SUSTAINABLE LAND MANAGEMENT

NEW STRATEGIES FOR SOUTHERN AMAZONIA

(Source: S. Hohnwald)

Rainforests in Pará are being felled to make way for pasture.

The forests in the Amazon region play a key role in absorbing the worldwide effects of climate change. The way in which the region's farmers manage their land is therefore of critical importance. An international research team led by the University of Göttingen wants to help to ensure greater sustainability in land-use.

Gigantic charred trees towering up into the sky, cleared forests, vast, monotonous fields – Gerhard Gerold, Professor of Geography at the University of Göttingen, has gathered many such impressions on his travels through the Amazon region in the heart of Brazil. But data on the breakdown of carbon compounds through deforestation and farming and the effects of this on climate cause him even greater concern than his personal observations. Reason enough to bring about change.

Gerold is the leader and spokesman for the joint project Carbiocial, aimed at investigating trends in soil carbon, biodiversity, and social processes in Southern Amazonia through interdisciplinary research. Gerold and his colleague Professor Karl M. Wantzen have developed the project jointly with Professor Eduardo Couto, head of the Institute of Soil Science and Precision Agriculture at the Federal University of Mato Grosso. The German Federal Ministry for Education and Research is supporting the project with 6.15 million Euros in funding so that

Cotton bales in the cleared agricultural landscape of Central Brazil.

German and Brazilian scientists under Gerold's leadership can spend five years working out land management strategies for Southern Amazonia. Their mission is to develop new possibilities for land-use in the tropical rainforests and savannahs so that the land stores more carbon, thereby reducing greenhouse gas emissions.
Although scientists have been investigating climate change for years, they still lack accurate models for calculating the effects of deforestation and increased land-use in the Amazonian region on world climate.

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The negative trend of increased greenhouse gas emissions could be reversed if carbon could be stored in Brazil's vast expanses of farmland through suitable agricultural technologies.
The signs are good. Ten German universities, the Helmholtz Centre for Environmental Research, the Leibniz Centre for Agricultural Landscape Research (ZALF), the universities of Innsbruck and Tours, and several Brazilian universities and research institutes, including the national agricultural research corporation Embrapa, wish to work together to find solutions.

Species-rich combined agro-silvopastoral systems help small farmers to manage their land sustainably.

Analyses of satellite images show that up to a quarter of the rainforests in the Amazon region have been cleared in the last 30 years. The timber has been sold and the cleared areas burnt to the ground to make room for cattle or for crops of soya, maize, and cotton.
There are consequences: firstly biodiversity is threatened, and secondly climate change is intensified. Because forests storing carbon are shrinking in number, and because land in agricultural use releases carbon dioxide, Brazil is held responsible for one fifth of worldwide carbon emissions caused by tropical deforestation. This process is also driven by the international agricultural markets, where there is high demand for soya products, palm oil, and sugar cane for biofuels.

»Ideally farmers should work their land in such a way that soil fertility and water quality are preserved.«

Soya plantations becoming widespread
Mato Grosso is one of the regions where the change of land-use is particularly apparent. Here the Carbiocial scientists are conducting research in two study areas near the towns of Sinop and Cuiabá. Agricultural development in Cuiabá began in the 1970s. Today cotton and soya crops dominate.

Intensive soya and maize crops make a stark contrast with intact rainforests near Sinop.

In Sinop, the second project area, large-scale deforestation began around 15 years ago. Soya plantations are now widespread. In the third study area near the town of Novo Progresso in the southern part of Pará on the other hand, cattle farming dominates in pastures surrounded by tropical rainforest. Here too, deforestation has clearly accelerated in recent years however.

The main focus of the scientists' interest is the local farmers, whose land holdings vary in size. In the south, near Cuiabá, they are generally between 2,000 and 15,000 hectares but often significantly smaller in the north, at 200 to 500 hectares. »Ideally the farmers should work their land in such a way as to protect the soil, so that important characteristics such as soil fertility and water quality are preserved«, says Gerold. The scientists want to test ways of achieving this in the field. As ecologist Wantzen points out, such methods could help the soil to store more carbon, improve soil quality and yields and reduce the pressure on the remaining areas of forest. »That would be a win-win situation for farmers and the climate«, he says. The scientists want to use scientific arguments to convince farmers of the benefits of carbon-friendly farming. And not only that: they also want to develop options which ensure a good income for the farmers, even if other more sustainable methods exist. As Gerold says: »Combining ecology and socio-economics sustainably, that is the challenge for the project.«

Soya and cotton fields are often laid right to the edge of the gallery forests.

New soil protection methods

German-Brazilian teams are tackling this challenge in twelve sub-projects. In land management, for example, the scientists want to propose ways in which the farmers can better preserve or even improve the humus content of the soil and thus its carbon content. This calls for farming practices better suited to the soils of the tropical rainforests. »If the land is ploughed too deeply, more carbon dioxide escapes«, says project coordinator Dr. Stefan Hohnwald. In future farmers could dispense with ploughing so that the soil is not broken at all, or turned only minimally. Seed would then be sown directly without working the soil beforehand. These »no tilling« methods have already been used by many farmers in the old colonization regions of central Mato Grosso for a number of years. In one sub-project led by Kiel University in cooperation with local farmers, carbon-rich biomass is added to the soil to test ways of improving humus-impoverished soils.

The scientists are also experimenting with the choice of crop. The monotonous cultivation of soya and maize, interrupted only by a fallow period during the dry spell, is permanently impoverishing the soil. In cooperation with their Brazilian partners in the Carbioma project the scientists are there fore experimenting with five-year crop cycles where after the maize and soya crops, grass is sown to feed cattle followed by millet and nitrogen-fixing legumes. Obviously such changes in land-use are not easily accepted by the farmers, as they are still

Only a few animal species such as the nandu can survive in soya monocultures.

making good profits in the global market. But the first dark clouds are already looming. »Diseases are increasingly spreading through monocultures; nutrients in the soil are being depleted, and the effort required to sustain yields is increasing«, says Gerold. Political scientist Dr. Regine Schönenberg, who is investigating the underlying socioeconomic conditions in another sub-project,

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has established through interviews and workshops with the farmers that their options for changing land-use are few. »The strict environmental laws, market diktats, and lending conditions mean that many farmers feel that their scope for entrepreneurial initiative is very limited«, says Schönenberg. This is not their only problem: most of the farmers have no regular land title, and therefore do not officially own the land. »They have no documented right to work the land«, explains Schönenberg, who lectures and conducts research at the Free University of Berlin.

These problems are now exacerbated as the farmers are increasingly suffering the effects of climate change. Longer dry periods, a delayed rainy season, and greater variability in precipitation levels – such effects are already being reported by many farmers. The Carbiocial scientists want to

Scientists and farmers discuss the effects of climate change on cotton crops in Mato Grosso.

simulate the consequences of climatic change for crop yields in further sub-projects.

Using models to calculate yields

One of the models used for this, the simulation model MONICA, was developed by geoecologist Dr. Claas Nendel at ZALF in Müncheberg. Using data on soil, sunlight, temperature, precipitation, and other parameters it describes the biochemical conversion of carbon, nitrogen, and water in agricultural ecosystems, and calculates plant growth and crop yields from these. »We can already run the model for maize and soya; we are still working on sunflowers, sugar cane, and cotton«, says Nendel. He must also consider how to adapt the model for the particular soil conditions in the south of the Amazon region. »Certain processes such as the transport or storage of nitrogen work differently in the tropics than in the mid latitudes«, says Nendel. Meanwhile Dr. Rüdiger Schaldach is working on another model for the Carbiocial project at the University of Kassel. The computer scientist wants to simulate the changing use of the Southern Amazonian landscape up to the year 2050. »We want to estimate regional trends as to how agricultural use might change under different socioeconomic conditions such as world trade«, says Schaldach. He is working with the land use model Landshift. This model too needs to be adapted to the realities of farming in Southern Amazonia so that the scenarios are accurate. »For example we have to integrate the farmers' different crop

The Nelore breed of cattle is often reared on large farms as it is well adapted to the tropical climate.

rotations and colonization processes«, he explains. Incorporating these regional specificities into the model is a real challenge. Together with a climate model, these two models should eventually be

» We want to estimate regional trends as to how agricultural use might change under different socioeconomic and economic conditions.«

developed into a decision support model. This may sound complicated, but in practice it should yield meaningful results and provide a good basis for scientists to predict the ecological and economic consequences of different land management strategies in the three regions. How are yields and profits affected if climate changes and farmers switch to a different crop rotation, for example? How does this affect the humus content of the soil? How many greenhouse gases are then released by the agricultural activity? »This should be as simple an instrument as possible, ideally in the form of a palmtop computer which farmers and environmental authorities can use on site«. This is how Gerold describes his vision, which should become a reality in the Amazon region and which could be applied throughout Latin America, with variations.

Farmers as multiplicators

For this to work out as intended, however, the scientists depend on the cooperation of the farmers.

Experiments aimed at increasing soil carbon in a maize field near Campo Verde.

All is going well so far. In an experiment on one farm in Cuiabá, for example, the farmer is working eucalyptus bark, sugar cane molasses and wood chips into the soil of one field and the scientists are analysing how this improves the soil and enriches it with carbon and nitrogen.
»If this produces positive results, this farmer could be a multiplicator for his colleagues,« says Hohnwald. The local farmers hope above all for new knowledge from the scientists: »Amazonia is very diverse, and the production of knowledge through initiatives such as the Carbiocial project gives us a better understanding of the local Amazonian region«, says Lincoln Queiroz, farmer and representative of a farming association in Novo Progresso. Only by understanding local processes and their interactions with other parts of Amazonia and the planet, the farmers can work their land sustainably.
The research project is still in its early stages. If it has been successful by the time it ends in summer 2016, some diplomacy will be required: »We don't want to wag our fingers at the farmers and tell them what to grow and how to grow it. The aim is to show them alternative farming methods«, says Gerold. Here the farmers' awareness of the national and international debate on climate protection is an advantage. »Farmers wish to prove that they can also farm in environmentally friendly ways«, says Gerold. »So perhaps the Carbiocial project has come just in time«.

Production systems investigated in the region are: agricultural systems (intensive and extensive), livestock

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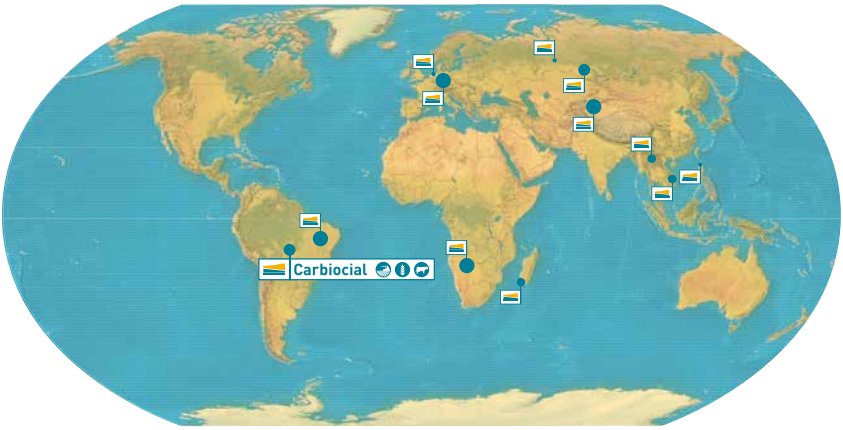
Funding: 6.1 million Euros

Funding period: June 2011 to May 2016



»Carbiocial« is one of twelve regional projects funded by the Funding Measure »Sustainable Land Management« (Module A) provided by the Project Management Agency (PT-DLR) on behalf of the German Federal Ministry of Education and Research (BMBF).

Science Portrait 4 is published in the context of the Funding Measure »Sustainable Land Management« of the German Federal Ministry of Education and Research (BMBF).
www.sustainable-landmanagement.net

Publisher:
Scientific coordination and synthesis (GLUES)
Helmholtz Centre for Environmental Research – UFZ
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Author: Benjamin Haerdle, November 2012

English Translation: Christina Freeman for Green Ink (www.greenink.co.uk), February 2013

Layout: Metronom | Agency for Communication and Design GmbH, Leipzig

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Federal Ministry of Education and Research
FONA Research for Sustainable Development BMBF
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