatively frequent.

Environmental conditions affect human health in the Amazon forest

LUCIA: Land use, climate and infections in Western Amazonia
Budget: US$ 906.500
Lead agency: Universidade Federal de Minas Gerais (Brazil)
PI: Alisson F. Barbieri
Countries: Brazil, Ecuador, United States, and Peru



http://institutodegeografia.org/lucia/

Abstract:

A computer model to estimate malaria transmission as a result of changes in climate and land-use proves useful for public policy making and reduce social and economic consequences.

Climate change, migrations or land use changes due to urbanization, road building and deforestation for agriculture and trade, increase the occurrence of infectious vector-borne diseases transmitted by mosquitoes and some animals.

In the south-western Amazon, two types of parasite are responsible for malaria cases, a potentially fatal disease. They are *Plasmodium falciparum* and *Plasmodium vivax*, which infect humans through the bite from mosquitoes *Anopheles darlingi* and cause the disease.

A computer model simulating the activity of the agents present in the infection process - mosquitoes, parasites and human beings- was able to reproduce accurately spatial and temporal variations in the transmission of malaria in environments with low endemicity that are subject to river flooding, a frequent event in the Amazon region of Brazil, Ecuador, and Peru. The information obtained makes it possible to develop public policies to reduce the social and economic impacts on the people affected by the parasite.

With the support of the Inter-American Institute for Global Change Research (IAI), economist and demographer Alisson F. Barbieri, Institute of Geosciences, Federal University of Minas Gerais in Belo Horizonte, Brazil, and his network *Land Use, Climate and Infections in Western Amazonia* (LUCIA), which includes researchers from several countries, validated the Agent based model (ABM) in three regions of western Amazon to prove how the combination of land use and climate dynamics impact on the vulnerability and health of people: in the northeast of Ecuador, where three factors, i.e., mining, indigenous people and settlers; in Machadinho, Brazil, where agricultural expansion and

deforestation increase the vulnerability of its inhabitants; and in Madre de Dios, Peru, where gold mining and deforestation impact on human health.

Con base en el caso del Perú, the model was validated with information on malaria incidence reported empirically in the locality of Padre Cocha, from 1996 to 1998. The model includes the representation of agents –mosquito habits, different transmission patterns of infection by *Plasmodium*, as well as the population dynamics in the region–, and of the environment where the malaria infection cycle takes place; for instance climate changes or floods in the adjacent water bodies.

Studies showed that risk is low in the center of the settlement, away from the rivers, while homes that are in the peripheries are more susceptible for the disease. Moreover, the management of sources of mosquito larvae development is key to vector eradication or reduction, which was simulated by the model.

Consequently, once the model was able to reproduce past conditions that matched the records, although not all the factors were represented in their full complexity, several potential scenarios were put forward in order to understand the effects of management of the places of larvae development, in an area of more than 200 meters around settlements. It was found that eliminating larvae sources causes the disease to disappear. In view of these research results Ecuador has already modified their mining-related policies, says researcher Barbieri.

Sponsored by the IAI, researchers continue their research based on the lessons learned. One of which is the importance of involving decision makers from the inception phase of research projects. Another lesson is that measuring vulnerability needs to consider not only human and social aspects but also environmental conditions.

> In addition, the migration that is taking place in the region in the past years, makes it necessary for national health monitoring and surveillance systems to consider past migrations and environmental conditions to correlate them with disease episodes.

Arid America: a challenge to guarantee water for society and environment

Innovative Science and Influential Policy Dialogues for Water Security in the Arid Americas (Aguascapes)
Budget: US$ 800,000
Main agency: The University of Arizona
PI: Christopher Scott
Countries: Argentina, Brazil, Chile, United States, Mexico and Peru

http://www.aquasec.org

Abstract:

A study of watersheds in six countries in the American continent concludes that collaborative work between the communities that live in the ecosystems, their political and social leaders, and scientific researchers, allows all parties to reach consensus on how to move beyond climate effects, and guarantee the availability of water resources.

Scientists from the Center of Excellence for Water Security (AQUASEC) supported by the Inter-American Institute for Global Change Research (IAI) spent several seasons on the frontiers between Sonora (Mexico) and Arizona (United States), the valleys in the east and west of the Andes of Chile, Argentina and Peru, and the northeast of Brazil, identifying the challenges of accessing water in these regions, and also making viable proposals for better resource management.

These are arid areas where climatic variability (droughts and floods) and land use require that inhabitants look for alternative ways to access water resources, for example through underground water, since it is impossible to find water permanently on the surface. This water shortage inhibits ecosystem services, reduces socioeconomic development, and changes the landscape.

The research team found that, despite the uncertainties, vulnerability and risks that insecurity in water access generates, there are also opportunities, particularly when scientists, decision-makers and communities work collaboratively.

During the five years of the project, AQUASEC scientists – some of them members of the Intergovernmental Panel on Climate Change (IPCC) – studied the social, ecosystemic and hydroclimatic interactions in 12 river basins: Mendoza and Tunuyán in Argentina, Capibaribe and Pajeu in Brazil, Maipo and Limarí in Chile, Piura and Ica in Peru, Santa Cruz and San Bernardino in United States, and Sonora and Yaqui in Mexico.

These are regions where the water resource is so valuable that it generates competition between urban and rural citizens. These basins are comparable with others that were the object of a previous study in another project supported by IAI, entitled *Towards an integrated evaluation of water security in the context of global change in the Americas.*

With a methodology that included climatic scenarios, mathematic simulations and surveys, the scientists concluded that "it is possible to improve adaptation to climate change with a reasonable efficiency, through cultural and productiveness activities without needing big investments."

In order to generate public water policies that allow adaptation to the varying availability of water and promote "sustainable management" the project promoted interaction between the different actors, which included scientists, water or land managers, rights holders, water user associations, members of civil society and decision-makers.

Whilst looking to identify the consequences of hydroclimatic variability and land use, as well as possible institutional changes in water management, the research team outlined adaptation and resilience strategies specific to each studied area, taking into consideration both local practices and directives of the institutions responsible for water management.

"Each region, considered individually, represents an ideal lab where interactions between society, ecosystem and hydroclimatic features in a global context of change can be observed and can help teach lessons," the researchers say.

When they shared information, the different actors were able to reach consensus on ways to guarantee the availability of water resources based on conceptual and practical analysis of the social use of water and taking into account the dependence of human beings on this resource, hydroclimatic processes, and historical knowledge of climatic conditions and land use in these basins.

Christopher Scott, lead researcher of the project, is director of the Udall Center for Studies in Public Policy and lecturer in hydric resources at the School of Geography and Development at the University of Arizona. Scott acknowledges the threat that the situation in these regions represents to human life and ecosystems in the basins.

“Most scholars and observers agree that the world’s dryland areas share numerous risks associated with growing demand for water in the face of large-scale environmental change,” says one of the papers written by the researchers. “And while context will always determine specific challenges, we believe that science-policy dialogues that aim to address vulnerability and promote adaptive capacity can be designed to improve environmental decision-making in most settings,” the paper says.

The secrets of the ocean

Climate, ocean goods and services in South America
Budget: US$884,870
Main Agency: Argentine Institute of Oceanography.
PI: Alberto R. Piola
Countries: Argentina, Brazil, Chile, United States, Peru and Uruguay

http://sacc.coas.oregonstate.edu/~sacc/

Abstract:

Scientific knowledge on what is happening in the oceans in the southern part of the American continent supports decision-making for the sustainable management of fisheries and actions to adapt to climate change. The research of the international network VOCES, supported by IAI has unveiled many secrets of the Patagonian Sea.

Water bodies such as oceans and the marine species that live there do not respect national frontiers. Water and wind, as well as flora and fauna, do not need passports to navigate underwater or across the surface of the sea. Yet, in these environments biodiversity is suffering, mostly as a result of the actions of human beings.

It happens worldwide, but also in the southern part of the American continent. As a result, countries have created a network to study and understand how climate change and climate variability influence oceanic, atmospheric and terrestrial ecosystems.

From the marine waters of Patagonia to the coasts of Brazil, Chile and Peru, scientists of different disciplines and nationalities are studying the effects that ocean currents, strong winds and tides have on small- and medium-sized artisanal fisheries, increasing the algal or jellyfish populations in some cases, or even reducing clam or shrimp populations, in others.

For instance, they have found that the Patagonian Sea has particularities that do not happen in other regions. The most evident has to do with a phenomenon that scientists call upwelling, and refers to the ascent of deep ocean waters – usually cold and rich in nutrients – to the surface.

Along the coasts of California, in the United States, Chile and Peru, this phenomenon happens because of the action of the wind. But in the southern part of the continent, the Falkland current sparks the upwelling, helped by the abyssal topography, with the same force as the one caused by the wind in other regions. With the wind this phenomenon can last a few days, yet in the Patagonian Sea it can happen all year long.

“These results suggest that Patagonia could be an important source for iron and other nutrients that fertilize the entire Southern Ocean,” researchers say.

But there is more. The Southern Ocean is absorbing carbon dioxide from the atmosphere through biological processes mainly connected with phytoplankton, anchovies, hakes and calamari. It is being deposed in the bottom of the sea where it could rest for hundreds of years. For this reason, the Patagonian Sea is considered as an important CO2 reservoir.

The international network, VOCES, supported by the Inter-American Institute for Global Change Research (IAI), is working to understand these dynamics, producing results based on scientific evidence, comparing them with the findings of peers at climate change meetings, and calling the attention of national and regional decision makers.

The results have been so overwhelming that, in 2016, the Senate of the Argentine Republic approved a declaration in which the project was declared of national interest, through the case file 523/16. The document says: “Reliable scientific information, based on greater available certainty, is an essential component of the development of legislative policy which can evaluate proposals using science, improving its impact on people’s lives.” The document calls for the harmonization of rules across countries, allowing them to more effectively “respond to natural complexity and mitigate the impact of humans”.

VOCES, has coordinated regional marine research initiatives, promoted new scientific research, improved understanding of the processes that occur between marine systems and the deep ocean, and determined their impact on species of great importance for the region. This allows decision makers to develop policies to deal with global warming and protect fisheries.

According to the researchers, the large marine ecosystems of Patagonia, Humboldt and southern Brazil “sustain more than 20 per cent of the global fish catch, host unique biodiversity, and absorb 40 per cent of global CO_2 emissions”.

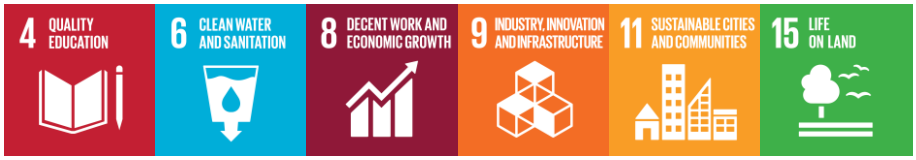
Because of the importance of fisheries in the region, the project has ensured its assessments have also taken into account the historical and social impact of developments on people who live from artisanal fishing. For example, it looked at the overpopulation of jellyfish in Peru, which impedes the production of anchovies, the country’s main fishing resource.

The products and activities researchers have developed during the execution of the project include more than 40 published articles, a book, and several workshops involving decision makers.

If IAI has influenced and contributed to the discussions of the Intergovernmental Panel on Climate Change, the United Nations Framework Convention on Climate Change and the Ocean Conference (New Yok, 2017) through numerous funded researches, the contributions of the studies developed in the oceanic ecosystems around South America are the ones that have influenced the most in public policies.

Impact of huge highways in the jungle

RAICES: Effects of anthropogenic habitat perturbation on rodent population dynamics and risk of rodent-borne diseases (CRN 3076)
Budget: US$884,870
Main agency: Tulane University, United States
PI: Daniel Bausch
Countries: Bolivia, Ecuador, United States and Peru.



http://www.iai.int/en/post/detail/crn-3076-raices-perturbacion-antropogenica-y-roedores

Abstract:

Research on the impact of the construction of highways in pristine ecosystems, supported by the Inter-American Institute for Global Change Research (IAI), draws attention to its possible consequences for human health.

The Peru-Brazil Inter-Oceanic Highway connects the Brazilian ports on the Atlantic Ocean with the Peruvian ports on the Pacific Ocean. It is a transcontinental highway of 2,600 kilometers, built between 2002 and 2011, which has produced developmental and economic benefits. However, a five-year study concludes that besides the improvements in sanitary and food infrastructure, it has caused a change in human land use which has generated a loss of biodiversity and a transformation in fauna dynamics.

The research, co-financed by the Inter-American Institute for Global Change Research (IAI), reached several conclusions. Among these, the construction of highways changes population composition and distribution of wild rodents. This in turn increases the potential for human contact, putting the health of surrounding populations at risk due to the life-threatening nature of some of the diseases that rodents transmit.

The field study took place in four populations in the department of Madre de Dios, Southeast Peru: Santa Rosa, Florida Baja, La Novia and Alegría. These populations are mainly dedicated to forestry and agriculture. The interdisciplinary group of scientists interviewed leaders and members of the communities individually and in groups to learn about the highway's impact on their quality of life and health. They suggested topics such as the change in the communities' dynamics because of the arrival of migrants at the beginning of the construction. They also applied surveys to measure the impact of the communities' perception of their health and the risks to their well-being. They took samples of the rodents in the region and identified the presence of bacteria that produce infectious diseases when transmitted by these vectors.

Perception of the communities

The study was based on two focus groups, 35 in-depth interviews with key informants of the region, and the application of a survey which 522 people answered. One of the most surprising results was that 90% of those who answered the interview and had seen rodents around their houses could not name the diseases the rodents transmit. They describe them as nasty animals, and they use cats as an eradication method.

The informants declared that the quantity of rodents had increased since the construction of the highway but were not conscious of the risks that this entailed. “If rodent-borne diseases are not on the radar of health professionals, they may not consider presumptive treatment, which could result in unnecessary morbidity and mortality”, concludes one of the published articles based on the research.

As part of the construction works and due to the easier access to agricultural and mining work, the region has experienced the arrival of a large number of workers, many of them immigrants. The study did not find any differences regarding access to food or health services between the incoming construction workers and the residents. Instead, the study identified social gaps between the incoming population and the resident one, mostly because of the perception that the residents have of the incomers. The latter are perceived as using the land in non-sustainable ways for agriculture and then leaving. Since both populations had greater similarities than differences regarding well-being and since they both trust the local government more than the national one, the researchers’ recommendation is that the responsibility of enacting potentially necessary changes should fall to local leaders. They propose the encouragement of social cohesion through participation in organizations, secure property rights and improving job opportunities.

In general terms, the local population perceives that the construction of the highway has both positively and negatively impacted their well-being. Perceived positive impacts include increased access to infrastructure (including healthcare) and a variety of food products, employment opportunities and cultural exchange. Perceived negative impacts include changing community dynamics due to migrants, an increase in the risk of certain diseases (e.g. dengue fever and gastroenteritis), road accidents, increased crime (drug-related and sex trafficking), increased contamination of food and water sources, soil depletion and flooding, and decreased biodiversity due to gold mining, much of it illegal.

Rodents as disease vectors

The research team made a longitudinal study collecting wild rodents in habitats with different levels of anthropogenic perturbation in the surroundings of the mentioned communities. The samplings were taken every four months between December 2013 and September 2016. Researchers analyzed samples from a sub-group of 97 rodents of eleven different species, collected between 2014 and 2015, and they found that 78% of them were positive for *Bartonella* bacteria and 24% for *Leptospira*. These microorganisms cause serious infectious diseases that, without care or proper treatment, can be lethal. The numbers of these rodents varies according to season, as well as with changes in land use. Even though a large presence of *Bartonella* was found in both the rainy and the dry season, and in disturbed areas, *Leptospira* presence in animals was more prevalent during the rainy season.

Changes in land use because of human activities, as well as deforestation and agricultural expansion, can contribute to an increase in animal-human interaction and cases of zoonotic transmission. Taking this into account, scientists draw attention to the need for better knowledge of what they call a “pathogen landscape”, which is present in human settlements around the highway, in order to understand the risk of the population acquiring infectious diseases.

“People living in Madre de Dios struggle between the prospect of development and the increasing global need and pressure for conservation”, researchers say.

Despite the fact that the study centered around the Inter-Oceanic Brazil-Peru route, it also included other areas where the construction of roads in pristine forests in Ecuador and Bolivia has had consequences for the environment and human health.

Because of this, they recommend more complete public health strategies, adapted to the dynamics of the areas where habitat transformation by human activities occurs. They also endorse collaboration with community leaders in order to improve empowerment and encourage an exchange of ideas about how to manage and adapt to changes in their environment. Finally, they suggest implementation of public policies for land use which consider the health of the ecosystem before any intervention.

Regarding the different approaches utilized in this research, ecologists, mastozoologists, veterinarians, epidemiologists, social scientists, experts in remote sensing and geographic information systems, and experts in the diagnosis of pathogens all participated in the study.

The silent benefits of the oceans: the value of phytoplankton

Assessment of marine ecosystem services at the Latin-American Antares time-series network (CRN 3094)
Budget: US$699,979
Main Agency: National Institute for Space Research, Brazil
PI: Milton Kampel
Countries: Argentina, Brazil, Chile, Colombia, United States, Mexico, Peru and Venezuela.

https://antaresiaiproject.wordpress.com/

Abstract:

The health of the oceans and their ability to absorb CO_2 relies mostly on phytoplankton. Research supported by the Inter-American Institute for Global Change Research (IAI) shows the value of these tiny plants as ecosystem service-providers.

The tiny unicellular marine plants that are the basic food source for marine life as a whole – including fish and whales – are also useful to human beings because of their ability to absorb carbon dioxide dissolved in water in the form of organic compounds.

We are talking about phytoplankton – a word that comes from Greek and means 'wandering plant'. In fact, these organisms transport themselves freely by floating adrift in the sea. In this way, they provide what biologists call 'ecosystem services'. One of them is key for our survival: they produce half of the available oxygen on the planet.

Researchers supported by the Inter-American Institute for Global Change Research (IAI) are studying phytoplankton as if it was a human patient that they must monitor – physically, chemically and biologically – in order to diagnose its condition, and therefore the health of the marine ecosystem. The scientists are looking for a connection between the dynamics of phytoplankton in the ocean and its benefits to society, through permanent monitoring in five observatories in Latin America: the Permanent Station of Environmental Studies of Argentina (EPEA, in Spanish); Ubatuba in Brazil; Ensenada in Mexico; IMARPE in Peru and CARIACO in Venezuela. The motive for this research centers around the fact that today's oceans are not the same as 40 years ago, because of natural causes as well as human activities that have generated climate change. In addition, phytoplankton plays a very important role in this process. Why?

The ocean alone provides the ecosystem services that benefit humanity the most: it absorbs around a third of the CO_2 emissions of the planet, but not homogeneously. It depends on biological and environmental conditions, such as the kind of phytoplankton and its size (big or small cells). Under some conditions there is a greater absorption of CO_2, and this study was able to prove that this is due to the different kinds of phytoplankton in certain areas.

This means that it is not only terrestrial forests that fulfill this carbon sink function. The ocean does too, even though society does not fully know about it. “To a large extent it remains invisible to society since it is not measured regularly”, say the researchers, among which are the oceanographers Vivian Lutz and Milton Kampel. The phytoplankton, which is the basis of the oceanic food chain, works also as a “sensor of climate change”, says the ecologist Rubén Negri, who is also part of the project.

This research was carried out within the collaboration of the Antares Network, to which eight countries of this continent belong. Scientists from other disciplines have also participated in order to understand not only the processes that occur in the sea around Latin America but also the socioeconomic factors. They aim to quantify the benefit of oceans for human beings. The researchers have also reviewed the literature on sea capture fisheries and its potential to facilitate climate change analysis.

This data will help to confirm the degree of importance of care of the oceans and to provide rigorous and convincing information to be addressed to decision makers. This is even more salient now that the planet will soon enter the Decade of Ocean Science for Sustainable Development (2021-2030), as declared by the United Nations. “We hope that scientific research will help reduce the uncertainty around policy formulation”, the researchers conclude. Not only is it necessary to generate data and scientific information, but it is also important to know how to communicate it.

In the long term, the studies will include data from monitoring stations in Chile, Colombia, and Ecuador, in order that all Latin American countries be represented in the Antares Network. However, studies that will produce long-term information about the conditions of phytoplankton and the oceanic environment are difficult and expensive, “which causes a knowledge gap about the limiting factors that affect the health of marine ecosystems, and how this impacts human society and food security”.

Production and/or conservation?

BEST-P: Bridging ecosystem services and territorial planning, a southern South American initiative
Budget: US$698,995
Main agency: National Council of Scientific and Technical Research, Conicet, Argentina
PI: José M. Paruelo
Countries: Argentina, Chile, United States, Mexico and Uruguay

http://bestp.agro.uba.ar/

Abstract:

This big project, delivered in three South American ecosystems analyses the bond between territorial arrangement plans and ecosystem services. Supported by the Inter-American Institute for Global Change Research (IAI), the research concludes that conservation is possible without reducing the productivity of the silvopastoral sector.

It is not easy to convince those who have worked for decades in agricultural or livestock activities to transform their properties – or part of them – to provide conservation ecosystems. Likewise, it is hard to suggest that decision makers consider the ecosystem while working on territorial arrangement plans. We don't need "greenwash", but instead to understand that, in the end, these conservation areas are useful, since they generate what researchers call *ecosystem services*.

This project brings together a team of 23 researchers including sociologists, anthropologists, ecologists, climatologists, agronomists and economists, who represent nine institutions from five countries of South America. They have worked for more than five years with a main goal: that the concept of ecosystem services – the goods and services that ecosystems provide – should be an essential component for land use planning in south of the continent.

For instance, the group has found that this region registers the highest rate of natural habitat transformation in the world.

Human beings modify land use according to a variety of factors, such as social, economic, cultural, historical, and political, which BEST-P has taken into account in its studies. Supported by the Inter-American Institute for Global Change Research (IAI), the studies have been centered in three ecosystems of five countries: the Grasslands of Rio de la Plata in Argentina and Uruguay; the dry-forests of the Gran Chaco in Argentina, Paraguay and Bolivia; and the Valdivian forests of south-central Chile.

For the Chacopampean plain, the network of researchers has focused its work on four ecosystem services: capture of organic carbon in the soil; recharge of groundwater; hydrological yield and avian biodiversity. The team has done this based on observations and simulations of biomass and the yield of soil organic carbon using the CENTURY model. “The simulations show that the replacement of woods for annual crops has generated a loss of 66mg of carbon per hectare of biomass in the surface, a loss of 40% of carbon in the highest soil layer, to a depth of 1m,” the researchers said. “This loss of soil carbon has affected negatively ecosystem services such as weather and regulation of soil drainage, as well as erosion protection.”

A key problem is deforestation of the Argentinian Chaco, as more than a half of it is illegal. The researchers conclude that the lack of instruments to quantify the damage caused hampers efforts to constrain this process. This has consequently decreased what ecosystem services can offer, compromising the sustainability of agricultural production.

The fieldwork measurements showed that in the semiarid Chaco forest patches have a positive effect on drainage of agricultural parcels. By expanding the results, they concluded that if producers decide to preserve the remnant of forest that they still have in their properties, in some areas of southern South America “they can improve their conservation results by 30–50% without significantly reducing productivity”.

The team also studied and analyzed other aspects of ecosystems, such as climate regulation, trace gas emissions and the kind and distribution of habitats. In some of them, they analyzed the recovery potential of ecosystem services through the restoration of ecosystems and landscapes that have been impaired or degraded.

The book *The place of nature in decision-making: Ecosystem services and rural territorial arrangements* has been produced as a consequence of the projects carried out by BEST-P researchers. It is a valid tool to combine conservation of ecosystems with development of the studied rural areas, useful for public policy and relevant for other regions of the continent. The book emphasized that, in order to understand the territory, it is not only necessary to understand “the ‘current picture’ but also the historical trajectory of the human and natural dimension”.

Thus, ideal land use planning achieves a greater offering of goods and services, or effectiveness, and a fairer distribution of them, or equity. In this last aspect, the researchers concluded that, for instance, due to land-use change during the past 15 years the aboriginal communities of Chaco have lost more than 25% of their subsistence resources. “Territorial disputes, motivated by land-use changes have affected the basic human rights of peasants and indigenous people.” said the researchers. In addition, they concluded that “throughout southern South America, the costs and benefits of this land

transformation for the different stakeholders are poorly characterized, and the benefits are not available to the most vulnerable social sectors."

Some of the results of the Project have affected the instances of decision-making, such as in the implementation of the Native Forest Law of Argentina. They have also been shared with local communities and landowners through workshops and training sessions. Twenty videos that show the findings of the project can be seen at the following link: https://www.youtube.com/playlist?list=PLIhbZHvVRROQWcJeDO_MPU-cv68dJKNHB.

In one of them, while speaking with a community that suffered because of land-use change, the principal investigator of the project, José Paruelo, said: "I do not know if we are going to find a solution, if we are going to solve the problem, but we will not stay still."

Lack of preparedness prevents effective public-sector drought response

Interdisciplinary research to improve information provision for decision making (CRN 3107)
Budget: US$180,000
Main agencies: Bioversity International, with the support of the Tropical Agricultural Research and Teaching Center (CATIE), Action Against Hunger, Ministry of Agriculture, Livestock and Food (MAGA), National Coordination for Disaster Reduction (CONRED), and the Climate Change, Agriculture and Food Security program of the CGIAR (CCAFS)
PI: Jacob van Etten, Anna Muller
Countries: Colombia, Costa Rica and United States.

https://ccafs.cgiar.org/es/agroclimas#.XNGf3-hKjIV

Abstract:

As part of research supported by the Inter-American Institute for Global Change Research (IAI), two emergency drills for droughts in Guatemala were conducted in order to improve emergency planning for future climate eventualities.

As the famous proverb preaches, 'Prevention is better than a cure'. The research aims to provide information useful to public decision-makers in facing the frequent droughts that affect the agricultural activities and lifestyles of the residents of Chiquimula, Guatemala, one of the most drought-vulnerable areas.

The project was based on emergency drills, an original and applicable idea even though droughts do not occur overnight, unlike earthquakes, volcanic eruptions or avalanches. Droughts can last for months and have long-term effects. Unfortunately, decision-makers often realize the emergency so late that the rains begin again and the impetus to act on the matter vanishes. This means that the need for a solution to the devastating effects that droughts generate - such as food insecurity - remains unfulfilled.

This is why researchers from different institutions, led by Bioversity International, with the support of the IAI proposed a project that prioritizes proactivity in circumstances that are commonly addressed in a reactive way, such as droughts. Would drills be a good resource to prepare the Ministry of Agriculture, Livestock and Food (MAGA) of Guatemala for swift action in the face of a slowly unfolding natural event?

Chiquimula is a unique case: precipitation ranges from 600 to 1000 millimeters per year. Between 2009 and 2015 it suffered four extreme and unusual drought events, called *canicula*. The region is characterized by a poor rural population, which is very vulnerable to food insecurity.

Jointly with other international institutions and the MAGA, researchers designed two emergency drill protocols for droughts, which took place in 2014 and 2015. These drills aimed to generate useful, precise and timely information so that decision-makers could act with diligence and avoid costly lessons from trial and error.

The researchers used the Institutional Response Plan (PIR, in Spanish), developed by the MAGA in 2012 to reduce the impact of droughts on agricultural infrastructure, crops and human life. PIR's five stages – monitoring in the field, release of an alert statement, an emergency declaration, and actions during and after the drought – are based on information flow between the MAGA and other institutes. In the drills, only the first two stages were undertaken.

Each drill lasted a day and a half. During the full day the drill was performed, and the following half-day was devoted to analysis of the strengths and weaknesses during the process. Some of the highlighted strengths were the empowerment and confidence of public officers who work in the field, as well as the farmers' network, the pertinent steps outlined by the PIR and institutional coordination at a local level.

However, there were more weaknesses than strengths. Among them, the communication problems between the different departments of the MAGA; the absence of an appropriate tailored poll to deliver data, which threatens the reliability of the information because it influences whomever is delivering it; the paucity of available supporting information; the high turnover of employees in the ministry; and poor communication infrastructure i.e. roads and mobile signal.

From the analysis, researchers concluded that drills could be a useful tool for the MAGA since they allow them to assess the drought response and provide information. They also warn that tangible transformations in organizations depend on the context in which they occur.

They gave some recommendations, notably the implementation of a training program on PIR for public officers as well as for farmers in order to standardize evaluation equipment in the field and improve communication infrastructure.

Knowing the citizen to understand urban vulnerability

Coping with hydrological risk in megacities: Collaborative planning framework for the Mexico City Metropolitan Area (CRN 3108)
Budget: US$180,000
Main agency: National Autonomous University of Mexico, UNAM / Arizona State University
PI: Luis A. Bojórquez Tapia
Countries: United States and Mexico

http://megadapt.weebly.com/
https://lancisapc.wordpress.com/

Abstract:

Research based in the Mexico City Metropolitan Area, supported by the Inter-American Institute for Global Change Research (IAI), proposes a socio-hydrological perspective based on information, knowledge, and dialogue to counteract the risk of floods or lack of water.

Suppose that you are a decision-maker, and you have the challenge of making your city sustainable and resilient. Historically, some sectors have faced vulnerability to water scarcity and flood risks – including the public health issues associated with contaminated water. Political promises to provide seemingly magical solutions no longer work; action is required. But how best to proceed?

Tackling the problem from the perspective of 'sustainability science' may be useful. According to the project's researchers, funded by the IAI, sustainability science offers tools, methods and strategies to identify, represent and deliver information to decision-makers from all levels about the social and political processes that they can put into practice for effective governance and risk and vulnerability management.

This means that even though it is important to think about 'hard' infrastructure – what you can see and touch, such as engineering, it is also necessary to take into account the 'soft' infrastructure - social relations, norms, values and customs of the people who inhabit the area. For this reason, the solution proposed by the biologist Luis A. Bojórquez-Tapia, the geographer Hallie Eakin and other researchers is to work within a socio-political infrastructure, which creates behavior patterns and actions to build a sustainable and resilient landscape.

Sustainability and resilience combine in this socio-political infrastructure. They are the basis for the development of urban planning which captures, quantifies and visualises the preferences, social relations and political influences of its inhabitants. When the two interact they counteract urban vulnerabilities, allow these processes to become tangible public policies, and promote citizen action.

The participation of decision-makers and the inhabitants of the cities and their various interest groups is only possible if they understand the motivations, values, preferences and customs that affect the possibility of risks arising from hydrological problems.

Based on interviews, focus groups and participative workshops, the researchers identified ‘mental models’ about urban dynamics that show the different social actors in hydrological management, finding testimonies – such as narratives or discourses – that explain the possible causes and consequences associated with water dynamics in the cities. These mental models were the bases for the development of a computational platform for the simulation of urban vulnerability to hydrological problems. Through mathematical processes known as dynamic geospatial algorithms, the platform allowed the exploration of how certain actions and decisions could lead to the emergence and evolution of multiple vulnerability patterns. By juxtaposing simulation outputs with possible solutions, it shows how the narratives of social actors can germinate the seeds of a ‘sustainable urban transformation’. The researchers say in one of their articles that “the narratives and discourse that structure the decisions must change in order to unveil paths of alternative solutions that would otherwise be discarded”.

This approach may help to form better communication channels between society and the government in order to better face the threats to megacities arising from the combination of rainfall increase, severe droughts, and water scarcity, for instance.

“This framework could help decision-makers to navigate through the complexities of urban management”, conclude the IAI researchers.