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ProSilva

Stance concerning good management of Carbon

Forests play a very important role in the carbon cycle and therefore offer an efficient way of controlling atmospheric CO_2 which is one parameter responsible for climatic change.

The function of the forest should not simply be understood through carbon sequestration in ecosystems, but as a sustainable resource with opportunities for regular harvests of the best products and for enhancing the energetic value by and end-products (Chenost Rubio, 2008 [2].

The key word for sound management of C in forest is to minimize the decomposition of deadwood thus allowing to substitute high energy consuming products (i.e. cement, iron, fertilizers) [5] with timber extracted from thinning at the appropriate time; in order to preserve stand stability and vitality while maintaining the natural fertility cycle.

ProSilva forest management system is perfectly compatible with those objectives and with the other roles of the forest by insuring that the multiple functions of the forest are preserved. This system is more favourable than forest management based on age-classes and regular thinnings that lead to the renewal of the forest through final clear-felling and is also considerably better than monoculture systems.

Rationale of the importance of the forest on carbon cycle

- The total biomass of the forest ecosystems (above and underground) represents 53% of the total C stock [8]
- Forests play an essential role in C recycling through photosynthesis process. 5% of the atmospheric C is recycled annually by forests [13]. Forests therefore operate as carbon recycling pump.
- Natural forest ecosystems show –over the whole ontogenic cycle- a balanced C result (i.e. neutral). Without the decaying of deadwood this balance will be mostly positive. In young and mature stands where the biomass accumulates and where mortality is low, the balance is mostly positive (fig. 1). The balance changes as the stand reaches maturity due to crown reduction and to biomass decomposition that releases carbon. Forest management based on economic considerations disrupts those stages.
- Regular forest harvesting and adequate use of timber products allow for the extension of C sequestration over time (100 years and over for structural timber). It also allows for substantial energy savings through substitution.

Good management of C

- To optimise the use of products showing the best ecological and energetic balance while preserving the natural fertility of the production systems.
- Substitution seems to be the option having the most significant effect. It is therefore necessary to:
    - avoid decaying of deadwood as much as possible, except for the amount necessary to preserve biodiversity.
    - avoid in and off mineralisation process by ensuring a continuous cover that is compatible with the forest renewal.

Exploited forest allow for a rationalised use of the timber which will otherwise decay while releasing CO_2

- Substitution is the most significant contributor to good C management along with letting the increased number of land being deserted by agriculture return to forest. The use of timber in construction offers the best substitution. This is due to both the long C sequestration duration and the possibility to use this timber as fuel wood at the end of the product cycle. Other timber products that can't be use for building can be used as fuel wood, which is a clean energy to replace fossil fuels.
- The undergrowth biomass (root system) is important (over 33% of the totality of the C) [11] with a renewal rate that is much shorter. 50% of the small roots die annually [14] with a decomposition cycle that is much quicker than the one above ground. As a result the heterotrophic decomposition of the small roots along with their mychorizal mantle contributes up to 1/3 of the C cycle and up to 2/3 of the N soil cycle [10].
- The organic matter resulting from the decomposition of the undergrowth biomass and the litter (leaves and twigs) contribute to the natural fertility of the forest ecosystem thus avoiding the reliance on fertilisers that are costly both financially and in terms of energy. The annual input of small roots to organic matter is equal in volume to the one of the undergrowth biomass [10].

Forest exploited according to Pro Siva principles improve C balance

European silviculture that combines thinning and regenerative cuttings (e.g. selective thinning according to Schädelin) collects around 40-50% of the production through thinnings; and decreases natural mortality due to self-thinning and over density.
- ProSilva silviculture collects 100 % of the production through thinnings ensuring lower mortality due to ageing and hazards.
- Perennial high forest allows concentrating the production on high quality and big volume timbers that can be use for construction. For example irregular high forest produces twice more medium and big trees and more sawing material than regular high forest [15] and coppice with standard systems.
- Continuous renewal -without major disruption of the canopy by avoiding clear-felling-favours regular input of organic matter [4]. This also prevents in and off mineralisation process (and therefore release of CO_2) and leaching of volatile compounds such as sulphite, nitrate and nitrite which will occur with clear felling.

Importance of standing volume (current biomass)

- A good C balance is no characterised as much by the total standing volume than by the use of the timber. Continuous management aims for a constant standing timber volume which is a compromise between the optimisation of the mean annual increment and the continuous renewal of the ecosystem. This optimal volume is generally clearly below the one of natural mature forest and old age-class forests but it doesn't lead to the diminishing of the increment [15]. On the other hand it does contribute to the stability of the forest with regards to natural hazards.
- In effect according to the " Eichhorn's law": the total production (i.e. more or less the mean annual increment) is roughly the same regardless of the thinning type, almost within large limits. Accumulating too much standing volume will increase the forest vulnerability without increasing its total production.
- In perennial high forest (continuous cover forests) the production cycle tends to optimise the best trees rather than maximising the biomass.

The importance of wood energy

- An efficient management of C should be connected with energy saving (better insulation, NEGAWATT concept according to Lovins, 1979 [9]) and with the use of renewable energy.
- There are three energy levels associated with wood use. The order depends on the best balance result and on the potential accumulation of uses (building and wood energy) such as 1) wood fuel with low moisture content (pellets), 2) bio fuel (methane and methanol), 3) raw material (e.g. polymer).
- Direct use as fuel wood for timber material that is not suitable for building and construction. Even in the case of an objective aiming at the production of high quality timber there is always an important volume of wood left on the ground following harvesting (thinning of young stands, crowns, etc.) that could be used as fuel wood.
- Fuel wood only contributes for a small portion to the global energy balance (< 5%). It could cover up to 10 or 15% through the better use of left over wood following harvesting (including pulp and industrial timber), better recycling of sawmill by-products, etc.
- Its main vocation is as firewood as its energy efficiency is by far superior (i.e. 80%) to the one of bio fuel produced through pyrolysis process (50%). Wood gas could present an interesting alternative [17] (70-85% heat return) with possible cascading effects (utilisation of by-products as firewood).
- The current part of wood in the global energy balance could be greatly increased by producing wood outside forests (edge rows, farmlands). This should not be detrimental to the current needs for farm crops and other farm productions such as biofuel (sugar beet). Wood energy could potentially cover 40% of the heat energy needs.
- Ligniculture systems with very short cycles are not the most efficient models (in terms of environmental footprint) unlike natural forest where the annual mean increment doesn't culminate before 60 years [1, 7]. The inherent advantage of forests is that they can produce wood product without a need for soil work or use of chemicals, which are high energy consumers. They therefore rank much higher than intensive production systems in terms of environmental footprint [17].
- The most environmentally friendly wood energy product is the one consuming less energy to eliminate moisture (i.e. pellets). This could be applied to forest products but does imply to re-think the issue of natural drying in the forest. This could modify harvesting techniques but does not alter ProSilva silvicultural principles.

ProSiva position on wood energy production produced outside forests
- ProSilva considers that additional wood production outside forest is feasible everywhere and in the long-term as long as natural fertility is used (without soil treatment and chemicals) and where the natural dynamic can favour forest establishment. Deserted, set aside and other in-production farmlands could be considered, as long as there is no incompatibility with other production needs (i.e. food crop). The multi functionality of the forest, mixture and irregularity are possible even in the case of extensive management.
- Extensive production is possible on sites with difficult access and harvesting conditions, by allowing spontaneous forest establishment with the use at establishment stage of soil improving species such as locust trees.

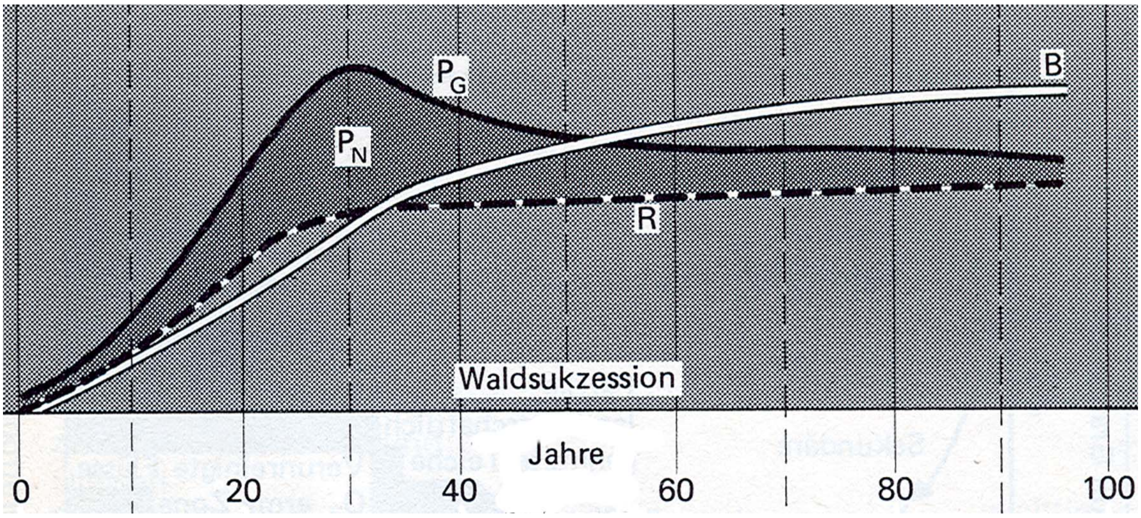

Figure 1 : Forest ecosystem constituents (NW Pacific forest).
P_G = Goss Production ; P_N = Net Production ; R = Respiration : B = Total Biomass
From Kira & Shidei (1967), in : Odum 1980

References:

[1] Burschel, P. Weber, M Wald- Forstwirtschaft- Holzindustrie: Zentrale Grössen der Klimapolitik. Forstarchiv 72 (2001): 75-85.
[2] Chenost, C, Rubio, M Forêt, bois énergie, bois matériau et carbone. Rendez-Vous techniques ONF 20 (2008): 41-43
[3] Dvořak L, Bachmann P, Mandallaz D Sturmschäden in ungleichförmigen Beständen. Schweiz. Z. Forstwes. 152(2001): 445-452
[4] Edwards, NT, Ross-Todd, BM: Soil carbon dynamics in a mixed deciduous forest following clear-cutting with and without residue removal. Soil Sci Soc Amer J, 47 (1983): 1014-1021

[5] Hofer, P, Taverna, R, Werner, F Nutzung des geernteten Holzes: Substitution und Senkenwirkung. Schweiz Z Forstwes 159 (2008): 288-295

[6] Kira, T, Shidei, T. Primary production and turnover of organic matter in different forest ecosystems of the western Pacific. Japanese J Ecol 17 (1967): 70-87

[7] Kürsten, E., Burschel, P Forstliche Energieplantagen und Treibhauseffekt. Holz-Zentralblatt 117 (1991): 1952-2012

[8] LeTacon, F: Stockage du Carbone dans la biosphere continentale, Comptes Rendus Acad Agric France 88 (2002): 3-5

[9] Lovins, AB: Soft energy paths: toward a durable peace, Hasper & Row, New-York 1979, pp 231

[10] McClaugherty, CA, Aber, JD : The role of fine roots in the organic matter and nitrogen budgets of two forested ecosystems. Ecology 63 (1982): 1481-1490

[11] Nadelhoffer, KJ, Raich, JW: Fine root production estimates and belowground carbon allocation in forest ecosystems. J. Ecol. 73 (1992): 1139-1147.

[12] Odum, E.P.: Grundlagen der Ökologie, Thieme, Stuttgart-New-York.

[13] Rubio, M Forêt et cycle du carbone, Rendez-Vous Techniques ONF 20 (2008): 30-34.

[14] Santantonio, D, Grace, J.C: Estimating fine-root production and turnover from biomass and decomposition date; a compartment flow model. Can. J. For. Res. 17 (1987): 900-908

[15] Schütz, JP,: Sylviculture 2; La gestion des forêts irrégulières et mélangées. Presses Polytechniques et Universitaires Romandes, Lausanne, (1997)

[16] Waide, NT, Caskey, WH, Todd, RL, Boring LR : Changes in soil nitrogen pools and transformations following forest clearcutting. In: Hydrology and ecology at Coweeta. Swank, WT, Crossley, DA (eds), Ecological Studies 66, Springer, New-York: 221-232

[17] Zah, R, Böni, H, Gauch, M, Hischier, R, Lehmann, M, Wäger, P: Ökobilanz von Energieprodukten: Ökologische Bewertung von Biotreibstoffen, Bundesamt für Energie, Bern (2007) http://bafu.admin.ch/php/modules/shop/files/pdf/phpKVKm5f.pdf