Peat fires drive temperatures up

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Peatlands, especially those in tropical regions, sequester gigantic amounts of organic carbon. Human activities are now having a considerable impact on these wetlands. For example, drainage projects, in combination with the effects of periodic droughts, can lead to large-scale fires, which release enormous amounts of carbon dioxide (CO2) into the atmosphere, and thus contribute to global warming.

Using laser-based measurements, Professor Florian Siegert and his research group at Ludwig-Maximilians-Universität (LMU, Germany) in Munich have now estimated the volume of peat burned in such fires with unprecedented accuracy. The new data imply that, in 2006, peatland fires in Indonesia released up to about 900 million metric tons of CO_2. This is more than the total amount of CO_2 emitted in Germany in that year, and represents about 16 % of the emissions associated with deforestation worldwide. "Our work once again underlines the decisive role played by acutely endangered tropical wetland ecosystems in the context of global warming", says Siegert. "The study also provides important data for the upcoming World Climate Conference in Copenhagen. One of the goals of that meeting is to reach agreement on how financial and other incentives can be employed for the protection of tropical wetlands, and so help preserve their enormous capacity for carbon storage.

Over the course of millions of years, plant material can be converted into coal. The first step in this process leads to the formation of peat, an organic material that is combustible and is harvested for heating purposes in many parts of Europe. As a condensed form of plant mass,

peat is also an important storage form of carbon at near-surface levels. "It is estimated that, in the tropics, peat swamps cover an area of 30 to 45 million hectares", says Professor Florian Siegert from the GeoBio-Center of the LMU Munich. "This corresponds to about 10% of the total area of peatlands in the world, and means that tropical peatlands represent one of the largest near-surface storage sites for organic carbon that we have". - And almost half of this reservoir is located in a single country, Indonesia.

Many of the coastal peatlands on Borneo formed over 20,000 years ago. Since that time - as in most tropical peatlands - convex domes of peat, up to 20 metres thick, have developed. They serve as the basement layer of tropical peat swamp forests and possess a huge capacity for storing carbon. Indeed, the total amount of carbon locked in the peatlands of Indonesia alone is thought to be more than 50 gigatons. However, these areas are in imminent danger. Left in their natural state, they are simply too wet to burn. But drainage measures and deforestation disturb their ecological equilibrium and make them vulnerable to fire, which is almost always caused by human activities. Private companies often exploit fires to prepare the ground for the establishment of large-scale plantations for the production of wood pulp and palm oil,.

The fires, however, are doubly dangerous. The smoke they produce contains tremendous amounts of aerosols and toxic gases, which can lead to serious health problems in many areas of Southeast Asia. Furthermore, the soil-bound organic carbon is transformed into carbon dioxide, a greenhouse gas which plays a leading role in global warming. The problems are further exacerbated by the fact that climatically induced periods of aridity increase the combustibility of the peat. For instance, during the drought associated with the El Niño phenomenon in 1997/98, up to 2.57 gigatons of carbon was released from the wetlands of Indonesia alone. "Estimates vary widely", says Siegert, but it is assumed that the carbon released amounted to at least 13% and perhaps

as much as 40% of the total carbon emissions attributable to the burning of fossil energy sources. Such levels of carbon dioxide represent a very considerable contribution to overall warming of the globe."

The Munich researchers have now used a novel method to measure exactly how much peat is consumed during a fire. This is the most direct and reliable way of estimating how much carbon dioxide is set free. Because direct access to the wetlands is difficult, Siegert and his team performed their measurements from a helicopter using a technique referred to by the acronym LIDAR (for Laser Detection and Ranging). LIDAR uses a laser that emits high-frequency optical signals, and the echoes produced when the signals hit the ground are recorded, allowing one to determine the level of the surface with centimetre precision. "Using this instrument, we were able to show that the catastrophic fires in 2006 destroyed the peat layer to an average depth of 0.3 metres", says Siegert. This value, together with other data, led the scientists to conclude that from the 2.79 million hectares in their study area more than 180 million tons of CO2were released, equivalent to 20% of all the CO2 emitted in Germany that same year.

As Siegert emphasizes, "This huge input originated from just 13% of the peatlands in Indonesia". When one uses the new data to estimate the level of CO2 released for all of Indonesia in 2006 - a year with a weak El Nino, in which rainfall was relatively low - one comes up with a figure of up to 900 million tons. This value exceeds the total emitted from all sources in Germany in that year, and corresponds to about 16% of all emissions attributable to deforestation worlwide. The regular occurrence of large-scale forest fires alone makes Indonesia one of the largest producers of atmospheric CO2 in the world, and this status is confirmed by the latest, high-precision data, once again emphasiszing the importance of peat burning for global warming. But this significant source of emissions has yet to be taken into account by the IPCC (the Intergovernmental Panel on Climate Change) and incorporated into

computer models of regional and global climate.

Most studies on changes in land use and their effects on climate change have considered only total forest biomass. The new data demonstrate that, in future, one must also focus on the biomass that is stored in the soil. The carbon content of peat swamps is dependent on the thickness of the peat layer, and can be up to 20 times greater than the amount stored in forest trees. Siegert points out that "growth of the market for palm oil, stimulated by increased demand for cheap biofuels, will make the situation worse, as the incidence of fires this year has already shown. This is something that should have repercussions for European policies in the area of renewable energy sources. Also on the agenda in Copenhagen are programmes such as REDD (for Reduced Emissions from Deforestation and Degradation in developing countries'), which is designed to provide monetary incentives aimed at protecting tropical peat swamp forests and their giant carbon stores".

More information: Derivation of burn scar depths and estimation of carbon emissions with LIDAR in Indonesian peatlands, Uwe Ballhorn, Florian Siegert, Mike Mason, and Suwido Limin, *PNAS* online, 26 November 2009

Source: Ludwig-Maximilians-Universität München