Big data project reveals where carbon-stocking projects in Africa provide the greatest benefits

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This is a photo from a carbon forestation project in Patako, Senegal. The project is being coordinated through the EU-funded Undesert Project. It involves planting indigenous trees in a degraded area and getting carbon credits from these. Credit: Fatimata Niang-Diop

It is increasingly recognized that climate change has the potential to threaten people and nature, and that it is imperative to tackle the drivers of climate change, namely greenhouse gases. One way to slow climate change is to increase the number of trees on Earth, as they, through photosynthesis, take up the greenhouse gas carbon dioxide, converting it to carbon products which are stored in the vegetation (in the form of wood, roots, leaves) and oxygen.

New forests continue to accumulate carbon for hundreds of years. Therefore, forestation projects are one way of generating 'carbon credits ', which are tradable units on the carbon market. The more carbon is stored in the vegetation, the more profitable such projects are.

Restoring forests should bring especially high carbon returns in areas where plants grow fast and to big sizes, but where past disturbances such as deforestation, fires, and degradation have resulted in much of the vegetation being destroyed, because the difference between what is there and what could potentially be there is so large. However, little information exists on where such areas are, and how big their carbon storage potential is.

Researchers from Aarhus University, Denmark, the University of Pretoria, South Africa, and the Council for Scientific and Industrial Research in South Africa have now developed a method to calculate the difference between the potential carbon that could be stored in vegetation if there were no disturbances and the carbon that is currently stored in vegetation in tropical Africa.

The researchers based their analysis on a satellite-derived map of current carbon being stored in vegetation. Combining it with data on environmental factors that affect plant growth, such as climate and soil, they could model the maximum amount of carbon that could be stored in vegetation across tropical Africa. By subtracting the actual amount of carbon currently stored in vegetation from this, they could thus show where in Africa carbon-stocking projects would be particularly profitable.

As part of the forestation project in Patako, Senegal, the local community is being educated about the benefits they will receive from the project through the carbon accreditation scheme. Credit: Anne Mette Lykke

People and biodiversity factors are also important

In reality, such a map of where most carbon could be stored is probably of limited use for deciding where to plan carbon projects, because there may be a number of constraints to setting up forestation projects to stock carbon. For example, a densely populated agricultural area with high levels of rainfall and temperatures might bring high carbon returns; however, it would be unlikely to be profitable as land value in these areas is high, and because it would be problematic to have to relocate people. Therefore, such constraints must be considered when planning carbon forests.

In addition, it might be a good idea to consider whether there are wider benefits to setting up such projects.

"We used our map which showed where carbon forests would bring high returns, to ask where carbon-stocking by forestation would not only be highly profitable, but where it would also minimize conflict with people, and benefit biodiversity and people", says Michelle Greve from the University of Pretoria, who led the project as part of her PhD at Aarhus University.

"Therefore, we applied a method to optimally select areas which would not only have high carbon returns, but would also conserve native biodiversity and support ecosystem services, that is, services that the environment provides which benefit humans. The areas also had to have low land value and human population density, so as to reduce conflict with people, and high levels of governance, because setting up projects in areas with high levels of violence and corruption would be too risky and have too low chances of success", Michelle Greve explains.

Michelle Greve and her colleagues could thus identify areas where carbon projects would have wider co-benefits. An example of an area that showed high carbon returns, but was less important when these other factors were considered, was the region around Lake Victoria in East Africa. The area currently has little vegetation biomass due to heavy degradation, but has an excellent climate for tree growth, and thus has a high potential for carbon stocking through forests. However, it does not support as high biodiversity as some other areas and, more importantly, it is also densely populated by people who practice intensive agriculture in the area. So setting aside land here to plant carbon forests would not be optimal.

Rather, regions of the Upper Guinean rainforests of West Africa, and the Lower Guinean rainforests which are situated on the coast of Nigeria and Cameroon, were identified as having more optimal combinations of high carbon stocking potential, high co-benefits for wildlife conservation and humans and high feasibility.

"There is a great need to reduce the amount of greenhouse gasses in the atmosphere. Our approach exemplifies how strategies to do this can be targeted to optimize feasibility and co-benefits for biodiversity and people", concludes Jens-Christian Svenning, professor at Aarhus University and supervisor on the PhD project.

More information: The article "Spatial optimization of carbon-stocking projects across Africa integrating stocking potential with co-benefits and feasibility" will be published in *Nature Communications* on 19 December 2013.

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