Tropical forests affected by habitat fragmentation store less biomass and carbon dioxide

December 9 2009

Altered wind conditions and light climate lead to a general change in the microclimate at the forest edges. Big old trees are particularly vulnerable to these factors. With the help of FORMIND, a forest simulation software developed at the UFZ, the researchers modeled different sizes of forest patches left over after landscape fragmentation. The smaller a patch of forest is, the worse is the ratio between edge and area. Credit: Photo: Henning Steinicke/UFZ

Deforestation in tropical rain forests could have an even greater impact on climate change than has previously been thought. The combined biomass of a large number of small forest fragments left over after habitat fragmentation can be up to 40 per cent less than in a continuous

natural forest of the same overall size.

This is the conclusion reached by German and Brazilian researchers who used a simulation model on data from the Atlantic Forest, a coastal rain forest in the state of São Paulo, Brazil, around 88 per cent of which has already been cleared. The remaining forest fragments are smaller, so the ratio between area and edge is less favourable. The reason for the reduction in biomass is the higher mortality rate of trees at the edges of forest fragments, according to the results published by researchers from the Helmholtz Centre for Environmental Research and the University of São Paulo in *Ecological Modelling*. This reduces the number of big old trees, which contain a disproportionately high amount of biomass.

Altered wind conditions and light climate lead to a general change in the microclimate at the forest edges. Big old trees are particularly vulnerable to these factors. With the help of FORMIND, a forest simulation software developed at the UFZ, the researchers modelled different sizes of forest patches left over after landscape fragmentation. The smaller a patch of forest is, the worse is the ratio between edge and area. Simulation results suggest that a natural tropical forest of our study area contained approximately 250 tonnes of aboveground biomass per hectare, a forest fragment measuring 100 hectares has around 228 tonnes of biomass per hectare, while a patch of rain forest measuring one hectare has only 140 tonnes of biomass per hectare. In other words, the biomass in the forest remnants in this study fell by as much as 40 per cent.

"This finding is of great significance for the function of rain forests as a biomass store. It is important to be clear about the fact that we are losing more than just the deforested areas. Even the remaining forest is thinned out as a result. It is a mistake to think only in terms of total area. We have to start thinking in terms of the spatial configuration of the remaining forest fragments as well," says Dr Jürgen Groeneveld of the

UFZ, explaining the significance of the study for climate policy. As well as the biomass yield per hectare, these fragmentation-related spatial (edge) effects also have impacts on climate balance and biodiversity, i.e. on several dimensions of sustainability.

The simulation integrated results from other researchers who are conducting unique long-term experiments on fragmentation in Amazonas. However, a large number of questions remain unanswered: Are the edges stable? Can the forest regenerate or does the degradation continue inwards? The researchers therefore view the figures as a preliminary, cautious estimate. "But if it is confirmed, it is a really fundamental finding," adds Dr Sandro Pütz of the UFZ. "Forest fragments cannot perform in the same way as continuous forests." The researchers therefore intend to investigate the long-term effects over the coming years to find out how the rain forest remnants develop in the long term. The results of this study will also have fundamental consequences for forest conservation, at least in terms of the carbon balance: "In any case, in terms of carbon storage, it is better to protect 100 continuous hectares than to protect 100 one-hectare patches," says Jürgen Groeneveld.

The Atlantic Forest was severely deforested in the second half of the 19th century for construction timber, charcoal and grazing and arable land. Although

only around an eighth of the original forest area remains, these remnants are still regarded as international biodiversity hot spots, since they are home to an as yet not fully recorded, but impressive number of endangered animal and plant species that are not found anywhere else. Credit: Photo: Christoph Knogge/UFZ

The data used in the model come from the tropical coastal rain forest in the state of São Paulo, Brazil. The Atlantic Forest was severely deforested in the second half of the 19th century for construction timber, charcoal and grazing and arable land. Although only around an eighth of the original forest area remains, these remnants are still regarded as international biodiversity hot spots, since they are home to an as yet not fully recorded, but impressive number of endangered animal and plant species that are not found anywhere else. Since 2003, Brazilian and German researchers have therefore been investigating the long-term effects of landscape fragmentation on habitats in the Atlantic Forest, which used to stretch along the whole of Brazil's east coast and is today one of the most endangered rain forests in the world.

The new findings from the ecological modelling experts led by Andreas Huth and Klaus Henle are also relevant for negotiations at the UN climate conference in Copenhagen. Under the heading REDD (Reducing Emissions from Deforestation and Degradation), the conference will be discussing a mechanism for including the forests in climate protection. Forests bind carbon dioxide. Deforestation or degradation of forests leads to a further release or less fixing of carbon dioxide per unit area, thereby increasing the greenhouse effect. Around 20 per cent of total global CO_2 emissions comes from the destruction of forests.

More information:

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Source: Helmholtz Association of German Research Centres (news : web)