Uruguay: Eucalyptus plantations degrade soils and release carbon

In spite of all the scientific evidence existing on the negative impacts of large scale monoculture tree plantations, the Climate Change Convention insists on promoting them under the false argument that plantations can alleviate the effects of climate change, acting as “carbon sinks.”

The negative impacts of monoculture tree plantations in forest areas have been thoroughly studied and documented in nearly all the countries where they are located. However, there is a tendency to minimize the negative impacts these plantations cause on grasslands, the main ecosystem of countries such as South Africa, Swaziland, Uruguay, the south of Brazil and vast areas in Argentina, where such monoculture plantations continue to expand.

This situation, explains Carlos Cespedes, a researcher at the Uruguayan Faculty of Science, is what encouraged him to undertake a study for his doctoral thesis, aimed at assessing the effects of the conversion of grasslands to tree plantations.

In a previous paper, this researcher had demonstrated that eucalyptus plantations have negative effects on grassland soils. In this study, Cespedes had verified that monoculture eucalyptus plantations cause a considerable loss of organic matter and increased acidity, associated to the alteration of the normal values of other physicochemical properties.

The soils of Uruguayan grasslands have an acidity level (pH) of approximately 6.5 – 6.8 (that is to say they are classed as “slightly acid”) although in the case of sandy soil grasslands, these values may be around 5.5. In the analysis of eucalyptus plantations on these same types of soil the results showed much lower values, situated at about 4.5 (values that are defined as “strongly acid”). To understand the importance of this figure it must be stated that pH is expressed on a logarithmic scale, where one point of difference in the pH (5.5 versus 4.5) is considerable. However, it is important to know that a pH of 5 represents a threshold, that is to say, above or below this value significant changes take place in the soil (which would not happen if the change were from 7 to 8 or from 3 to 4), such as changes in its Cationic Exchange Capacity (CEC), a property that is strongly linked to soil fertility as explained further on.

Acidity was higher in the first layer of soil (known as horizon A) and although it decreased somewhat in the deeper layers (horizon B), the pH was equally lower than in the grassland soil. The explanation for this notorious increase in acidity given by various authors is the extraction of significant amounts of calcium from the soil, which is accumulated in the tree biomass in the form of crystals (calcium oxalate). As would be expected, the low pH rate led to a notorious increase of aluminium in the soil, in concentrations that may be toxic for most native species of flora. As a result, certain species of plants that inhabit these soils now – following years under eucalyptus trees – find that soil conditions have become inappropriate for survival. However there are species that have managed to adapt themselves to the new soil characteristics, such as “Bermuda grass” (Cynodon dactylon), an exotic invasive species. For the microorganisms, these changes could be even more serious, due to the fact that they are very sensitive to physicochemical changes in the soil.

This more acid environment is a factor that also contributes to the spread of fungi, particularly basidiomycetes. These fungi generate a web of mycelia over the soil (the “body” of the fungi that can be seen in the soil as white filaments) inducing a phenomenon known as “water repellency” of the soil, preventing water from penetrating in-depth easily. This leads to a smaller infiltration to the water-table and a comparative increase in surface runoff, stimulating soil erosion.

The decrease in soil organic matter responds to various interrelated factors. Among them it is important to note that there is less incorporation of organic residues to the soil in a eucalyptus plantation than in the case of grasslands. The eucalyptus residues remain on the surface and due to their biochemical nature they are more resistant to biodegradation. Furthermore, the decrease also originates in the “exportation” made by the eucalyptus plantation of the organic matter originally accumulated on the soil by the grassland.

The drastic drop in soil organic matter leads to a decrease in the Cationic Exchange Capacity (CEC). CIC expresses the capacity to retain mineral nutrients in the soil, that is to say, it determines its potential fertility. The research showed that the CEC decreased in horizon A due to the influence of the eucalyptus trees. This decrease in CIC in horizon A is serious, given that it is on this soil horizon that agriculture and livestock production is based. On decreasing organic matter and CEC, not only does soil fertility decrease but important negative effects take place in its structure, in the aeration and in biological activity among other phenomena.

Tree plantation defenders argue that the plantation of trees can even improve soils, although they sometimes add that this does not happen in well cared for, well managed, scantly degraded soils such as the excellent grassland soils of Uruguay. But they maintain that this soil improvement could take place in soils that are not as excellent.

However, another important finding in this research is that monoculture tree plantations also have negative effects on soils with a history of other agricultural uses. Not even in sandy soils – where according to the defenders of tree plantations all that could happen would be an improvement – has it been possible to prove this. According to the results obtained by Cespedes, tree plantations would be the worst option, even for this type of soils, as in their case, degraded by agricultural activities and abandoned, they would be recolonized by herbaceous plants – many of these native species – that in a certain time-span would improve the soil considerably, which would not be the case if the soil were planted with eucalyptus.

But perhaps the most important finding of this research is that it shows that eucalyptus plantations on grasslands have a significant negative effect on the soil’s carbon balance.

Lately, one of the most used arguments to justify large-scale monoculture tree plantations is that they can be used to improve the climate and counteract the greenhouse effect. It is argued that as the trees grow, they take carbon from the air in greater quantities than they release. According to this vision, plantations are defined as “carbon sinks.”

However, this research has shown that this is false in the case of grasslands, which accumulate vast amounts of carbon, but of a totally different kind than that captured by tree biomass. Carbon stored by grasslands is called stable carbon (humic substances); this is a carbon reserve that can be stored there for hundreds or thousands of years, and that under certain conditions, can continue to increase. This organic carbon, initially captured by the live mass of grassland plants – mainly the roots – gradually progresses through soil organism activity to increasingly stable organic complexes. However, tilling, the use of agrochemicals and the plantation of exotic and fast growing tree species,

destroy a major part of this reserve. As a result, the grassland soils reverse their role as “sinks” to become a source of CO2 emissions.

Furthermore, carbon storage by plantations will last a relatively short time insofar as the trees will be felled, used or even – as happens frequently – will burn and release all the carbon into the atmosphere. In this respect, the promoters of the so-called “Clean Development Mechanism” affirm that although this carbon stored by trees does have a low mean residence time (MRT) it is a carbon that was already in the atmosphere (as carbon dioxide) and contributing to the “greenhouse effect.” Therefore, its contribution is equally valid given that it does not use new carbon, but recycles an already existing one. This opinion could have some validity if tree plantations did not have carbon emissions from the soil as a counterpart, as has been proved in this research.

Cespedes’ doctoral thesis not only shows that monoculture eucalyptus plantations degrade the soil in an irreversible way, but that they also destroy soils that act as enormous carbon reservoirs. Those encouraging such plantations will therefore need to invent new lies to promote them. And they have increasingly few left!

Article based on the doctoral thesis of Carlos Cespedes available at http://ethesis.inp-toulouse.fr/ , on interviews with the author and material from the article “Impacto de las plantaciones de eucalyptus en el suelo” (Impact of eucalyptus plantations on the soil) by Teresa Perez, available at: http://www.guayubira.org.uy/plantaciones/Cespedes.html