communiqué

Balancing CO_2 in South America - IAI research backs regional approaches to climate change

After Copenhagen, it is becoming clear that regional approaches to carbon management may be the way forward. The American Institute for Global Change Research (IAI) has been working to improve the regional understanding of crucial processes of the carbon cycle.

The United Nations Climate Change Conference ended last month in Copenhagen without a binding agreement to cut CO_2 emissions. This has frustrated many people, but according to Holm Tiessen, IAI Director, "it probably achieved as much as it could. The climate convention discusses overall emission limits for the average temperature rise to stabilize at 2° C, but this does not reflect the realities of the globe." Temperature increases in polar and high mountain regions are already close to the 2°C mark, while in low and mid altitudes temperature may have risen by as little as 0.4° C. Tiessen adds that "the effects of climate change differ greatly between ecosystems, landscapes and societies. Regional differentiation of knowledge and decision making is needed to address the challenges of global change." Through its research programs, the Inter-American Institute for Global Change Research (IAI), is working to provide a regional understanding of carbon sources and sinks. This is part of its broader agenda: to develop research on climate change and inform the policy sector about viable approaches.

Two collaborative research networks, funded by the United States' National Science Foundation (NSF) through the IAI, illustrate how important the understanding of regional processes is to the mitigation of climate change. One team led by the *Servicio de Hidrografía Naval* of Argentina in collaboration with scientists in Argentina, Brazil, Chile, the United States and Uruguay is identifying the physical and biological mechanisms that control the exchanges of CO2 between the ocean and the atmosphere. "CO_2 sequestration is particularly important in the Southern Ocean, where water masses sink and upwell, and where nutrient levels are unusually high", said Alberto Piola, the coordinator of the group, "not only because it hosts some of the largest chlorophyll blooms of the southern hemisphere but also because the Southern Cone is the only continental landmass not covered by ice south of ~35ºS. Sediments from that landmass, and particularly the outflow from the Rio De La Plata, are possibly the main source of iron for the fertilization of the nutrient rich waters of the Southern Ocean".

Oceans play a fundamental role in the equilibrium of the climate system by redistributing the heat gained near the equator and controlling the hydrological cycle, and also by sequestering greenhouse gases from the atmosphere. The oceanic sequestration of CO_2, about 50% of anthropogenic emissions since the mid 1800´s, is associated with the sinking of cold waters at high latitudes and the photosynthetic activity of marine algae (phytoplankton) in nutrient-rich ocean regions. By

absorbing large amounts of CO2 from the atmosphere, continental margins are among the largest contributors to this global ecosystem service. The Patagonia continental shelf occupies a surface area of 1 million km2, about 4% of the global continental margins. It absorbs 22 Tg C yr^{-1} (million metric tons of carbon per year) and emits about 5. The resulting net absorption of 17 Tg C yr^{-1} is approximately 5% of the carbon absorbed on global continental margins. This rich biological activity is sustained by upward nutrient fluxes associated with ocean fronts near the shore and along the shelf break.

Unfortunately not much is known about how Patagonia's biological processes feed into the large scale circulation nor how its numerous fronts will respond to climate changes. "Global carbon models are suspected to miss at least one-half of the global ocean carbon flux to the deep ocean. This deficiency not only reflects our lack of understanding of the dynamic processes controlling upwelling and cross-shelf exchanges, but also our lack of information about regions away from the highly developed nations of the northern hemisphere", said Piola.

The Patagonian shelf break is one of the most important fisheries regions on earth, with a harvest of millions of tons of fish and squid every year. Today, most experts agree that marine ecosystems are badly overfished and that at the present pace no fisheries are sustainable. Overfishing not only depletes fish but also disrupts the marine ecosystem's food web. For instance, increasing populations of jellyfish are possibly associated with decreased predation by diminishing fish populations. Such changes could eventually affect zooplankton and phytoplankton communities - thereby disrupting the ability of the ocean to capture CO2 through phytoplankton photosynthesis. Although still poorly understood, such alterations of the marine ecosystem would be analogous to the impact of land-use change on the continental carbon budget.

Another IAI research team from Argentina, Uruguay, Paraguay, Brazil and the USA, led by Esteban Jobbágy at the University of Buenos Aires, Argentina, examines the impact of land cover and land use changes on the carbon balance of the La Plata Basin, the second largest hydrological system in South America. The basin is facing the largest and fastest landuse changes in human history, changes that have affected some 30 million hectares over the past 25 years (the period of more recent introduction of annual crops such as corn, wheat, sunflower - and most recently, soybean). Growing those crops over that period has reduced soil carbon by about 30%, with loss rates of 28 Tg C yr-1. The most important carbon stocks are in soil organic matter. Carbon losses from pastures over the last 300 years (the period when mostly pastures were established in the La Plata basin) were also high, but at rates 16 times lower.

The regional carbon balance therefore shows a carbon sequestration at the continental shelf of some 17 Tg and carbon release from the continent's soils near 30 Tg per year. The former is largely beyond human control, but possibly vulnerable to both global change and fisheries management, and the latter is directly attributable to agricultural activities. This knowledge carries important implications for decision making.

Some of the landuse conversion is now driven by a desire to substitute fossil fuels by "carbon-neutral" bio-fuels. However, the project on landuse demonstrated that letting the natural vegetation recover on former agricultural land is better for the greenhouse gas balance than growing biofuel crops. Carbon released from soil under corn grown for ethanol creates a "carbon debt" that may completely offset any carbon gains from using this biofuel for at least 50 years. Furthermore, carbon stored in soils under recovered grassland was higher than the possible C credits generated with corn for ethanol on the same land for 40 years, and it had equal or even greater economic net present value.

“Because of the large carbon releases resulting from land conversion, in most cases preserving idle or set-aside lands seems a better alternative for the greenhouse gas balance than growing biofuel-crops" said Esteban Jobbágy. "And on land where agriculture is to be continued, the most promising alternatives for improving both carbon sequestration and soil fertility do not come from no-till practices alone, but from combining no-till with enhanced crop production, reducing nutrient losses and increasing carbon inputs to soil, especially via roots.”

Wildfires are common in the dry forests of the Gran Chaco region which covers one million km^2 in the La Plata Basin of Argentina, Paraguay, Bolivia and Brazil. Wildfires consume about 5% of the biomass produced by dry forests of the Gran Chaco each year. Extractive use, such as the collection of fire wood, is already practiced in these dry forests. Expanding such activities to produce bio-energy from selectively used natural forest trees (that would otherwise get burned), in typical medium-sized thermoelectric plants with 40% efficiency, could save emissions in the order of 5 Tg C yr^{-1}. Thus, energy from natural biomass may provide economic gains in those countries while preserving native habitats from more destructive agricultural transformation. Forest managers in Europe already mark non-economic trees which are then removed mostly for firewood by local communities. This shows that such schemes, if they include safeguards for biodiversity conservation, are viable even in richer societies. As a by-product, the removal of combustible material from the forests would reduce the wildfire risks.

Research work by the group has resulted in a map of changes in vegetation cover over the past years that help identify which areas of the continent hold promise for carbon capture, and which regions are the hot spots of carbon loss. The maps are available at http://lechusa.unsl.edu.ar/.

Monitoring of the impacts of fisheries on ocean ecology and carbon budgets, of landuse on soil carbon stocks, and of vegetation management on wildfires will be important to understand options and interventions in the mitigation of greenhouse gas emissions. This research is being continued by the IAI through several research programs (details can be found under "active scientific programs" on the IAI’s webpage: http://www.iai.int). The IAI, founded by an international agreement in 1994, is an intergovernmental body by which scientists and decision makers of its 19 member countries in the Americas can jointly address critical issues associated with global change. With support from its member nations it will continue to play a crucial role in generating regional understanding of drivers of global change in the Americas.