State of the world's forests, local timber construction. Titan, CNES technical space center, Kourou: R + 3 in Angélique, wood from the Amazon rainforest managed by the ONF

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The global forestry situation

1. Forests and global warming

We have started to see the effects of global warming on the populations of temperate and boreal zones, resulting in very serious damage, such as attacks by xylophagous insects and bark beetles. In question, the increase in temperatures in each season and the water stress generated by repeated heat waves.

In these regions, and in 2015 alone, an area estimated at 40 million ha was affected by various diseases and / or associated with colonization of the bark beetle, the most destructive xylophagous insect that dries up trees. over two or three seasons and generates a slow death of the colonized forest plot.

To cure this pathology, few tools, except the exploitation of the wood before it disappears by itself, carried away by the cycle of biodegradation. Caring for the forests would therefore involve greater exploitation in order to rejuvenate the stands and reduce local trophic competition, in particular the access of the root system to soil water.

On these ecosystem risks linked to global warming, the tropics are not left out. In these regions where the effect of the seasons is less, since there is no winter, global warming affects the populations in another way. In these areas, there is an increase in forest areas destroyed by natural fires caused by droughts and violent storms.

For example, the year 2015 will go down in history with a burnt area of 98 million ha. More recently, a data that cannot yet be found in official statistics because it is too recent, concerns the fires in Australia in 2019 which alerted the whole world to the ecological risk of global warming.

These fires destroyed an area of around 19 million ha in the same country. Even if this area remains less than the 117 million ha that disappeared with the fires of 1975-1976 in this southern region, the fires of 2019 resonated as an echo in the debate on the natural dangers of global warming.

On the occasion of the UNCTAD summit in 1992, the concept of sustainable development was publicly outlined. Above all, it has been spontaneously associated with the destruction of forests, especially the tropical rainforest of the Amazon basin. The media have gone so far as to convey the idea of the destruction of the planet's lungs by disseminating photos of voluntary deforestation by fire in Brazil, shock images that have made people aware of the complex problematic of ecosystems.

But to claim that the Amazon rainforest is the lung of the planet is nonsense, since the primary rainforest is an ecological balance. This means that what it synthesizes in terms of carbon by photosynthesis is degraded by respiration or the biodegradation of dead parts, the volume of biomass being in equilibrium. This is the principle of primary forests, they synthesize as much as they degrade. Their interest does not lie in forest production but in the ecosystem biotope they host.

Indeed, for the forest to be a CO fixator$_2$, it is necessary that there is a forest growth, therefore an increase in the volume of biomass and therefore in the volume of standing timber in the forest zone.

Nevertheless, the gloomy outlook for global warming triggered, as a follow-up to Rio 1992, a management of the environmental crisis with the programming of an annual meeting to monitor global warming and the application of the agreements signed by the member states. This is the COP, the Conference of the Parties. The first COP, an intergovernmental meeting of countries tasked with finding solutions and making commitments to reduce environmental risk, took place in 1995 in Berlin.

This idea of offsetting greenhouse gases, especially CO_2, by the forest led, on the occasion of the COP 3, in 1997 in Kyoto, Japan, to the Kyoto Protocol.

The Kyoto Protocol is based on its own CO fixation mechanism$_2$ through forest growth. The activation of this protocol launched the race for forest plantations all over the planet in an attempt to cancel all or part of the production of CO_2 by human activities. These plantations are also there to counterbalance deforestation, itself caused by the needs of population growth in the world and the need for land to feed all the newcomers.

2. Deforestation and forest plantations: surface assessment

The forest ecosystem has therefore become a central element in research into the consideration and management of the greenhouse effect, which generates global warming. The Kyoto Protocol's own mechanism was validated in 1997. However, it did not come into force until seven years later, when Russia signed this agreement. Indeed, a minimum of 55% of polluters adhering to the mechanism was necessary for its activation. This was the case when Russia signed in 2005, but fortunately, many countries had anticipated this validation, in particular the large polluting countries such as China, India or the USA.

As a result, the evolution of the world's forests must today be analyzed from three very distinct angles:

1- Deforestation of primary forests;
2- Forest plantations under the Kyoto Protocol;
3- And the forest balance resulting from these two phenomena and the growth or loss natural growth of existing forests.

This analysis is already proving to be relatively complex at this stage, despite increasingly precise satellite data. “Accidental” deforestation, in the sense of ecological accident, caused by the ravages of bark beetles and fires favored by repeated droughts and heat waves should nevertheless be included.

3. Deforestation

Under the UN hospices, and thanks to satellite technologies available since the 1990s, increasingly precise forest inventories are carried out every decade. These are the “Global Forest Resources Assessment”, initially the FRA, “Forest resource analysis”.

We therefore have very precise data since the 1990s, from which it is possible to analyze deforestation, in quantitative data on the surfaces involved, in geographic data by country and in qualitative data on the ecosystem concerned.

The *fig 1* below is an overview of the situation since 1990, i.e. the evolution of net forest area in the 1990s, then 2000 and finally, the last decade, 2010-2020.

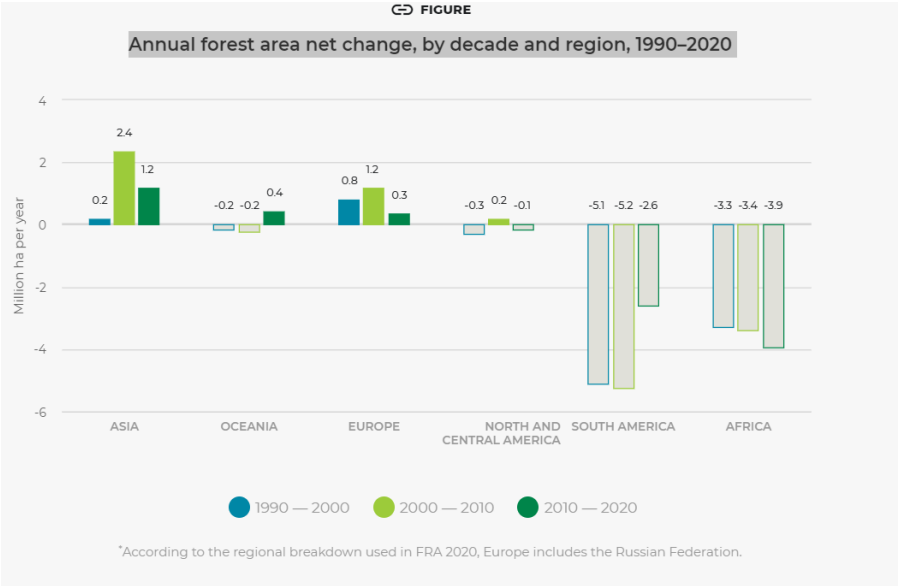

Fig. 1: Evolution of deforestation by decade, since 1990, for the six continents

We can clearly see a slowdown in global deforestation. In four continents, the forest area is growing. For Amsud and Africa, the situation is still negative. This situation is improving in Amsud but deteriorating in Africa. Indeed, Africa is facing the full force of demographic pressure and the fact that it does not yet master the techniques of protecting primary forests and forest plantations.

Regarding the deforestation of primary forests, the data show that the areas of deforestation fell from 16 MB of ha / year in the 1990s to 11 MB of ha / year in the 2010s, which gives us an overall loss on the 30 years of approximately 420 MB of ha. Reduced to the overall forest area of 4.06 billion ha, this represents an area of around 10%.

At the same time, the world's population has grown by 50%, from 5.327 billion to almost 9.0 billion today.

TITAN: CNES offices in Kourou, R + 3 in local wood

1. The design office

The wood structure design office, present in France, Switzerland and branch since 2015 in Portugal, has its in Guyana.

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This establishment follows work since 2010 on wood projects in French Guiana and the realization of many large-scale works.

As with the other entities, the accent was placed on the valuation of solid wood and the development of large-scale structures on the model of concepts developed in metropolitan France.

2. The project

TITAN is above all an architecture:
"In the Anthropocene era, humans have to come to terms with the idea of the earth's spatial and temporal boundaries. Architects have a major role to play in helping them to achieve this "Guy Amsellem (born July 7, 1960)

The project **TITAN** began in 2016 in French Guiana in an equatorial environment, at the National Center for Space Studies in Kourou, with the creation of technical offices necessary for the launch of our rockets.

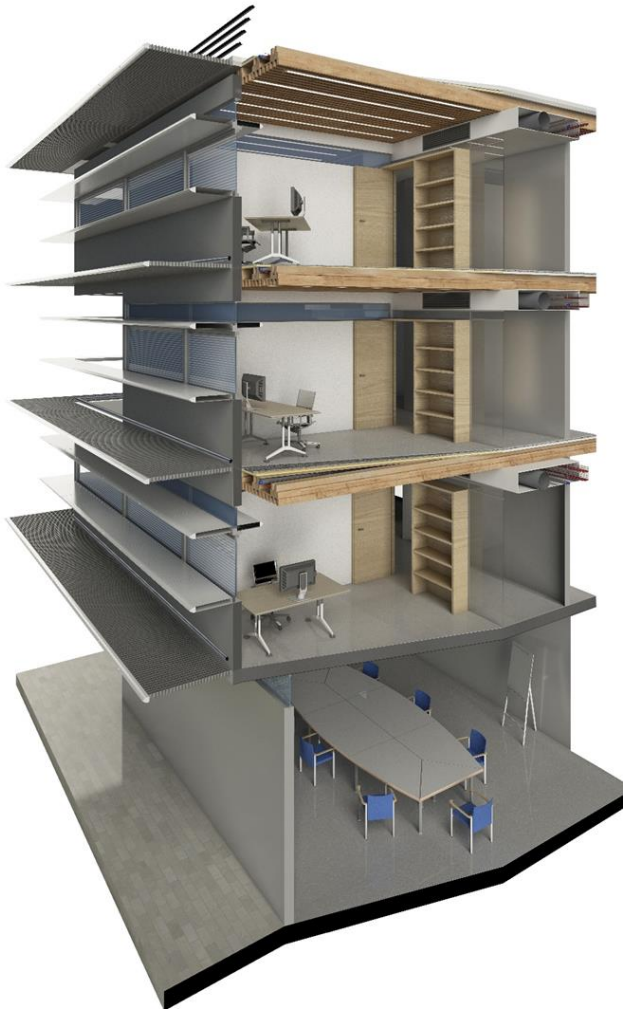
It is a building designed mainly in local wood from the Guyanese forest, managed by the ONF and engaged in a sustainable management process.

The unique approach, whether architectural, technical or economic, consists of a philosophy and an approach of Amazonian Environmental Quality (QEA®). The 21th

century must take sustainable development into account.

The history of the project has been built up through successive design phases to achieve a perfect match between needs and expectations.

The concept of the building, with three levels of Solivium® floors, is a challenge to modernize the material within a spatial environment itself with adapted construction principles, a simple, efficient and lasting building, serving an architectural charter of rigor and functionality.



Grid and modular spaces offer scalability, and great light autonomy with *light shelves* glass facades and the central atrium (skylight). Wooden ceiling tiles provide excellence in acoustics and visual comfort.

The search for structural and conceptual optimization is omnipresent while developing an ambitious character of a declining architectural style, from the tertiary sector to social housing: adaptability due to a process using the simplified raw material, the

board ; very good acoustic and thermal comfort in a noisy and hot equatorial climate; high structural resistance and creation of large free space with modular partitioning for offices or accommodation from T1 to T6 on a R + 1 or R + 6.

The emphasis is on an optimized technical concept and a design concerned with controlling installation times with a maximum of prefabrication, in modules of 6 m for the facades, and modules of Solivium® and false ceilings also optimized by the rigor of the constructive framework and the fine layout which limits the falls.

- Passage of networks between Solivium®;
- Integrated and removable false ceiling;
- Crenellated underside (acoustic wave disconnector);

- Dry and acoustic resilient screed (reduction of impact noise).

Optimization of the raw material in terms of section, and mechanical quality:
- D70 120x120 post on R + 1;
- D50 120x120 post on R + 2 and R + 3;
- Solivium® D50 optimized following mechanical test;
- False ceiling D45 in Angelica sapwood (30% of sawing losses) and pomace;
- Load-bearing facade and running lintel taken in the thickness of the floor without fallout;
- Se

This pilot project was the subject of great control to achieve significant structural, acoustic and energy performance, but also to contribute to the development of the local timber industry on an international scale.

The rigor and simplicity of the constructive choices were guided by a sharp knowledge of the skills of local businesses that we must make aware of a concept of the overall cost of the building. This cost has been greatly reduced with the rooftop photovoltaic plant supplying 50% of the building's energy needs and a thoughtful design to limit maintenance costs. The wood is protected from the elements and UV rays, and is left in its natural state without maintenance during the life of the building.

Titan is a **opportunity,** a lesson in knowledge for the local development of the material but also the promotion of local construction agents.

Titan is **alliance** of the scientific culture of CNES, the technical knowledge of the design offices, and the artistic features of the architects in a very heterogeneous department.

3. Details and constructive principles

The project includes an office building of 2200 m² on 4 levels. The building is composed of a concrete core with a wooden structure that revolves around it.
The wooden structure consists of a post-beam associated with Solivium® wooden slabs. The design is simple and efficient with regard to static and dynamic actions, with horizontal diaphragms (wooden floor with nailed paneling).

Solivium® Floor Type Cut

Floor Complex

1 - Soft floor covering - 10mm - Noraplan sentica acoustic type 2 - CTBX plywood - 10mm (Excluding lot)

3 - Dry screed - 2 Fermacell plates 2 * 12.5mm - 2E22 (Excluding batch)

4 - Wood fiber 20mm -Type "Pavaboard de Pavatex" (Except lot) 5 - OSB panel 3 - Anti-termites - 18mm

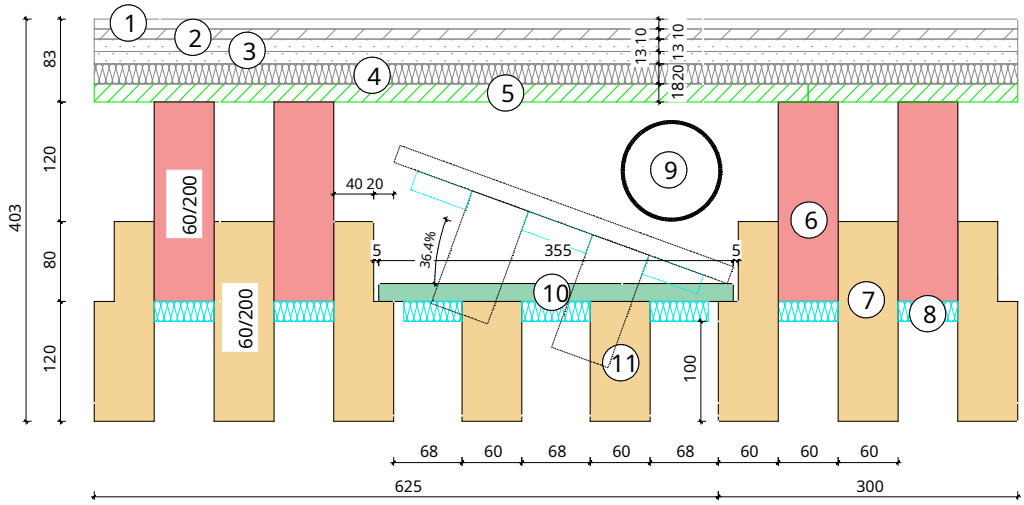
Solivium:

6 - High tablecloth - Local wood 60 * 200mm - D50 - CL 3.2T - Angélique 7 - Low tablecloth - Local wood 60 * 200mm - D50 - CL 3.2T - Angélique

8 - Acoustic resilient - 20mm - "Rockfon Coloral Tint Drop" type 9 - Electrical / fluid network passage

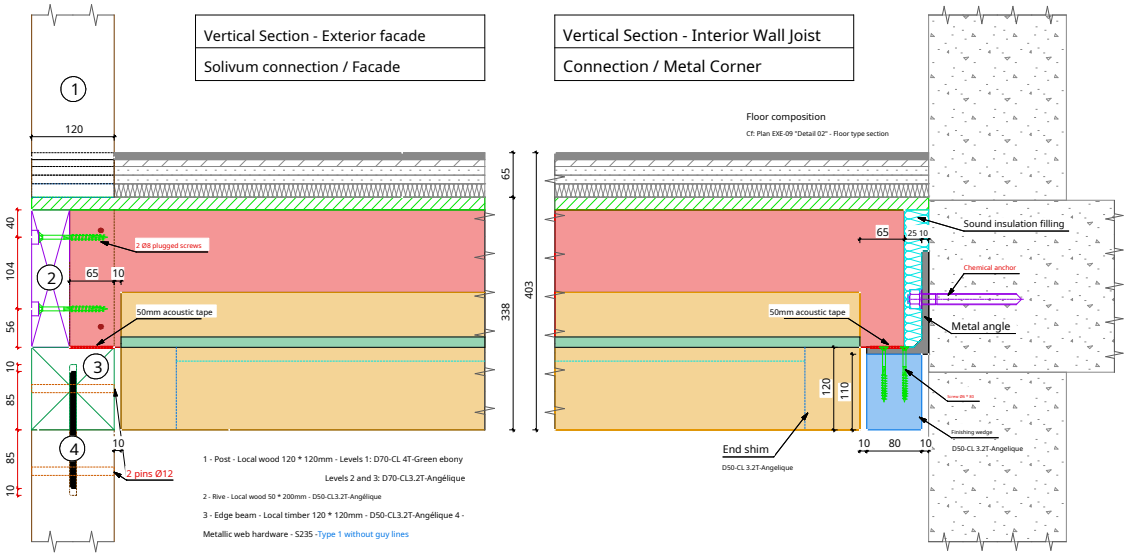
10 - Removable false ceiling - OSB panel 3 - Anti termite - 18 mm

11 - Low hanging tablecloth - Clear local wood 60 * 120mm - CL 3.2T - Grignon



These wooden slabs allow a 6.5 m span to be crossed while leaving a free frame for the passage of networks.

This slab is composed of a 60x200 mm high and low plank in Angélique D50. The boards are assembled together forming an offset which increases the inertia of the assembly. Thus, the maximum available section of the woods makes it possible to cross a greater span than a single non-recomposed element.



4. Mechanical tests

Within the framework of this project, the valorization of local woods was strongly privileged. With this in mind, CNES has taken charge of several laboratory tests in order to use the available wood to its maximum capacity. Several tests have been carried out within the FCBA and the CTBFG (Center Technique des Bois et de la Forêt de Guyane):

- Mechanical bending test 3 and 4 points;
- Mechanical shear test;
- Connector lift and resistance test;
- Reaction to fire - Ds2d0;
- Acoustic test - Attenuation index R 51dB / Impact noise level Ln 59 dB;

With all of the tests results exceeding expectations.

Set-up for 3-point bending tests

5. Photos of the construction site