Peatlands and Climate Change : Carbon Sink or Source ?

Fatima Laggoun-Défarge

Cross as the 12th recipient of the John Castaño Honorary Membership Award. The award was presented at the 22nd Annual Meeting of the Society, held in Louisville, Kentucky, 11th - 14th September, 2005.

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Letter from Aureal Cross and Family

(Adapted from letter sent to Rachel Walker, Editor)

Aureal currently maintains an office and lab in the Natural Science Building at Michigan State University as Professor Emeritus of both Geological Sciences and Botany. He is almost done packing his extensive collections of thousands of fossils, rocks, prepared research samples, books, papers and maps, along with more than 200 field notebooks. The research materials include most of the samples and research notes, reports and the 50-60 theses (Ph.D. and M.S.) written under his direction or partial guidance over the extent of his teaching career. They are being sent to the Field Museum in Chicago for permanent research or display.

Aureal's health is good at 91, and he is still doing research on fossil plants, coal and past climates. Most of his time is spent with his wife, Aleen, who has Parkinson's disease, requiring much care. Aleen has been his companion for 63 years, and Aureal attributes his career success to her presence, stating that "I couldn't have done all of this without her."

Aureal considers himself 'first and foremost a teacher' and greatly enjoys finding opportunities to reacquaint with past students and colleagues from his almost 70 year long career. He is grateful to have been chosen to receive this prestigious award from TSOP.

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The project PEATWARM (*Effect of moderate warming on the functioning of* Sphagnum *peatlands and their function as carbon sink*) is funded by the French National Agency for Research under the "Vulnerability: Environment – Climate" program (ANR-07-VUL-010). PEATWARM began in January 2008 and will run for 4 years.

Scientific Context and Objectives:

The debate on the effects of climate warming on global stocks of carbon (C) in soil is front page news. One scenario is the accelerated decomposition of organic matter (OM) and the resulting increase in the CO_2 concentration in the atmosphere. However, biogeochemical models of OM decomposition have so far been established for "mineral" soils with a moderate to low OM content, and there are very few available data on wetlands, especially peatlands. Peatlands are now recognised as valuable pools of sequestered C. Their response to climate changes becomes crucial in predicting potential feedbacks on the global C cycle. In addition to the high C pools, ombrotrophic peatlands are of great interest for climate issues since they are hydrologically independent of groundwater, and consequently their substrate moisture is directly related to atmospheric conditions. To our knowledge, to date no study has addressed the entire range of effects of increased temperature on *Sphagnum* peatlands, including responses of biodiversity, community structure and ecosystem function. There is an urgent need to understand the link between these key compartments in peatlands, particularly in relation to C cycling in the face of global change.

Within PEATWARM, our aim is to use peatlands as a model and to analyse their vulnerability in the context of climate change using an experimental system that simulates an *in situ* increase in annual temperature. The underlying idea is to determine to what extent climate warming can modify the functioning of peatlands in temperate regions, thus deteriorating their carbon sink function.

We will particularly determine how a moderate temperature increase affects:

(1) the major plant functional groups

(2) the balance of above- and belowground C fluxes (especially by the isotopic signature of respired CO_2)

(3) the microbial diversity and activity in *Sphagnum* mosses and below-ground peat

(4) the dynamics of labile and recalcitrant organic matter of below-ground peat.

The ultimate objective is the creation of a biogeochemical model of C coupled with N and S cycles that includes interactions between these key compartments and that attempts to extrapolate changes to the system over the next two decades.

Strategy:

The warming device consists in the use of *in situ* fiberglass Open Top Chambers (OTC) based on a standardised protocol from the ITEX (International Tundra EXperiment) systems. ITEX is a scientific network of experiments focusing on the impact of climate change on selected plant species in tundra and alpine vegetation. OTCs have particularly been used for

subarctic peatland ecology.

Within PEATWARM the studies that will be conducted on the control sites and the heated plots (OTC) will use complementary techniques never before used together: peatland ecology, plant ecology and ecophysiology, microbial ecology, isotopic and molecular geochemistry, organic petrology, paleoecology and C cycle modelling. PEATWARM will not only consider the effect of temperature increase on surface plant biodiversity but will also look at the effect on the below-ground biodiversity in terms of microbial populations and the labile carbon dynamics.

The Selected Site and Experiments:

The project will use both field studies (controls and warmed plots) and experiments in climatic chambers under controlled laboratory conditions (temperature, humidity and nutrients) to test threshold effects.

The selected site, Frasne bog situated in the Jura Mountains (France), is an undisturbed ombrotrophic *Sphagnum* peatland protected by the EU Habitat Directive of the Natura 2000 and which has been classified as a Regional Natural Reserve for more than 20 years. The OTCs are placed in two sites of the peatland: a transitional *Sphagnum*-dominated poor fen site and an open bog site with typical hollows and hummocks. The project management will be supported by the local site manager and the French Peatlands Relay Agency.

After Peatwarm: A Network For Global Warming and Peatlands :

Beyond the duration of PEATWARM project, we plan to maintain the warming devices (OTCs) in the site for at least the next two decades in order to monitor gas emissions as well as abiotic parameters (water table depth, pH, temperature…). This will enable us to monitor *long-term* controls of peatland C turnover in the face of global change. With the same aim in view, we are initiating a French network for research related to "Global Warming and Peatlands". The goals are (i) to develop integrated and inter-disciplinary research within one or few instrumented sites (ii) to gather data and build a common database for sharing knowledge and experience and (iii) to transfer this knowledge to managers and peatland-owners. The peatland of Frasne will be proposed as a pilot site for the network as the peatland is well equipped with monitoring devices.

Ultimately, our goal is to compare our data and model with those obtained on sites equipped with the same ITEX systems. To design suitable models for testing scenarios, a relevant comparison might be carried out with peatlands occurring at high latitudes, i.e. boreal and sub-arctic peatlands, where the effect of warming is expected to be more marked. Such cooperation could fruitfully be developed within a EU Network. The creation of a Network for European sustainable peatland management against the threat of global warming will contribute to the development of current and future legislation for the protection of these key ecosystems.

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Photo 1: View of the Frasne peatland (Jura Mountains, France) in October 2007. Photo: F. Laggoun-Défarge

Photo 2: Members of the PEATWARM consortium at the 1st meeting in January 2008 in Orleans (France). About 30 scientists, technical staff and PhD students are involved in PEATWARM in 8 French and Swiss laboratories. The project is coordinated by Fatima Laggoun-Défarge supported by 6 partners responsible of the workpackages: Daniel Gilbert (Montbéliard, France), Daniel Epron (Nancy, France), André-Jean Francez (Rennes, France), Valéry Catoire (Orléans, France), Laurent Grasset (Poitiers, France) and Alexandre Buttler (Besançon, France and Lausanne, Switzerland). Photo: T. Cantalupo.