WBA fact sheet

THE CARBON NEUTRALITY OF BIOMASS FROM FORESTS

SUMMARY

The use of forest biomass is carbon-neutral, because the carbon contained in wood originates from the atmosphere and it is released to the atmosphere by wood decay or by combustion. Before a tree can be burned it has to grow by absorbing carbon from the atmosphere. Theories on carbon debt and 'payback time' of biomass are not credible, because they are based on the unrealistic assumption that trees are first burned and then grown!

It is a fundamental requirement of sustainable forestry that the carbon stock in forests remains stable or increases over time. Deforestation and unsustainable forest management lead to a decline of the carbon stock in the forest – this has to be avoided. The forests are part of the global carbon pool atmosphere - biospheres within which the carbon moves as part of the natural carbon cycle.

The carbon released by burning fossil fuels is not part of the 'natural' carbon cycle. It rapidly increases the CO_2 content of the atmosphere. In 2011 about 90% of total CO_2 emissions were caused by burning fossil fuels. The use of fossil fuels creates a carbon debt that will be a huge burden for future generations.

Replacing fossil fuels with renewable energy has to be the core strategy with regards to future climate policies. Utilizing biomass from sustainably managed forests can play an important role in this strategy. Several countries have demonstrated that a build up of carbon in forests and an increase of forest biomass for energy is simultaneously achievable by good forest management practice.

Claims are being made, that trees should rather be left to grow to stock further CO_2 and not be harvested. This is no solution however, because forests stop to grow as soon as trees are mature. It would also mean not to use the sustainable products from forests: timber, paper, energy and to replace them by fossil fuel based products.

The WBA favors a global afforestation program to reach a net increase in the global forest area by 100 million ha by 2025, sustainable forest management worldwide and more utilization of forest biomass instead of fossil fuels. To avoid a reduction of carbon sequestered in forests due to the growing demand for solid biomass governments are urged to enforce a forest management policy in their countries based on the principle of sustainability. The WBA proposes to introduce sustainability criteria as developed by the WBA since 2009. Certification systems based on these criteria should be introduced for consumers or traders of large quantities of solid biomass.

Note: This fact sheet explains the role of biomass from forests in the global carbon cycle. WBA sees an urgent need for this clarification on this issue after having analyzed the different opinions being discussed. This paper does not deal with emissions along the supply chain from the forest to the final consumer.

FORESTS AND THE CARBON CYCLE

On the planet earth a natural carbon cycle exists between the atmosphere, the ocean and land (in soils as humus, in the vegetation such as in trees and plants and in other forms of biomass). The plants sequester carbon from the atmospheric CO_2 using the photosynthesis process, which is powered by energy directly from the sun, see Figure 2.

This carbon is later released to the atmosphere by the decay of the organic matter or by its use as food or as biomass for energy. Using biomass for energy production means taking part in this natural carbon cycle. Therefore the use of biomass is carbon-neutral.

In contrast to the biological carbon cycle, the combustion of fossil fuels injects additional carbon stored over millions of years deep beneath the earth's surface into the atmosphere and thus unbalances up the global carbon cycle. The natural sinks are not big enough to absorb the huge amounts of fossil derived carbon, so part of it remains in the atmosphere with an

Photo: istock, diplomatonline.com

Figure 1. The section of the boreal forest, Alberta, Canada. Boreal Forest or Taiga is the world's largest land ecosystem, and makes up 29% of the world's forest cover; the largest areas are located in Northern Russia, Northern Canada and Northern Scandinavia.

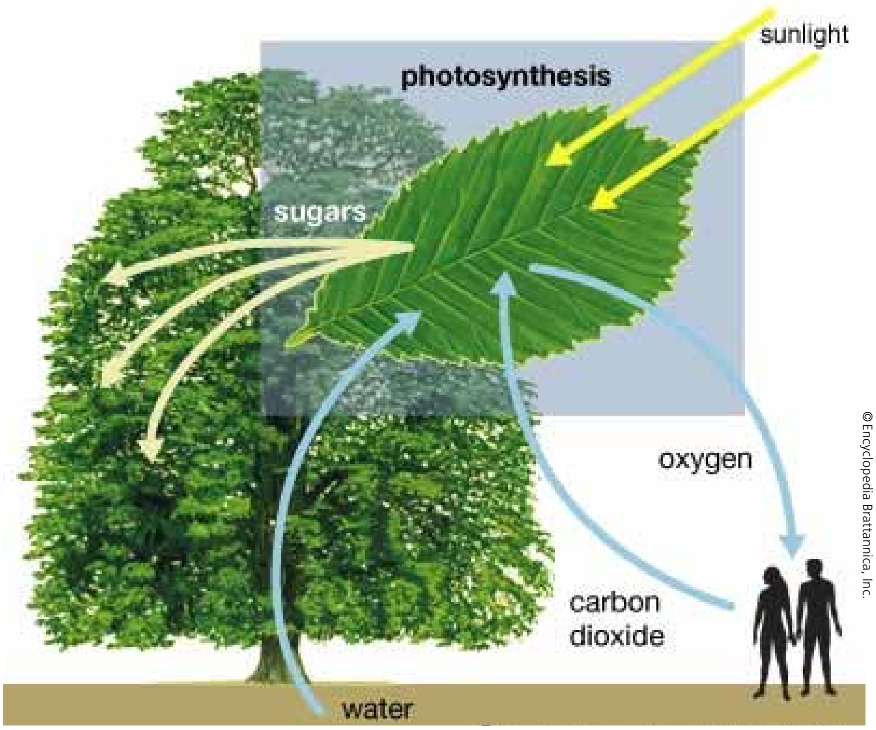


Figure 2. Photosynthesis is a process used by plants and other organisms to convert the light energy captured from the sun into chemical energy that can be used to fuel the organism's activities.
$6CO_2+6H_2O \xrightarrow{light} C_6H_{12}O_6+6O_2$ ($C_6H_{12}O_6$= sugar)

ensuing negative impact on the climate. In light of this the replacement of fossil fuels by renewable energies is decisive for successful climate mitigation policies.

In some circumstances the use of forest biomass can increase the CO_2 content of the atmosphere. This can happen, when net release of the forest stored carbon occur as a consequence of deforestation, of the over use of forests or of the transformation of overage forests to young productive forests and these shifts in a specific area are not compensated for by a net growth of forest biomass. These changes do not add additional carbon in to the land-ocean-atmosphere cycle, they only redistribute it; they should be avoided as they are harmful for the climate.

THE NATURAL LIFE CYCLE OF A TREE AND THE DIFFERENT FOREST ECOSYSTEMS

Each and every tree passes through variant stages over its lifetime: the phase of planting and first establishment, followed by the growth phase, the mature phase and the decay phase. Each tree constantly absorbs CO_2 by assimilation (by photosynthesis) and release of CO_2 by breathing (respiration), Until a tree progresses to it's mature stage it is growing and absorbs more CO_2 by assimilation than it releases by breathing. In this phase the tree is a carbon sink. In the mature phase CO_2 uptake and release are in equilibrium, the tree is carbon storage. As follows, during the decay phase, a tree will become a net carbon source.

Newly established forest, without further human interference and harvest of wood, will pass through a similar phase over time:

a) Planting phase - the forest is established

b) Production phase - the net wood production reaches its maximum

c) Mature phase -the growth of younger trees and decay of old trees reach equilibrium and carbon storage is static.

Using the concept of a production function, showing on the horizontal axis the time in decades, and on the vertical axis the volume of produced wood in cubic meters, can portray these different phases of the development.

At the beginning (phase a), the new forest seedlings are planted and annual increment is slow; the production (phase b) follows and the annual increment goes up and reaches in this example more than 5 m³ wood/ha annually (50 m³ per decade), from the 5th to the 9th decade (black line). After the 7th decade the annual increment starts to decline and falls in the 12th decade towards zero. In this phase the cumulative production (red line) plateaus at its maximum. This is one example of a forest on the northern hemisphere without wood harvest. Depending on latitude, altitude, precipitation, temperature, soil, species etc., this production function can vary strongly, however the basic relations concerning the development of the increment over time are always similar. The Figure 3 can be used to explain the different concepts of the following forest systems:

The unmanaged forest

In a forest ecosystem undisturbed by human influences, normally trees of all phases exist together and over a longer period of time they absorb about the same amount of CO_2 from the atmosphere as they release via decomposition and breathing. These forests are considered to be in equilibrium and serve as carbon storage, not as a carbon sink. Such unmanaged forests belong to sector c of Figure 3. A carbon storage reach a maximum as is demonstrated by the red line but no net production of biomass occurs as shown by the right end of the blue line in Figure 3.

As demonstrated, newly planted forests are absorbing more CO_2 than they release – they are considered to be carbon sinks and are building up additional carbon storage as long as they are in phase a and b of Figure 3.

Figure 3: 1 hectare forest, wood production in m³ over time without wood harvest

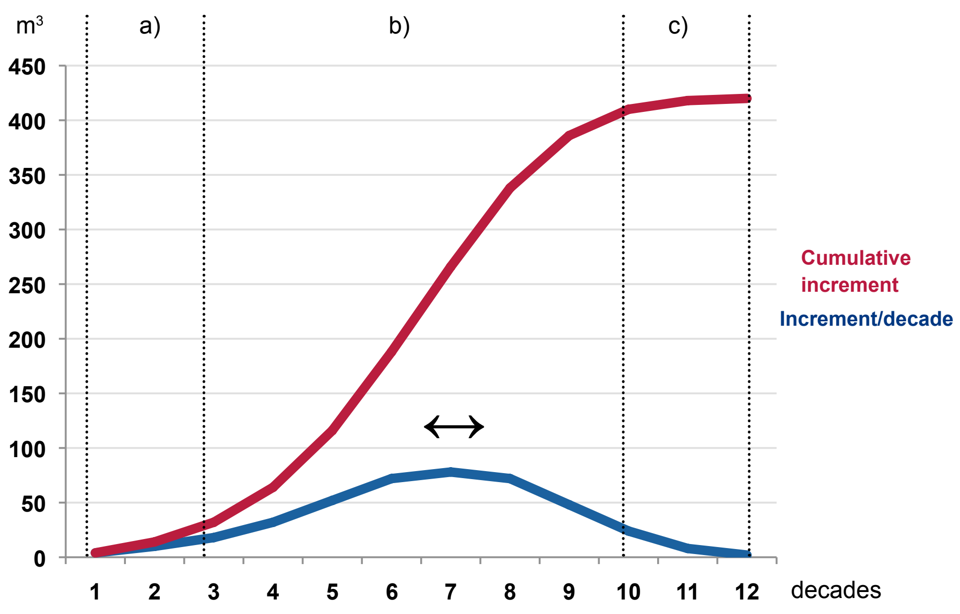


Figure 4. In a sustainable managed forest trees of different age grow side by side. The photo shows a sustainable managed forest in Sierra Nevada, USA, certified by the Forest Stewardship Council (FSC). Source: ppcnet.org

However as soon as they reach their phase of maturity – phase c - they are no longer carbon sinks but serve as carbon storage, and will eventually turn into a carbon source, if they are transformed into younger productive forests without utilization of the wood or stored carbon.

The sustainably managed forest

Sustainable forest management means that the average annual wood output can be kept stable for hundreds of years without decreasing the stored carbon content of the forest. A sustainably managed forest can be described as follows:

The fertility of the soil is safeguarded and the quantity of wood harvested and removed is equal or less than the quantity produced. Trees are harvested before reaching their stage of maturity or natural death. These forests have a net growth of biomass that can be harvested.

Figure 5 demonstrates that one key element of a sustainable forest management is the more or less stable net production of biomass per unit of time (per year or decade); here presented by the blue curve. One part of this net production is harvested – the green line. The harvested volume may change from period to period. If less wood is harvested than produced (green line below blue line) the total wood stock and thus carbon stock increases (red line). This form of forest management can go on for hundreds of years; it combines the storage of carbon with the net production of biomass to become materials for buildings or for energy production.

In these forests the quantity of carbon sequestered also grows but does not reach the level of mature forests. Typically these forests comprise trees of different ages as shown in Figure 4.

Regarding forestry policy, additional criteria for sustainable forestry management are in use. The most important being maintaining biodiversity, avalanche or watershed protection, social services and recreation these are important but are of no relevance concerning the carbon cycle.

The opposite of sustainable forestry management is the overuse of forests resulting in more carbon being released than is sequestered by growing trees. Deforestation is the extreme case of such disequilibrium.

HOW TOO NARROW BOUNDARIES OF AN ANALYSIS CONTRIBUTES TO MISLEADING RESULTS

Any forest ecosystem has a lifetime of centuries and covers many hectares. If an analysis of the carbon cycle of a forest is limited to a short time period or a single stand the interaction over time and space might be overlooked, and misleading conclusions are the consequence.

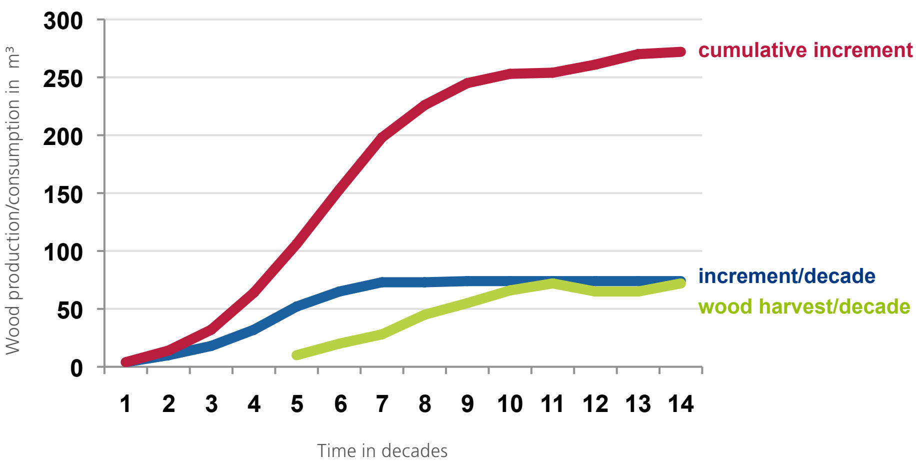
Misleading conclusion 1: carbon debt

A first misleading result of a too-limited analysis is the myth of the 'carbon debt' of forest biomass. There is no carbon debt in using forest biomass, because all the carbon released by using the biomass was previously absorbed from the atmosphere. It is not possible to burn a tree that has not already grown by absorbing all its carbon from the atmosphere. The majority of assumptions in the theories on carbon debt and payback time of biomass are wrong, because they assume that first you burn the tree and then you grow it!

In addition, in a sustainably managed forest the young growing trees absorb all the carbon that is released by any burning of biomass from old trees. This fact might be overlooked if one studies only an individual tree or a defined area instead of considering the ecosystem of the forest as a whole.

In regions with an unsustainable forest

Figure 5: 1 ha forest, sustainable managed, regular harvest



management there is a net shift of carbon release from the forest biomass to the atmosphere. But also in this case the carbon stems from the atmosphere and no additional carbon is injected from the earth crust to the natural carbon cycle.

Misleading conclusion 2: leave the trees in the forests

Another misleading result of a too narrow analysis is the conclusion that it is better for the climate to leave trees in the forests and use fossil fuels instead rather than sustainably harvesting the trees and using part or all of them for energy.

One argument behind this position says that the burning of wood releases more CO_2 per unit energy than combustion of oil or gas and therefore the CO_2 content of the atmosphere remains lower if the trees continue to grow and absorb CO_2 and fossil fuels are used instead. This argument may have some validity as long as the trees are growing vigorously – phase b of the production function – but it is not valid any more if trees are getting mature.

As soon as this phase is reached, no net carbon is being absorbed while the emissions of burning fossil fuels continue to increase the carbon content of the atmosphere directly.

Alternative suggestions infer that burning old trees releases CO_2 immediately, whereas the decomposition of old trees to CO_2 and other green house gases in nature takes many years, so there is a time lag in favor of less emissions now by not burning trees. This analysis ignores that mature trees occupy the space that could otherwise be utilized by young trees. These old trees are no longer a carbon sink but a slow carbon emitter. If fossil fuels are used instead of this biomass two sources of emissions exist: the burning of fossil fuels and the decomposition of biomass. The fact that by comparison the impact on the climate will be worse.

Misleading conclusion 3: the build up of over-aged forest is sustainable

Finally, it is sometimes argued using forests, solely as carbon storage and not as productive ecosystem, might help to comply with politically defined climate targets within limited time frames and that ultimately there is no need to care about the situation afterwards. This argument completely ignores the principle of sustainability as it was defined in the UN report: ***"Our common future"***.

" Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Sustainability cannot be reduced to a concept of a few years defined by political targets; it is a principle that includes the responsibility of the present generation for the well being of the generations to come!

The transformation of productive growing forests to unproductive mature forests and using fossil fuels instead is in several respects not sustainable:

- The capacity of forests to store carbon is used up by the present generation,

- The fossil fuel resources are depleted,

- Climate change will be accelerated as soon as the forests don't absorb additional carbon

Misleading results of a too-narrow analysis about the role of forests in the carbon cycle might cause decision makers to postpone the transformation of the energy systems to the next generation. But there is no time left for this kind of procrastination.

THE GLOBAL ROLE OF FORESTS IN THE CARBON CYCLE

The global forest area in 2010 was 4,032 billion hectares, with 30% of these forests being used for wood production. The growing wood stock on this area is estimated at about 527 billion m^3 wood, and the annual removal is 3.4 billion m^3!

Over the last 10 years the forest area was increasing in Asia (mainly China), in North America and Europe and decreasing in Africa, South America and Australia. The global net loss in forest area annually was 5.2 million ha.

In the boreal forest zone, (Northern Russia, Northern Canada and Northern Scandinavia), the regeneration of these forests takes place after fires, massive insect attacks, wind throw, etc., resulting in more or less even-aged stands. Very large areas of these forests in Canada and Russia are over-mature and so already in or close to the stage of being a carbon source.

The forests store a huge amount of carbon in the growing wood stock, in litter and dead biomass and in the soils. In 2010 the total carbon stock of forests is estimated with 652 gigatonnes (Gt) carbon, of which about 289 Gt is in the growing biomass. The loss of carbon stored in forest biomass due to deforestation and overuse is estimated at about 0.5 Gt per year (1.8 Gt CO_2).

The carbon stored in forests can be increased if deforestation is strongly limited and new forests are created by natural expansion or afforestation. A net increase of the global forest area by at least 100 million ha would lead to an additional carbon uptake of 0.27 Gt carbon (1.0 Gt CO_2) annually. (This assumes biomass production of 5,4 t biomass dry matter/ha annually)

These figures have to be set in relation the global carbon emissions caused by fossil fuels. In 2011 these emissions reached 9.26 Gt carbon (34 Gt CO_2), 34 times more than the additional 100 million ha of forests could absorb annually. During the last years fossil fuels have become the dominating cause for the increasing CO_2 content in the atmosphere as the following carbon balance for the year 2010 shows:

TABLE 1: GLOBAL CARBON BALANCE FOR 2010:

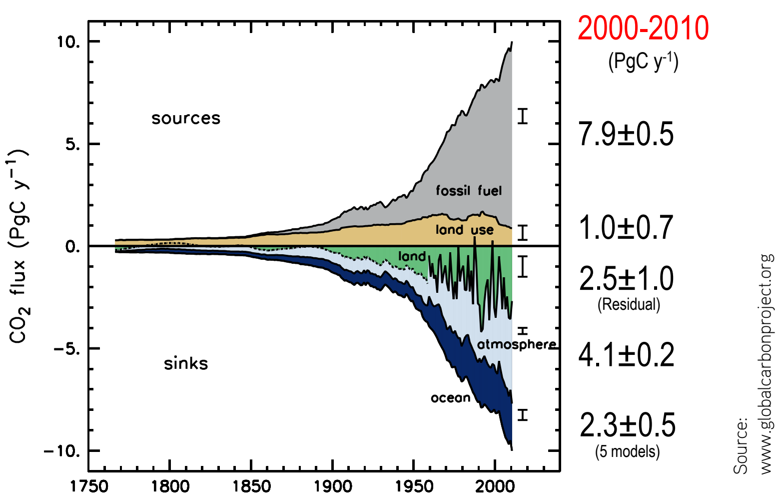
Carbon sources in Gt		Carbon sinks in Gt	
Fossil fuels	9,1	Biosphere	2,6
Land Use Change	0,9	Oceans	2,4
		Atmosphere	5,0
Total	10,0	Total	10,0

Source: www.globalcarbonproject.org

As Table 1 shows, 90% of the CO_2 emissions come from burning fossil fuels and the cement industry and 10% from land use changes. Within this 0,9 Gt related to land use 0,5 Gt, that corresponds to 5% of total emissions are due to deforestation and overuse of forests. On the other hand, it can be seen that the biosphere in total, absorbs more CO_2 than land use related sources emit.

These relations changed dramatically over the last 50 years as Figure 6 demonstrates. Whereas around 1950 the

Figure 6. Human perturbation of the global carbon budget



emissions from fossil fuels and land use were almost equal. Currently the emissions from fossil fuels are 10 times higher and these emissions are increasingly stored in the atmosphere.

Therefore the reduction in the use of fossil fuels is the central challenge of the climate policy. Better management of already used forests, the transformation of 10 – 15% not used forests to sustainable managed forests and the use of the increment of 100 million ha new forests for energy could contribute to the energy system with an additional 30 EJ, replacing 8% of the fossil fuels.

EUROPE AS A POSITIVE EXAMPLE

In Europe, the forest area increased over the last 10 years by 676,000 hectares, and the carbon stock is also increasing. Even in countries with a high share of biomass in the energy system such as Sweden – where biomass provides over 30% of the primary energy demand - the carbon stock in the forests today is much higher than decades ago. This example shows that an increase of forest biomass and build up of carbon in the forest can be reached simultaneously by applying sustainable forest practice. ■

POSITION OF WBA

Biomass is a carbon-neutral energy source, because the plants absorb CO_2 from the atmosphere via photosynthesis and this carbon is eventually released to the atmosphere via the decay of biomass or by using it. Biomass in forests can be harvested while at the same time the carbon stock in the forest is increasing, ensuring a carbon-neutral source of renewable energy.

- WBA favors a further limitation of deforestation and a well-financed global afforestation program of 10 - 20 million ha annually for the next ten years in all continents, especially in Africa and South America, in order to reach a net increase of the global forest area by at least 100 million ha by 2025.
- To meet the growing demand of forest biomass for energy it is recommended to use a bigger share of the existing forests as sustainably managed forests and to improve the forest management worldwide.
- WBA considers the transformation of productive forests to over-aged forests for the sake of carbon storage without net biomass production as a mistake, and supports instead replacing fossil fuels by biomass coming from sustainably managed forests.
- WBA rejects the concept of 'carbon debt' of biomass. On the contrary, the carbon debt caused by using fossil fuels will become a huge liability for the coming generations.
- The growing demands for solid biomass might lead to a reduction of carbon sequestered in forests in some parts of the world. This should be avoided. Therefore WBA urges governments to enforce a forest management policy in their countries based on the principle of sustainability, and proposes to introduce sustainability criteria as developed by WBA in combination with a Biomass Certification system, to apply to companies using or trading in large quantities of solid biomass. On the way to a low-carbon economy biomass from forests will have to play an important role in replacing fossil fuels especially in the heating and transportation sector.

SOURCES

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