Potential Ecological and Social Impacts of Genetically Engineered Trees

Commentary on UNEP/CBD/COP/9/INF/27 Paper on Potential Impacts of GE Trees

Prepared for CBD COP-9, Bonn, Germany 19-30 May 2008

Introduction

It is the purpose of the Convention on Biological Diversity to protect biological diversity in all of its richness – this is also done in awareness of its importance for the functioning of vital systems such as ecosystems, climate systems and water systems. Forests include some of the world's most important biodiversity reserves with some forest soils alone containing thousands of species. Many of these species are endemic to particular ecosystems and the fragmenting of forest ecosystems has left these species highly vulnerable to new threats. It is therefore crucial that the CBD address emerging issues such as genetically engineered (modified) trees with an eye to ensuring that forest biological diversity is in no way negatively affected.

At the last Conference of the Parties, the CBD called for comments from Parties and other stakeholders with regard to "the potential environmental, cultural and socio-economic impacts" of GE trees. These have been compiled into two documents, INF/27, which is largely the CBD Secretariat's interpretation of the information and analysis submitted (or published thereafter), and INF/28 which is a summary of the submissions from each Party or stakeholder.

We thank the Secretariat for the considerable effort undertaken to assemble and order the information and research, which helps to provide an overview of this issue. However, it must be noted that a box of scientific reports and other documents pertaining to the environmental and social impacts of GE trees that was hand-delivered to the CBD Secretariat in Montreal by Global Justice Ecology Project and the STOP GE Trees Campaign was apparently lost and its contents not considered in the compilation of INF/27.

This document is a joint commentary prepared by those organizations involved in the CBD process that are urging for clear moratorium on the open release of GE trees, and was written in response to the INF/27 background document, to highlight areas of particular relevance and to point out areas where information has not been included or considered.

Section II: Crucial Omission Regarding the Impacts of Genetic Engineering Processes Due to Succumbing to "Trait-Confined" Analysis

INF/27 replicates a major fault in current risk perception and risk analysis: The prediction and analysis of impacts is limited purely to the genes and their traits that are genetically engineered into a tree (e.g. para 10, 13, 17). Such a focus fails to address the impact of the genetic engineering processes themselves on the genome of the recipient organism, such as transformation-induced mutations. It is well documented that genetic engineering processes can result in hundreds of genome-wide mutations, especially where tissue culture techniques are involved. There are two types of tissue culture, one is used in genetic engineering processes, the other in standard clonal and vegetative propagation techniques. Whilst both will give rise to "somaclonal" mutations and thus to somaclonal variations, the impact is vastly enhanced in tissue culture techniques as part of genetic engineering. INF/27 in its entirety fails to refer to mutations, disturbances and their consequences caused by the genetic engineering processes, and only once refers to "somaclonal variations" (para 24). Para 24 though fails to explain the reason for or extent of these somaclonal mutations and instead incorrectly returns to the issue of "traits".

Lack of Breadth in Analysis
INF/27 Para 13, states: "if insect resistant traits were conferred into endangered or threatened tree species, thereby increasing resistance, restoration and conservation could be promoted." The conclusion ignores the mutagenic effect and the impacts that genetic engineering processes have on the plant and its genome, which are far greater than just adding the "trait gene". Further, it overlooks studies on the use of insect resistant cotton (Bt cotton), for example, that have found insect resistance resulting in unforeseen and unforeseeable secondary effects, including decimation of beneficial insects, emergence of secondary pests, and emergence of new pests with a preference for the GE crop as compared to the conventional crop. Effects vary according to the precise conditions and location.

Para 13 further states that e.g. insect resistance will decrease the need for the application of broad spectrum pesticides in forested areas. This statement, however, assumes that the forested areas will be monocultures, yet the most effective long-term remedy for insect attack is to refrain from planting monocultures. Furthermore, if genes for insect resistance escape into wild populations of trees, the impacts would be broad, diverse and impossible to predict. Studies have identified larger impacts of the use of Bt, including the negative impact of Bt-toxins on the food chain, e.g. on predators of pests and reduced interaction of the plant root system with beneficial *mycorrhizae*.

Para 17 looks at the environmental risks of herbicide tolerance purely from the trait perspective, overlooking again the fact that genes used to confer herbicide tolerance interfere with the plants own metabolism, as in the case of glyphosate resistance. There are examples of both soy and corn engineered to tolerate glyphosate, showing an altered level of lignin production. Furthermore, impacts on soils due to leaching of glyphosate through the roots system need to be considered, as one impact of this appears to be the promotion of *fusarium*, which has a negative impact on numerous plants, esp. food crops such as maize.

Para 16 states that "the application of broad spectrum herbicides in plantations could reduce soil erosion by decreasing weed removal through tilling". However, the toxic effects on soil and wildlife of such "relatively benign" herbicides is already quite well documented. In fact, most of the soil erosion in plantations is not the result of tilling, but is caused by herbicide application, which removes protective vegetative cover and leaves the soil vulnerable to the erosive forces of rain. Erosion is further worsened through clearcutting.

Indirect Impacts Must be Addressed
The paper includes no real attempt to address the indirect impacts of GE tree plantings. A small sampling of potential issues include the following:

- Will the use of GE trees lead to increased conversion of forests to tree monocultures? If so, what will the impacts be on forest biological diversity, on resident human communities or on the climate?
- Will GE trees lead to conversion of agricultural lands to tree monocultures (as is already occurring in some countries)? If so, what will be the impact on the world's food supply?
- What could be the secondary effects of so-called "high yield plantations" of GE trees engineered for "increased productivity" - e.g. para 18? For example, would these increase demands on nutrients and water?
- Will a high demand for "improved quality" GE trees for cellulosic ethanol production push logging for other materials into native forests?

A Major Question Emerging from INF/27 Section II:
Should We Learn More About the Risks and Threats of GE trees By Risking the Very Contamination That Needs to Be Avoided?

In this regard it is critical to note that we cannot afford to make a distinction between trials and commercial releases since trials are also releases and carry the same threats, particularly the spread of GE trees and their transformed genetic material via sexual or vegetative propagation.

Are There Additional Incentives for Simplification and Erosion of Ecosystems?
Simplification of ecosystems and the attendant loss of biodiversity is an obvious threat any time we are discussing the development of large-scale monocultures. Historically the use of tree monocultures throughout the world has resulted in the widespread simplification of ecosystems and extinctions of endemic species. There have also been significant social, cultural and socio-economic impacts as well, due to rural and indigenous communities being forcibly relocated for the purpose of developing tree monocultures. The increasing demand for wood has accelerated this conversion of forests to tree monocultures.

The genetic engineering of trees to produce economically valuable traits such as reduced lignin or "enabling trees to grow more efficiently" (para 30) could provide economic incentives that will increase the trend toward simplification of forest ecosystems through conversion into tree monocultures, further threatening forest biological diversity. This would also be true for the use of trees engineered for tolerance to herbicides, as use of broad spectrum herbicides also reduces the complexity of ecosystems.

What are the Additional Impacts on Climate Change?
In these times when anthropogenic climate change is accepted as a major force threatening biodiversity, it is remarkable that the INF/27 paper mentions nothing about trees or forests in relation to climate at any point. There is no reference to the importance of forests in regulating water in the soil and in creating rainfall through *evapotranspiration*. Nor is there any reference to the greenhouse gas emissions caused by deforestation or the potential impact of GE tree plantations on local, regional and global climate. The contribution of biodiversity to mitigating climate change is an emerging issue of extreme importance. Studies have proven that the replacement of forests with tree monocultures has a negative impact on the climate, both through the deforestation process and because tree plantations do not sequester carbon as forests do. Once again, the economic pressure to replace forests with tree plantations as demand for wood and biomass increases will exacerbate climate change, which is itself the greatest threat to forest biological diversity worldwide.

What is the Extent of Ignorance about the Risks and Hazards Involved?
Given the task at hand, it would be impossible for any report to pinpoint all the potential impacts of GE trees. As the report itself acknowledges, there is only a limited understanding of what the risks and hazards actually are or could be. Most of this is not due to lack of field trials, but rather our lack of understanding of how trees interact and function in complex and diverse ecosystems and how trees function on a molecular level, including their responses to external factors.

Additionally, there have been virtually no attempts to assess the risks of GE trees over the long term. This means that there is inevitably a lack of understanding of the potential risks and hazards of GE trees. The CBD has recognised up until now that the potential risks involved in the release of genetically engineered trees outweigh the potential benefits, especially since many of those risks are impossible to foresee and could have devastating consequences.

Para 8 further makes the inaccurate statement: "While trees differ substantially from agricultural plants, the biosafety questions raised by genetic modification are essentially the same across the two domains and the debates in both fields have paralleled one another." Trees differ substantially from agricultural plants, not only in themselves but also in the systems they create. Trees are not merely longer-lived than agricultural crops; they are also integral parts of complex systems (forests), which play essential roles in managing water supply and rainfall, and also climate regulation. We therefore consider that the biosafety questions raised are not the same across both domains. Biosafety concerns are intended to serve the interests of biodiversity, where genetic engineering promotes the simplification of ecosystems for commercial purposes.

Beyond ecological concerns, possible social, cultural, socio-economic and health impacts on forest-dependent communities, while potentially quite serious, remain unassessed.

What Time-Frame is Needed to Test All Relevant Impacts?
INF/27 rightly points out that "trees require long periods of time to complete their reproductive cycle." (para 9). However, the same para 9 then concludes: "Therefore, research on genetically modified trees requires several years of monitoring, requiring that trees remain in the environment for longer periods than agricultural crops." Though monitoring for "several years" could contribute some data towards risk assessments, it would only offer a mere fraction of what would be required and might in fact be misleading as compared to a complete picture. For an adequate risk assessment, data would need to be collected a) over the whole life span of a GE tree, b) for a large number of its offspring from various periods and years of reproduction and c) for different growing conditions, including different biotic and abiotic factors. This would require many decades of study.

Decades of study would be needed as, for example, the same GE tree could demonstrate quite different responses or behaviour in different environments and conditions, including *gene silencing* occurring to different genes or at different rates and times, altered gene regulation and changes to the tree's metabolism, fitness and defences. It is vital to remember that inserting a genetic construct into a plant results in multiple 'injuries' at the DNA level (mutations) as the process inserts the construct randomly into a finely balanced complex of interactions and relationships, much of which we do not yet understand.

We therefore agree with INF/27 that: "Impacts ... are likely to vary depending on several factors including the trait, which is modified or introduced, the evolutionary history of the organism being modified and the size and location of the plantation." (para 10) but would contend that the factors to be taken into account go beyond those mentioned.

How to Prevent Gene Escape
The only reliable method for preventing the escape of genetic material such as transgenes from genetically engineered trees is to not release such trees into the open environment. In the open, the only way to prevent gene spread via sexual reproduction would be for the tree to permanently produce sterile seed and pollen or not to produce any pollen or seed at all. However, as is rightly pointed out in para 23, neither Genetic Use Restriction Technologies (GURTs or Terminator technology) nor any other molecular methods would offer the required 100% effectiveness or "complete containment" over the entire lifespan of a tree, especially under prolonged exposure to biotic and abiotic stresses.

Furthermore, INF/27 importantly points out that no answers have yet been attempted to prevent vegetative (non-sexual) reproduction, and none of the molecular methods investigated and developed can guard against such spread of transgenic material into ecosystems. (para 23). Additionally, the risks of GURTs are addressed (partially) in CBD Decision V/5 which recommends that such technologies not be approved by Parties for field testing or commercial use until their safe and beneficial use can be validated.

Sections III and IV Insufficiently Address Cultural and Socio-Economic Impacts
The INF/27 paper notes that concerns can broadly be defined as environmental, cultural and socio-economic and continues (para 6): "However, it should be noted that these three spheres are innately linked, as what occurs in the environmental realm will also have an impact on cultures and socio-economic conditions". Although Section III touches very briefly on how some of the potential environmental impacts may affect cultures and lead to the loss of cultural knowledge of ecosystems, Section IV does not address interactions between the realms adequately. For example, in para 32 it is stated: "economically valuable species could be modified to be grown in various locations outside their traditional range, allowing for greater production areas" without any reference to the potential for such modifications to lead to such trees becoming weeds, (invasive species), depleting water tables, furthering soil erosion, resulting in salinification of soil or encouraging conversion of yet more natural forests to tree monocultures. In fact, Section IV is far more about potential economic impacts than about social or socio-economic benefits or impacts.

Our Comments on the Conclusions of INF/27
We agree with many of the conclusions presented in INF/27, especially with the conclusions that:

- "the scientific data needed to assess the potential impacts of these trees is not currently available."
- The potential impacts of transgenic trees and their products on human health from ingestion, inhalation or direct contact via touch has generally been ignored.
- The precautionary approach should be applied when considering the use of genetically modified trees.

We do NOT agree, however, with the INF/27 conclusion that: "Much of the needed data must come from medium to large field releases with monitoring occurring over one full rotation. the pollen of some species can travel large distances (pine pollen for instance can travel distances of up to 600 km, though the average distance is likely to be between 50 and 100 metres), the monitoring used in studies must also cover large distances…" There are simply too many unknowns and too many indications that the escape of genes from GE trees released into the environment is both inevitable and potentially disastrous, both to forest ecosystems and to forest-dependent communities.

We are confronted with an unsolvable paradox: in order to carry out proper research on the impact of GE trees, experimental releases would be required that would themselves permanently alter the biosphere. Experiments have demonstrated that pollen can move thousands of kilometers in air currents. We still know very little about trees and the organisms and networks that depend on and provide services to them.

The solution to that paradox: the precautionary principle needs to be applied. We therefore demand that there be a moratorium on the release of genetically engineered trees into the environment. There are simply too many unknowns and too many indications that the escape of genes from GE trees released into the environment is both inevitable and potentially disastrous, both for forest ecosystems and for forest-dependent communities.

This paper is joint effort of the following organizations:

Canadian Biotechnology Action Network, www.cban.ca, coordinator@cban.ca
EcoNexus, www.econexus.info, info@econexus.info
Ecoropa, cvw@ecoropa.de
Friends of Siberian Forest, www.sibforest.org
Global Forest Coalition, www.globalforestcoalition.org, simonelovera@yahoo.com
Global Justice Ecology Project, www.globaljusticeecology.org, globalecology@gmavt.net
PIPEC (Pacific Indigenous Peoples Environment Coalition)
STOP GE Trees Campaign, www.stopgetrees.org
Timberwatch Coalition, www.timberwatch.org.za
World Rainforest Movement, www.wrm.org.uy, rcarrere@wrm.org.uy

End Notes:

- In general, traditional breeding is NOT referred to or regarded as "genetic manipulation", as it is simply an act of cross-fertilisation and selection.

- Article 3 of the Cartagena Protocol on Biosafety states:

(g) "Living modified organism" means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology

(i) "Modern biotechnology" means the application of:

a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or

b. Fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection;

Paragraph 5 of the present paper quotes from the FAO definition. However, although both define LMOs (or GMOs) more widely than simply the transferral of genetic sequences across species boundaries, the FAO definition is not as wide as that of the Cartagena Protocol on Biosafety. Since we are working under the rules of the CBD, we should use the definition as set out by the Cartagena Protocol.

As regards the origin of transgenes, these may in fact consist of an organism's own DNA sequence, of synthetic sequences or of sequences of other organisms – or any combination of those.

- We note that in para 19 the term "horizontal gene flow" is not the appropriate term. Whilst 'gene flow' is the general term for the spread of genes to either sexually compatible species via pollen/seed or to entirely different species via direct or 'horizontal gene transfer'. 'Vertical' refers to the passing on of genes to subsequent generations and 'horizontal' means non-sexual transfer of genes e.g. from bacteria to plants or vice versa. The term horizontal gene flow appears to be being used here to mean 'out-crossing' or 'gene flow via pollen or seed', though the use of the term 'vector' in this context is not clear.