Forests around the world affected by climate change

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Around the globe, forests are found to be undergoing strong changes due to human influence already today. Degradation of woods due to man-made climate change cannot be ruled out for the future, a special feature to be published in the *Journal of Ecology* 23 December 2014, now shows.

The research has been led by a team of scientists of the Potsdam Institute for Climate Impact Research (PIK). As part of the research two Wageningen University chair-groups co-supervised eight MSc thesis. The researchers belong to the Resource Ecology Group (Milena Holmgren) and the Plant Ecology and Nature Conservation Group (Juul Limpens).

Additional pressure

To understand and improve the resilience of forests, a combination of approaches from small-scale field experiments to large-scale computer simulations can help, according to the studies. Taking a risk perspective, the scientists caution that global warming puts additional pressure on some of the most valuable ecosystems on Earth. "Forests are probably more at risk than previously thought," says Christopher Reyer of PIK, coordinator of the Special Feature and lead-author of an overview article. "The observed changes affect forests as important as the Amazon, but also forests on all continents, possibly pushing some of them towards tipping points."

Up to now, no example could be found where forests tipped into a state where no regrowth is possible due to man-made climate change. Yet the overview article identifies substantial research gaps. "This is hardly good news," Reyer says. "It is in fact scary how little we still know about the resilience of forests, despite all the scientific progress we present in this special issue. From a risk perspective, climate change puts additional pressure on an exceptionally valuable ecosystem whose stability up to now cannot be properly assessed."

Forests for biodiversity, timber and CO2 storage

Besides being home to a large part of the world's plants and animals,

hence preserving biodiversity, forests are also of great economic relevance. They provide timber in many countries, as well as game and fruit. "Some tropical forests, such as the Amazon, are also key for regional water cycles," says Milena Holmgren of the Wageningen University in the Netherlands. "How dense these forests are, affects the amount of rainfall that is recycled and also the amount of water that is retained. When forests become less dense, a smaller amount of water is recycled as rain and also less water is retained in the soil. Less dense forests facilitate also the growth of grass which burns easily in dry seasons. Fire can change the rules of the game drastically because grass burns easily and recovers fast whereas trees are very sensitive and need more time. So once a forest has been opened and starts burning the end result can be a system that resembles a savanna with much grass and fewer trees. This changes the habitat for plants, animals and people."

"The fate of forests is important also because they store huge amounts of the greenhouse gas CO2," adds Holmgren. "Losing forests and releasing carbon to the atmosphere contributes to climate warming and to the impacts we start to see in many regions of the world."

"Alleviating the negative effects of climate change on reforestation efforts"

To assess the resilience of forests, long time scales are important. Over 2000 years, tropical peat swamp forests from Malaysian Borneo showed to be resilient even under disturbances such as fire or climate variability related to the El Niño weather phenomenon. Recent burning and agricultural expansion however clearly changed the landscape by replacing tropical peat swamp forests with open or even no forest. Still, things are not straightforward. Drought, on the other hand, is found to have variable effects on different tree species in different regions, and seasons, one of the new studies shows. In the end, it is a complex combination of stress factors that is likely to impact forests' resilience.

In Finland and Australia, scientists performed field experiments on regrowth of forests. The Wageningen University team examined how boreal peatbogs can shift to forests and concluded that shrubs can pave the way for greener tree dominated landscapes in the far northern hemisphere. The Australian team studied the timing of seeding and the use of seedlings in restoring sites. "Adapted restoration practices could help alleviate the negative effects of climate change on reforestation efforts," says Rachel Standish of The University of Western Australia. "We have some encouraging findings here. This is even more important as the area of disturbed forest ecosystems is clearly growing."

Provided by Wageningen University