Analysis of the forest as a productive system from a regenerative perspective

The forest is an **important productive system**, due to the materials it produces and because it can create very important carbon stocks. Unlike agricultural systems, **plant nutrition in the forest is the result of natural processes**. However, **most of our forests are highly transformed** and the biological activity of the soil and, with it, productivity is reduced.

Application of the principles of the regenerative model to a forest

The regenerative production model encompasses five basic principles that can be applied to a forest system.

1) PLANT DIVERSITY.

The greater the biodiversity, the better the forest functioning. This is **usually linked to greater environmental heterogeneity, a greater mix of species and elements of forest maturity** (**Figure 1**). However, the diversity of many of our forests is greatly reduced because **management has favoured monospecific forests** and has eliminated elements of maturity from the forest (senescent trees and dead wood). However, this management effect is not inevitable, and it **is possible to manage productive forests favouring greater diversity** and the recovery and maintenance of the maturity element.

A basic factor to maintain these diversity characteristics, as well as to guarantee good forest growth conditions, are the **tree's growth conditions, expressed in the shape of its crown**, and **the growth conditions of the forest, expressed in its structure** or how trees of different ages and sizes are distributed through the stand. These two fundamental characteristics are inevitably related, and knowledge of their operation will allow us to guide the dynamics of the forest to achieve the best stability and production conditions, in a sustainable way. In very intense harvests, where few or no trees are left (i.e., clearcutting), **thinning can cause temporary situations of loss of micro-climatic conditions and a lack of production**. For a time, the forest is no longer a forest, and we must understand how it works in this state and which elements (shrub stratum, herbaceous stratum, thinning remains, soil humus) guarantee the maintenance of the biological activity of the soil.

2) THE RETURN OF PLANT MATERIALS TO THE SOIL.

Leaves constitute the main form of return in the forest. The accumulation of leaves occurs following micro-topography, which leads to significant spatial variability (**Figure 2**). It is a material with a certain degree of lignification and a low nitrogen content. **Decomposition occurs on the surface, in the humidity and temperature conditions of the interior microclimate of the forest**. The process is carried out mainly by fungi, which decompose leaves forming a stable forest humus. For this process to continue, it is necessary to maintain the supply of leaves and the microclimatic conditions of the interior of the forest. This is guaranteed by a continuous presence of trees. **The objective of forest management in a regenerative context is that forest conditions are continuously maintained**. The growth, return and incorporation of organic materials into the soil should not be interrupted at any time. There is also a **return in the form of branches, especially linked to forest harvest**. These branches have a much slower decomposition that depends on the degree of crushing they experience. Large-sized wood is the material used after thinning and is not usually part of the return.

Figure 1. Mixed forest in autumn. Photo: Danier.

Forest exploitation produces a change in the microclimatic conditions and in the edaphic conditions (due to the removal of soil by dragging trunks). This encourages mineralisation of forest humus, affects biological processes and can represent a significant loss of soil carbon stocks.

Figure 2. Forest floor. Photo: MJ Broncano.

Figure 3. Heavy machinery for log extraction. Credit: Marc Gràcia.

3) INTERVENTIONS THAT BLOCK THE FUNCTIONING OF SOIL BIOLOGICAL PROCESSES.

When the harvesting is very intense, its effects on the forest humus can be important **and leave the soil uncovered**, leading to a degradation of the biological activity of the soil. The use of heavy machinery (**Figure 3**) necessary to extract large logs can also **cause compaction and destruction of the topsoil** if works are carried out in conditions of high humidity. In the exploitation of the forest from **a regenerative point of view**, the interventions are scattered and occasional and do not generate a significant impact. This type of management always keeps the ground covered and does not cause compaction phenomena on the forest floor.

4) THE FUNCTIONING OF SOIL AND THE CARBON CYCLE.

The forest is the terrestrial system that is capable of maintaining a larger carbon stock in the aerial part (although it should not make us forget the importance of the stocks in the soil). This aerial stock follows some variations in the shape of a sawtooth, linked to the use of the forest, with an average stock over time. This average value is the one that determines the greater or lesser effect of a forest as a carbon sequester. A determining element of this average stock is the presence of large trees.

The use of the forest affects the carbon cycle of the system in a more or less significant way through three different processes: **decreasing the carbon stocks of the aerial part** (extraction of logs, **Figure 4**), **decreasing the carbon stocks of the soil** (increased mineralisation processes), **and temporarily eliminating a more or less important part** (or even all) of the return of leaves that feeds the soil. These processes have a temporary impact, but if they are prolonged over time they can generate a loss of system production. **A forest with a good productive capacity can compensate for the extractions** (wood) **and losses** (soil) **of carbon** caused by harvesting. It is important to bear in mind in forest management the elements that can affect this productive capacity: diversity, continuous production, microenvironmental conditions inside the forest and factors that block the soil trophic network. Due to the time scale of forest dynamics, these elements of forest management can go unnoticed.

5) WATER AS A LIMITING FACTOR FOR THE PRODUCTIVITY OF THE SYSTEM.

The main elements for the **best use of water** in the forest are maintaining forest humus and the presence of dead wood on the forest floor. **The regenerative forest management system produces and maintains an important forest humus** and creates a structure dominated by large trees, but which maintains all ages. This allows a more efficient use of water and a greater capacity to adapt to environmental changes (diversity of conditions, ages and species).

Structure also has an important effect on the way trees make use of available water. In young forests with very high densities, the forest cover can be so closed that when it rains, the canopy retains a very important amount of water that does not reach the ground. **The decrease in the density of trees and the presence of mature and senescent trees, with lighter crowns, allows a better arrival of water to the ground**. At the same time, reducing the density of trees helps decrease competition among them for water, which is the limiting factor. In the current climate change situation, this modification of forest structure conditions (reduction of the density of stems) is the fastest way to help the forest to adapt to drier climate conditions than it had when it began to grow.

Figure 4. Truck with logs leaving the forest. Photo: Pxfuel, Creative Commons Zero - CC0.