The many virtues of **hardwoods**

Quebec Wood
Export Bureau

Canada Wood
Produits de bois canadien

Table of contents

Introduction

Hardwoods are a natural resource with many virtues. These trees are not only renewable, but also help protect the environment by mitigating climate change. They are a safe resource that contributes to human health in a variety of ways. Hardwoods are also a valuable resource owing to the many qualities of the products made from their wood.

In Québec, hardwood forests are both abundant and managed in a responsible manner to ensure they remain sustainable. Forest companies are subject to laws and regulations in this area. Many of these companies adhere to recognized sustainable management principles. This enables them to obtain environmental certification for the products they market. It is no coincidence if analyses made using modern scientific tools rank wood products among the most beneficial when it comes to sustainable development, compared with other materials used for the same purposes.

Whether they are used for flooring or woodwork, hardwoods offer naturally decorative coverings featuring the unique imprint of nature. Most people spontaneously like wood, but often don't know why. The following pages will shed some light on why these people are right to feel this way.

1 Abundant and sustainably managed forests

In Québec as in Canada, forests cover a large part of the territory and grow predominantly on public land. Wooded areas cover millions of square kilometres and the natural resource they contain renews itself constantly.

Whether in the boreal forest or the hardwood forest in the south, the volume of wood harvested is always lower than the allowable annual cut. This ensures that the forest can produce new wood through natural regeneration or the sustained yield management practices of forest companies.

In Québec, only a small percentage of forest land is commercially harvested.[1] Furthermore, a "Selection" silvicultural practice is used in hardwood forests, which has little impact on forest soils and improves the quality of stands.

A forest country

With its 4 million (M) km², Canada's forests cover close to half of the land area of the country and account for 10% of the global forest cover.[2] The greatest part of this resource is composed of boreal forest (1/3 of the world's boreal forest), but the southern part of the country is also home to large tracts of hardwood forests.

In Québec[3], forest land covers close to 1.3 M km², when the 517,000 km² of taiga and forest tundra in the north are included. This represents roughly 80% of the 1.6 M km² for the entire province. The deciduous forest, in the southernmost part of the province, contains over 111,000 km², to which are added close to 100,000 km² of mixed forest (hardwoods and softwoods) in the intermediate areas. The largest portion (92%) of

Québec's forests is on public land (1.37 M km^2), but in the temperate forest in the south (hardwoods and mixed forest), the portion of privately owned forests is considerably larger. The deciduous forest is much more heterogeneous than the boreal forest, and it is home to some thirty deciduous species, including several "noble" species such as sugar maple, red oak, linden and butternut, along with some 15 softwood species, such as Eastern hemlock and white pine.[4]

Continuous renewal

All these forest resources are constantly being renewed. Despite a significant volume of wood harvested every year, Québec's forest capital is enough to ensure the long-term renewal of the resource. How can this be explained? By the fact that the volume of wood harvested is below the allowable annual cut. According to the definition given by the Québec government, "the annual allowable cut is the maximum volume of timber of a particular species or group of species that may be harvested annually in perpetuity from a given management unit without reducing the productive capacity of the forest environment."[5] This capacity depends on the biophysical characteristics specific to forest stands, but also on the silvicultural practices in these stands.

In Québec, forest operators are required to manage forests they have under a contract, or own, in a way that ensures sustainable yield. This is what makes forest engineer Robert Beauregard, dean of the Faculty of forestry and geomatics at Université Laval, say that the "forest harvest [in Québec] is not considered deforestation, since harvested areas are converted back to growing forest." The Canadian forest industry for its part has stated that the rate of deforestation in Canada has been virtually zero over the last 20 years.[6]

In the hardwood (deciduous) forest, unlike the large boreal forest in the north, forest stands are composed of trees of all ages (uneven-aged forest). When calculating the annual allowable cut in this uneven-aged forest, the rate of diameter increase is determined for each tree species. The harvest is based on "selection cutting". The idea is to imitate nature where hardwood stands regenerate gradually due to openings in the forest canopy as older trees fall.[7] In essence, trees are harvested in a way that ensures the ongoing

regeneration of the various size categories "while maintaining or improving stem quality."[8] Studies conducted by the MRNF over the past 30 years have shown that after a few generations, stand quality had improved.[9]

Wood volume harvested below trees growth

The intensive survey zone on public land represents an area of close to 600,000 km^2. This zone (roughly a third of southern Québec) corresponds to land where forests "are managed according to the principle of sustainable yield." Forest land per se accounts for nearly 500,000 km^2. However, for all this area, forest harvesting affects less than 90,000 km^2, or just 6.3% of all public land in Québec.

For hardwoods alone, the volume actually harvested (in 2008) is not even half (47.1%) of the annual allowable cut, i.e. that can be harvested without affecting the forest capital.[11] This allowable cut, in hardwood forests, is estimated at 17.2 M m3 per year (10.8 M in public forests and 6.4 M in private forests), whereas the harvest in 2008 was only 7.2 M m3 (3.2 M in public forests and 4 M in private forests). For previous years, figures were similar, with a peak of 11 M m^3 in 2004. This therefore means that the surplus wood produced by the forest in relation to the wood harvested represents a volume of approximately 10 M m^3 per year. This would be enough to manufacture 5,200 M m^2 of flooring!

Furthermore, since there is very little planting is required in hardwood forest cutovers, and only over small areas at that, soils are not tilled or sprayed with pesticides, herbicides and fertilizers. As a result, erosion is seldom a concern as it is with bamboo growing practices.[12]

In all, as reported by the National Wood Flooring Association,[13] despite the many millions of trees harvested in North America since the early 20th century, there are more trees growing today than back in 1920. This is particularly the case for sugar maple. According to a study by Doyon and Bouffard,[14] the greatest increase in the temperate hardwood forest, for Québec and the United States, is that of the sugar maple: "Almost all studies on the historical evolution of forest vegetation show that sugar maple now occupies more land area in the temperate hardwood forest, whether in the United States or in Québec."

A variety of species and uses

Depending on the species, beyond the conventional uses of hardwoods for furniture, floors and panels, there are a variety of possible products.

White birch
Toothpicks, tongue depressors, ice cream sticks, sewing spools

Hickory
Ladders, tool handles

Oak
Barrels, pilings, caskets

Sugar maple
Butcher blocks, billiard cues, pianos, bowling allies

Ash
Tool handles, oars, paddles, baseball bats and hockey sticks

Linden (Aspen)
Venetian blinds, mouldings

Association forestière de la Montérégie, Plantation de feuillus nobles: **http://www.afce.qc.ca/references_utiles/docs/fiches_feuillus/fiche2_feuillus_nobles_AFM.pdf**

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2. Global Forest Watch. Online: **http://www.globalforestwatch.org/english/canada/forests.htm**
3. Ressources naturelles et Faune Québec, "Québec's Forest Resources and Industry, Statistical Portrait, 2010 Edition." Online: **http://www.mrnf.gouv.qc.ca/english/publications/forest/publications/stat_edition_resumee/resumeanglais2010.pdf**
4. Doyon, F. and D. Bouffard (2009) "Enjeux écologiques de la forêt feuillue tempérée québécoise." study conducted for Ressources naturelles et Faune Québec. Available online: **http://www.mrnf.gouv.qc.ca/publications/forets/amenagement/enjeu-foret-feuillue.pdf**
5. Ressources naturelles et Faune Québec. Online: **http://www.mrnf.gouv.qc.ca/forets/amenagement/amenagement-planification-possibilites.jsp**
6. Canada Wood-Bois Canada (2011) "Sustainable Forest Management in Canada," PPT presentation
7. Envirofoto and Les Éditions GID (2002) *La nature du Québec – La flore, la faune et les écosystèmes*
8. Doyon, F. and D. Bouffard (2009) "Enjeux écologiques de la forêt feuillue tempérée québécoise"
9. Idem
10. Ressources naturelles et Faune Québec, "Québec's Forest Resources and Industry, Statistical Portrait, 2010 Edition." Online: **http://www.mrnf.gouv.qc.ca/english/publications/forest/publications/stat_edition_resumee/resumeanglais2010.pdf**
11. Idem
12. *Evergreen Magazine* (March 2008) GreenBuilding.com
13. National Wood Flooring Association (Undated) "Benefits of Wood Floors", **www.woodfloors.org**
14. Doyon, F. and D. Bouffard (2009) "Enjeux écologiques de la forêt feuillue tempérée québécoise"

2 Certified forests

To show that they practice sound forest management and use resources legally and according to sustainable development principles, many forest companies adhere to forest certification standards. The respect of these standards in their forests guarantees good practices. Certification is granted by an independent body and the official stamp can be shown to clients. This gives companies access to larger markets and therefore a competitive edge. An increasing number of builders and ordinary consumers are aware of the social and environmental impacts of their purchasing decisions and want to know if the materials they use come from sustainably managed forests.

Certifying bodies have been defining, for the past 20 years or so, the sustainable management principles that companies must adopt to get this stamp of approval. The standards developed by these bodies are based on a host of criteria. In Canada and Québec, three credible certification systems are recognized and the most widely used is the international system of the Forest Stewardship Council (FSC).

Statistics show that Canada is well ahead of other countries when it comes to forest certification.[15] Canada alone is home to nearly 40% of the world's certified forest area.[16] There is a reason why there is more and more certified wood available on markets. And this wood is the only building material that is independently certified.[17]

Certification systems

As part of the adoption of the ISO 14001 environmental certification standard, of the International Organisation for Standardisation,[18] independent bodies have developed their own forest certification system.

There are three systems used in Québec and Canada: that of the Canadian Standards Association (CSA), a non-profit association accredited by the Standards Council of Canada; that of the Sustainable Forestry Initiative (SFI) administered by the American Forest & Paper Association but developed by the Sustainable Forestry Board, an independent and non-profit organization; and that of the Forest Stewardship Council (FSC), the most popular certification used by companies, awarded by an international and independent NGO based in Germany.[19] Canadian products bearing the European Programme for the Endorsement of Forest Certification (PEFC) stamp also meet CSA and FSC criteria since both systems are recognized by the PEFC.

Any company that wants to be certified is free to choose the system that it wants, depending on the values and needs of its clients. Criteria vary slightly from one system to the next, but their objective is all sustainable forest management. Criteria include:

- Conservation of biological diversity and maintenance of wildlife habitats;
- Protection and/or maintenance of special sites (biological and cultural);
- Maintenance of soil and water resources;
- Regeneration of harvested areas;
- Protection of forest lands from deforestation and conversion to other uses;

- No wood from illegal or unauthorized sources;
- Aboriginal rights and/or involvement;
- Public disclosure.[20]

All standards also offer the certification of the product's chain of custody, from the forest to the product's end user.

Canada well ahead

In 2011, according to Certification Canada, Canada was home to 151 million hectares of certified forests, which puts it well ahead of other forest countries, including the United States (49 M ha), Russia (30 M), Sweden (26 M) and Finland (21 M).[21] Québec alone accounted for 32.3 million certified hectares,[22] or almost as much as the United States, and more than Russia, Sweden and Finland. In 2009, roughly half the area of Québec public forests on which cutting rights are granted was certified by one of these systems.

It should be noted that forest certification does not replace government policies, such as Québec's forest regime. This regime is composed of a series of laws and regulations to ensure forest renewal while enabling economic development, and to which companies are subject regardless of whether or not they are committed to a certification process. Most of the requirements of certification standards are also found in Québec's forest legislation.[23]

15. Canadian Wood Council (Undated) *Quick Facts – Sustainable Building Series No. 10.* Available online: **http://www.canply.org/pdf/cwc/Sustainable_Building_Series_10.pdf**
16. Certification Canada. Online: **http://www.certificationcanada.org/english/status_intentions/status.php**
17. Canadian Wood Council (Undated) *Quick Facts – Sustainable Building Series No. 10.* Available online: **http://www.canply.org/pdf/cwc/Sustainable_Building_Series_10.pdf**
18. Ressources naturelles et Faune Québec – « Aménagement durable des forêts. » Online: **http://www.mrnf.gouv.qc.ca/forets/index.jsp**
19. Certification Canada. Online: ; **http://www.certificationcanada.org/english/programs_used_in_canada/** and Canadian Wood Council (Undated) Quick Facts – Sustainable Building Series No. 10. Available online: **http://www.canply.org/pdf/cwc/Sustainable_Building_Series_10.pdf**
20. Québec Forest Industry Council
21. Certification Canada (2011) Online: **http://www.certificationcanada.org/english/status_intentions/**
22. Certification Canada (2011) "Certification Status Report Québec – SFM" **http://www.mrnf.gouv.qc.ca/publications/enligne/forets/criteres-indicateurs/publications/537_compilation-AFPAC-1210.pdf**
23. Idem

3 Legislation that protects forests

In Canada, the natural resource management falls under provincial jurisdiction. Québec therefore oversees wood harvesting on public land. Over the years, the Québec government has adopted legislation that not only protects the resource, but also ensures its renewal and promotes its contribution to the economy.

Most forest-related laws and regulations come under the Québec forest regime which is overseen by the Ministère des Ressources naturelles (Department of natural resources) and was recently updated in 2013. Under this system, forest companies are required to practise sustainable forest management on public land. Legislation from other government departments, for the conservation of special areas, the protection of endangered or vulnerable species and the protection of water resources also have an impact on forest practices. Lastly, a few federal laws on forests, certain natural sites and various animal species are also in effect.

Forest-related laws and regulations

Provincial level (Government of Québec)

- *Forest Act* (Ressources naturelles Québec) in effect since April 1, 2012 – This Act aims to promote the recognition of forest heritage and sustainable forest management.
- *Sustainable Forest Development Act* (Ressources naturelles et Faune Québec) – After the Forest Regime of 1986, this act establishes a new system which will come into effect in 2013. It aims to implement sustainable forest development, in particular through ecosystem-based management.
- *Regulation respecting standards of forest management for forests in the public domain* (Ressources naturelles) – Outlines the protection that must be granted to components of the environment during industrial forest activities, to ensure the maintenance or restoration of the forest canopy and the conservation of other resources. This regulation will be replaced in 2013 by the *Sustainable Forest Management Regulation*.
- *Act Respecting Threatened or Vulnerable Species* (Développement durable, Environnement et Parcs Québec) – Protects threatened or vulnerable wildlife and plant species designated under this Act, along with their habitats.
- *Act Respecting the Lands in the Domain of the State* (Ressources naturelles et Faune Québec in collaboration with other departments) – Implements a land use plan for lands in the domain of the State, for which it determines the vocation.
- *Act Respecting the Conservation and Development of Wildlife* (Ressources naturelles et Faune Québec) – The object of this Act is the conservation of wildlife and its habitat
- *Environment Quality Act* (Développement durable, Environnement et Parcs Québec) – Aims to respect the quality of the environment, namely the protection and management of water resources.

Federal level (Government of Canada)

- *Forestry Act* (Natural Resources Canada) – Provides for the conduct of research relating to the protection, management and utilization of the forest resources of Canada and makes it possible to conclude agreements with the government of any province for forest protection and management.
- *Canadian Environmental Protection Act* (Environment Canada) – Aims to protect the environment and human health in the areas of federal jurisdiction.
- *Species at Risk Act* (Environment Canada) – Aims to protect wildlife species at risk in Canada, and their habitat.
- *Canada Wildlife Act* (Environment Canada) – Authorizes the federal government to acquire land to create protected areas and conduct research and conservation activities.

In addition, various plans and regulations from municipalities and regional municipalities contain policy directions and objectives for the practice of sustainable forestry that respects habitats on their territories.

4 A net carbon balance

It is now a well-known fact that forests and wood as a construction material are major carbon reservoirs that are perfect tools able to contribute to fight climate change due to the increase in greenhouse gas (GHG) emissions. We now know exactly how the carbon cycle works and what role forests play.

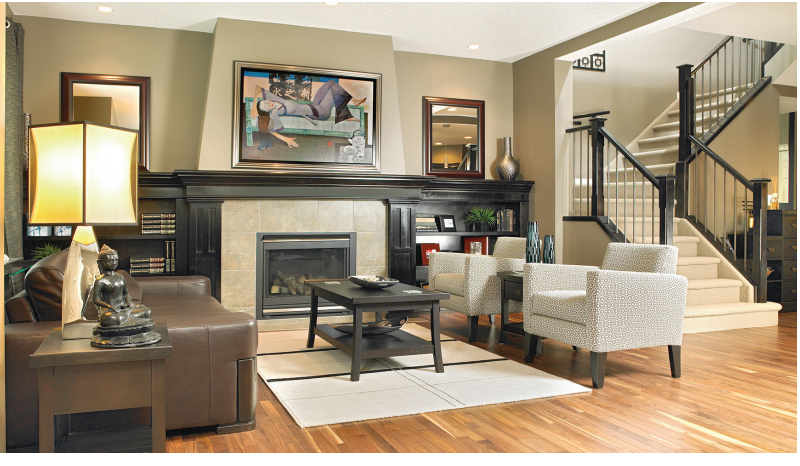
Carbone dioxide (CO_2) present in the atmosphere (both naturally and resulting from human activities) is partially absorbed by trees and other growing plants, which use it to synthetize the elements they need (sugars, cellulose, etc.). In return, trees release into the atmosphere the oxygen essential to all creatures in the animal kingdom.

When a tree is cut down to make a product, the carbon it contains is sequestered for the life cycle of this product, including in a recycled form. Moreover, it is not uncommon for a wood product to last for decades, even centuries, when used in construction. For example, a hardwood floor can “live” to be over 100 years old.

After this useful life, when it decomposes or is burned, wood will give back to the atmosphere the same amount of carbon it first sequestered. The result will be carbon neutrality, which will become a net carbon balance instead if, initially, the wood was chosen over a higher GHG emitting material. That is wood’s greatest environmental benefit. But not it’s only one!

Wood and CO_2

When a tree makes its wood, it absorbs the surrounding CO_2 through the pores of its leaves and transforms it into solid matter by photosynthesis. When the wood burns or the tree dies and decomposes, the carbon it contains will then be released. However, for the overall cycle, no additional CO_2 will end up in the atmosphere since it is the initially sequestered carbon that will simply be released.[24]



It is generally agreed that to produce 1 m^3 of this organic material called wood, a tree must absorb roughly 0.9 tonne of CO_2. This approximate quantity is based on the following reasoning, as explained on the website of cecobois.[25] "Firstly, a block of dry wood is composed of about 50% carbon (C) atoms. In other words, 1 kg of dry wood contains [more or less] 500 g of carbon. Hardwoods store more carbon since they are denser (they have more wood fibre). Secondly, since wood has a density of 0.4 to 0.5, one can surmise that 1 m^3 of wood weighs about 0.5 tonne. According to molecular mass ratios, 1 kg of carbon is required to obtain 3.67 kg of CO_2 (equation 1).[26] Multiplying these various ratios (equation 2)[27] gives a conversion factor of 0.9 tonne of CO_2 for 1 m^3 of wood."

It should be noted that younger trees during vigorous growth absorb more CO_2 than mature trees at the end of their life. Sustainably managed forests where mature trees are harvested to make room for young and more vigorous seedlings are therefore more effective carbon reservoirs than unmanaged forests.[28]

Furthermore, no other construction material but wood requires so little energy for its production and processing.[29] Using a piece of wood as a substitute for an

equivalent piece made of concrete or steel therefore helps avoid much higher GHG emissions. It is estimated that for each cubic metre of wood used in construction, instead of another material, there is an average of 1.1 tonne less CO_2 emissions into the atmosphere.[30] When added to the 0.9 tonne absorbed by the tree and sequestered in the material, this additional avoided emission therefore means that for each m^3 of wood used in construction, there are two less tonnes of CO_2 in the atmosphere.

Telling comparisons

Several studies have demonstrated to low potential of wood contributing to global warming compared with other construction materials. Among others, a life cycle assessment of a wood-frame house compared with similar houses built out of steel and concrete established that the latter released respectively 15 and 29% more GHG that the wood house. Another comparative study was conducted with ATHENA software on the global warming potential of various flooring systems. By estimated GHG emissions per square metre of floor ayant une portée de 6.25 m, this study showed that during its life cycle, a wood system releases almost two (1.6) times less GHG than a steel system and four (4.2) times less than a concrete slab system.[32]

Even when transported over long distances, wood continues to present a net carbon balance. A study conducted by the American Hardwood Export Council (AHEC)[33] suggests that transport accounts for a small part of the total carbon footprint of the production and export of hardwoods from the United States to Europe. Transporting a shipment by boat across the Atlantic over a distance greater than 6000 km only requires slightly more energy than a 500-km trip across land, according to this study.

A study on the carbon footprint of wood products manufactured in British Colombia and shipped to the United Kingdom, shows that in all cases, despite being transported more than approximately 16,000 km between the two locations, these products still represent a net carbon sink upon delivery. "CO_2 emissions from harvesting, manufacturing and transportation to the UK represent less than a third of the amount stored in the wood products," concluded the study.[34]

Reusable and recyclable

After its service life as a first product, a piece of wood can still preserve the carbon it contains for a long time if it is reused or recycled into another product. Wood is highly reusable, claims Recyc-Québec, a Québec Crown corporation that promotes recycling.[35] According to the Canadian Wood Council,[36] over a third of construction materials are recyclable. Many contractors do indeed recycle and send their dry demolition materials to sorting and processing centres.

The *Guide d'information sur le recyclage des matériaux secs* (guide on recycling dry materials), from Recyc-Québec, lists some ten types of recycling currently used, including for treated, engineered and natural wood. For example, they can be recycled into high-value-added particle and composite boards, mulch, soil amendments, bedding, paper and landscaping components. This type of recycling is practised both in North America and Europe, where the percentage of recycled wood in the composition of boards was already close to 23% in 2002.[37] In Europe, wood is recovered from panelling, flooring and furniture for its lustre and is even used to craft "antique" musical instruments.[38]

Another common way to recycle wood, when the product is at the end of its service life, is to convert it into fuel for the production of bioenergy. As mentioned above, the amount of carbon returned to the atmosphere is the same as the amount absorbed during the life of the tree and sequestered during the entire life of the product, therefore explaining its carbon neutrality. And in the same way that this carbon neutral state was converted into a net carbon balance when the piece of wood was chosen over a higher GHG emitting material during construction, the carbon balance still improves when the wood is used at the end of its life to produce energy, preferably instead of a fossil fuel that directly releases CO_2 into the air when it burns. As a result, the combustion of a tonne of wood provides the same heat as 500 litres of No. 2 oil (light fuel oil), but avoids net CO_2 emissions of 1.4 tonnes.[39]

Other environmental benefits

In addition to providing a net carbon balance, wood – and particularly floors – offers several other environmental benefits.

In a synthesis of research on wood products and their environmental impacts,[40] the authors concluded that the manufacture of wood floors not only releases less GHG emissions and requires less water than vinyl and linoleum coverings, but it also causes less water pollution and overall waste.

Studies comparing wood-frame, steel-frame and concrete houses draw the same conclusions for all these systems: "The manufacture of wood materials produces fewer contaminants in the air and water and requires fewer natural resources than the other structure materials analyzed."[41]

Evergreen Magazine[42] sums up the environmental qualities of wood by pointing out that this material is "one of the rare natural resources that is immediately renewable, recyclable, biodegradable and reusable."

24. Coalition BOIS Québec (2012) *Les changements climatiques.* Series of factsheets online: **http://www.coalitionbois.org/fr/le-bois-et-les-changements-climatiques/le-bois--un-choix-logique-/utiliser-le-bois-en-construction-pour-reduire-les-emissions-de-co2**
25. cecobois, « Le bois et le cycle du carbone. » Online: **http://www.cecobois.com/index.php?option=com_content&view=article&id=90&Itemid=99**
26. C = 12, O = 16, CO_2 = 44, therefore 44/12 = 3.67
27. $\frac{0.5 \text{ kg C}}{\text{kg wood}} \times \frac{0.5 \text{ T wood}}{\text{m}^3 \text{ wood}} \times \frac{3.67 \text{ kg } CO_2}{\text{kg C}} = 0.9 \text{ tonne of } CO_2 / \text{m}^3 \text{ of wood}$
28. FEP News, September-October 2009
29. CEI-Bois (2007) *Luttez contre le changement climatique – Utilisez le bois*
30. Idem and Coalition bois Québec (2012) *Les changements climatiques.* Series of factsheets online: **http://www.coalitionbois.org/fr/le-bois-et-les-changements-climatiques/le-bois--un-choix-logique-/utiliser-le-bois-en-construction-pour-reduire-les-emissions-de-co2**
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32. Cecobois (Undated) *L'avantage environnemental des systèmes de construction en bois dans le contexte des changements climatiques*
33. *Timber Trades Journal Online* (April 2011) "Green Movement"
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35. Recyc-Québec (2008) « Les résidus de construction, de rénovation et de démolition (CRD), » Factsheet
36. Canadian Wood Council (Undated brochure) *Sustainability and Life Cycle Analysis for Residential Buildings,* International Building Series, No. 4 **http://www.cwc.ca/documents/IBS/IBS4_Sustainability_SMC_v2.pdf**
37. CEI-Bois (2004) "Wood products as carbon stores"
38. CEI-Bois (2006) *Luttez contre le changement climatique : utilisez le bois*
39. Ressources naturelles et Faune Québec (2009) *Vers la valorisation de la biomasse forestière. Un plan d'action*
40. Sathre, Roger and Jennifer O'Connor, FPInnovations (Undated) "A Synthesis of Research on Wood Products and Greenhouse Gas Impact," Technical Report No TR-19
41. Canadian Wood Council (Undated brochure) *Sustainability and Life Cycle Analysis for Residential Buildings,* International Building Series, No. 4 **http://www.cwc.ca/documents/IBS/IBS4_Sustainability_SMC_v2.pdf**
42. Published by Green Building.com (2008)

5 The life cycle analysis : tool that shows the environmental benefits of wood

Any construction leaves a footprint on the environment. Resource extraction, GHG emissions, waste production... impacts will occur at all phases, upstream of the construction and both during the construction itself and during the life of the building.

To establish which products and processes will generate the smallest footprint, there is one method that is now internationally accepted[43] – the life cycle assessment (LCA). This scientific tool, which extensively uses computer simulation, provides an overall environmental portrait of a product or construction system by determining its global potential "cradle to grave" environmental impacts,[44] i.e. from the time the raw material is extracted to the time components are eliminated after demolition.

The profile of wood building systems, established by various LCAs, shows that their environmental footprint is clearly smaller than constructions using other materials.[45] And this is also specifically the case for floor coverings.

The LCA

The life cycle assessment (LCA) has existed in various forms for about fifty years, but it wasn't until the late 1990s that it became a scientific tool standardized by the International Organisation for Standardisation (ISO 14040 to 44).[46] It continues to be developed today using the latest data relating to construction practices and knowledge on the environment.

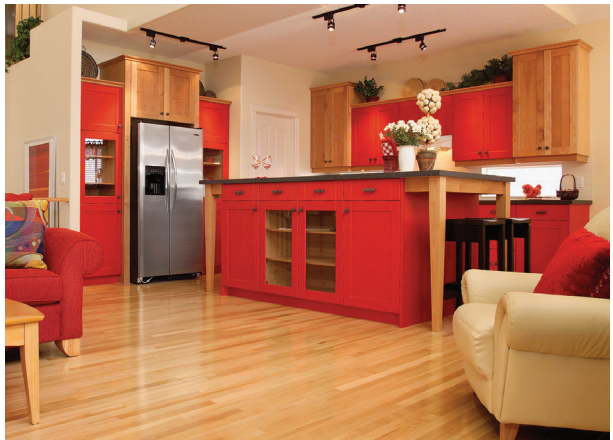
The LCA measures the environmental impact that a product or process has on the environment over its lifetime. It quantifies its effects, for example, the consumption of energy and raw materials required for the entire process, the contribution to global warming and smog, the potential of acidification and eutrophication of water bodies, the depletion of the ozone layer and the production of waste.[47]

Whereas other impact assessment methods are based on indirect impacts (e.g. distance between mill and market), the LCA measures direct impacts (e.g. the amount of polluting emissions caused by the transportation mode chosen), thus ensuring that the real effects of the product or process on the environment are taken into account.[48]

Wood profile

In North America, the computer tool developed – using a Canadian database – to conduct LCA analyses in the construction sector is called AthenaTM (Environmental Impact Estimator).[49] Various studies using this software were conducted to establish the environmental profile of wood.[50] Results are tangible.

The main analyses compared houses with frames made of wood, steel and concrete. Wood came out favourably for all aspects studied: energy, global warming, air and water pollution.[51] Several other studies also compared hardwood flooring with other types of coverings, and they also came out in favour of wood.



In one case, FPInnovations, a Canadian R&D institute, conducted a cradle-to-grave environmental profile for pre-finished hardwood flooring manufactured in eastern Canada[52] and compared it to profiles for alternative flooring products such as carpets, ceramic tiles, vinyl, cork and linoleum flooring. This life cycle assessment study concluded that hardwood takes second place for total energy used for a service life span of 25 years. However, when the durability (service life) was doubled (50 years), hardwood flooring outperformed all the other flooring types in the areas of fossil fuel consumption, acidification, eutrophication, and smog impact.

Swedish, German and American studies

Another study conducted by Swedish researchers[53] which compared the impacts of linoleum, vinyl and untreated hardwood floor coverings concluded that wood flooring is the most environmentally friendly, among other things, since linoleum and vinyl require the most inputs. According to the study's authors, wood coverings produce fewer emissions into the air and water, use less energy and generate less waste than coverings made of linoleum and vinyl.

A German study[54] on four types of wood floor highlighted the fact that these floors have "significantly less" impacts (by factors of 5 to 50) than all other products on the local market when it comes to global warming, acidification and eutrophication of watercourses, photo-oxidant formation and ozone depletion.

Lastly, two other studies[55] conducted by researchers at the University of Wisconsin in collaboration with the Consortium for Research on Renewable Industrial Material (CORRIM) reached similar conclusions. They pointed out that wood is a "desirable" floor covering with respect to the environment due to lower emissions into the air than other coverings, along with lower water consumption and lesser use of primary energy. They also emphasized the durability of floors. "The shorter service life [of other coverings] means that they will have to be replaced more often, and that supposes new environmental impacts," reported the researchers, who also focused on "desirable" end-of-life scenarios for wood from floors, and also on the renewable nature of the resource and net carbon balance of the material.

43. Canadian Wood Council (Undated brochure) Sustainability and Life Cycle Analysis for Residential Buildings, International Building Series, No 4 **http://www.cwc.ca/documents/IBS/IBS4_Sustainability_SMC_v2.pdf**

44. Coalition bois Québec (2012) *Les changements climatiques.* Series of factsheets online: **http://www.coalitionbois.org/fr/le-bois-et-les-changements-climatiques/le-bois--un-choix-logique-/utiliser-le-bois-en-construction-pour-reduire-les-emissions-de-co2**

45. Cecobois – Centre d'expertise sur la construction commerciale en bois (Undated) "Le bois... écologique,", in *Le bois : un choix d'avenir,* series of factsheets and brochure

46. Canadian Wood Council (Undated) *Quick Facts – Sustainable Building Series* Nos. 1 and 4. Available online: **http://www.canply.org/pdf/cwc/Sustainable_Building_Series_01.pdf**
http://www.canply.org/pdf/cwc/Sustainable_Building_Series_04.pdf

47. Canadian Wood Council (brochure Undated) *Sustainability and Life Cycle Analysis for Residential Buildings*, International Building Series, No. 4
http://www.cwc.ca/documents/IBS/IBS4_Sustainability_SMC_v2.pdf

48. Idem

49. Idem

50. Cecobois (Undated) *L'avantage environnemental des systèmes de construction en bois dans le contexte des changements climatiques*

51. Canadian Wood Council (Undated) Sustainability and Life Cycle Analysis for Residential Buildings, International Building Series, No. 4, online at **http://www.cwc.ca/documents/IBS/IBS4_Sustainability_SMC_v2.pdf**

52. Mahalle, L. – FPInnovations (2011) "A Comparative Life Cycle Assessment of Canadian Hardwood Flooring Types"

53. Jonsson, A., A.-M. Tillman and T. Svensson (1997) "Life Cycle Assessment of Flooring Materials: Case Study"

54. Nebel, B., B. Zimmer and G. Wer (2006) "Life Cycle Assessment of Wood Flooring Coverings: A Representative Study for the German Flooring Industry"

55. Hubbard, S. and Bowe, S. "Solid Strip and Plank Hardwood Flooring Stacks Up in Comparison to Alternative Floor Coverings" ; Hubbard, S. and Bowe, S. – CORRIM (2008) "Life Cycle Inventory of Solid Strip Hardwood Flooring in the Eastern United States"

6 Characteristics of wood

The wood has many advantages. In fact, it offers good fire resistance, it has recognized acoustic properties, it is sustainable and versatile and, finally, it has undeniable aesthetic qualities. Discover them!

Fire safety

Contrary to what a lot of people think, wood is relatively safe in a fire. Although wood is a combustible material, it retains part of its mechanical strength as it burns, whereas steel – which conducts heat 100 times faster than wood – absorbs and stores heat until it reaches a temperature that will deform and bend under a load. Furthermore, like all types of buildings, wood constructions can be designed and built in a way that minimizes risks. In fact, building codes require that all construction systems have the same level of fire safety, regardless of materials used.[56]

Fire-loss statistics reveal that people are just as safe in wood houses – low-rise single – or multi-family residential buildings – as in those made of any other material. According to the National Fire Protection Association, an international USA-based organization, only 0.2% of deaths in fires are caused by a floor or wall collapsing, whereas 90% are caused by smoke and heat generated from combustible products that occupants have in their homes and which are the first to ignite.[57]

As wood burns, it develops a protective char layer. According to tests conducted by the National Research Council of Canada,[58] the charring rate is roughly 0.65 mm/mm on a large piece of wood. After 60 minutes of burning, the wood will have burned down to a depth of 38 mm. The charred part will serve as thermal insulation by placing a barrier between the source of heat and the unburned wood. Since wood has very low thermal conductivity, as opposed to steel, the unburned part inside is practically unaffected as the external faces burn. It only loses from 10 to 15% of its strength.[59]

Steel, however, loses close to 60% of its initial strength when exposed to a temperature slightly over 600 °C, generally where flashover occurs. And at 1200 °C, a temperature frequently reached after this flashover,[60] it has virtually no strength left. This explains why during a fire a steel structure will collapse well before a wood structure with the same function.

Stringent requirements

Many wood products can be used inside a building. But is it necessary to point out that in several countries, construction elements – including wood floors – are submitted to increasingly stricter fire safety requirements?[61] This is especially true for building intended for public use, such as schools, but also for multi-family residential dwellings (and even single-family dwellings in some countries).

Most building codes require a fire resistance of less than two hours for the various parts of a building, including floors.[62] However, according to Canadian wood and housing organizations,[63] building elements can be designed – by using various products and processes – in a way that ensures such a resistance of up to two hours, which is considered more than enough time to allow the building to be evacuated. By comparison, according to the *Handbook of building materials for fire protection* by Charles A. Harper, the time it takes for a nylon carpet to ignite (at 50 kW/m^2) is a mere 10 seconds.[64]

Furthermore, the use and choice of interior finishing materials are generally regulated by a rating indicating the rate of spread of the flame at the surface of a material. The more this rating is low, the slower the rate of fire spread. For finishing materials for emergency exits, for instance, a rating as low as 25 may be required, whereas other uses allow a rating that is often as high as 150.[65]

Almost all wood products can satisfy a required rating of 150. In areas subject to stricter ratings, it is possible however to use fire retardant treated wood (wood that is pressure-treated using flame-retardant chemicals) or wood covered with a fire-retardant coating.[66] Treated this way, the wood can be used even if the rating must not exceed 25.[67]

56. Canadian Wood Council (Undated) *Fire Resistance and Sound Transmission in Wood-Frame Residential Buildings,* International Building Series, International Building Series, No. 3. Available online: **http://www.cwc.ca/documents/IBS/IBS3_Fire_SMC_v2.pdf**
57. Idem
58. G.C. Gosselin (1987) "Structural Fire Protection – Predictive Methods." *Building Science Insight '87,* National Research Council of Canada
59. Cecobois "Le bois et ses propriétés – comportement au feu." Online: **http://www.cecobois.com/index.php?option=com_content&view=article&id=98&Itemid=162 s**
60. Canadian Institute of Steel Construction (2006) "Fire. Facts for Steel Buildings"
61. FEP Newletter. issue 2/2011. *Floor Forum.* March-April 2011
62. Forintek, SCHL, SHQ (2002) *Wood-frame Construction, Fire Resistance and Sound Transmission.* Available online: **http://www.forintek.ca/public/pdf/Public_Information/fact%20sheets/Fire-Sound_ENGLISH%20FINAL.pdf**
63. Idem
64. Harper, Charles A. (2004). "Handbook of Building Materials for Fire Protection." McGraw-Hill
65. Idem
66. Cecobois *Le bois et ses propriétés – résistance au feu – finis intérieurs.* Online: **http://www.cecobois.com/index.php?option=com_content&view=article&id=98&Itemid=162 s**
67. Cecobois, lexique (online) **http://www. cecobois.com/index.php?option=com_content&view=article&id=156:bois-ignifuge&catid=23:securite-incendie&Itemid=28**

Acoustical properties

The acoustical properties of wood have been recognized for a long time. Firstly, wood is a resonant material and this resonance is used in the crafting of all kinds of musical instruments and the finishing of concert halls. Secondly, the honeycomb-like structure of wood, composed of microscopic cavities, or pores, absorbs and attenuates sound, which is useful for limiting noise transmission between rooms in a building. This intrinsic quality can be further improved by an appropriate building design.

Wood for music lovers

Wood has long been used to make musical instruments. And the type of wood to use has always been a concern of instrument makers. Each type of wood has its own special qualities and each type of instrument has its favorite wood species. Maple, for example, is very popular for making violins and wind instruments such as the bassoon, according to Joël Dugot, curator at the Museum of Music in Paris. When making its guitars, yellow birch is appreciated for its "sound somewhere between the mellow tone of mahogany and the bright sound of maple," writes the Québec instrument making company "Art & Lutherie" on its website,[68] adding that "Canadian wood has excellent tonal qualities." Cherry and ironwood are also species appreciated by Québec's stringed instrument makers.[69]

Already in the 16th and 17th centuries, said Joël Dugot in a presentation,[70] maple was used both for its physical qualities (hardness and flexibility) and beauty for crafting bowed instruments. The backs of the famous Stradivarius violins are indeed made of maple.[71] Ash was also popular for this type of instrument, along with poplar, linden and walnut – for their aesthetical qualities – for crafting harpsichords.

The acoustical qualities of wood are also prized for finishing state-of-the-art concert halls. A good example is the Raoul-Jobin hall at Palais Montcalm in Québec City, entirely renovated a few years ago and said to provide exceptional sound quality, which makes it one of the best concert halls in the world. Its concrete walls are covered with high-density wooden panels and finished with maple veneer, whereas the stage floor is made of red oak on a wood frame, which naturally amplifies sound.[72]

A great sound-insulating material

With regard to the sound insulation ability of wood, it can be explained by the material's low density and by the absorption of the sound wave in the wood pores, which convert acoustic energy into heat and therefore reduce sounds.[73] This particularity is used, among other thing, to create soundproof spaces, such as recording studios.[74]

Each material and even each tree species has its own sound absorption coefficient when it comes to wood. This coefficient expresses the amount of sound that a material absorbs for a given frequency. For example, maple wood (rough) has a coefficient of 0.13 at a frequency of 4000 Hz, whereas red oak has an absorption coefficient of 0.15 and ash of 0.16.[75] The closer the coefficient is to 1, the greater the absorption. By comparison, concrete has an absorption coefficient of 0.04, plaster of 0.03, and glass of 0.02 (always at 4000 Hz). The coefficient of a glued down wood floor is 0.06.[76]

Wood buildings do not have the same impact noise transmission problems – especially through floors – that are often seen in concrete buildings. They also provide a superior level of comfort for airborne sound, for example music.[77] Moreover, the intrinsic qualities of wood can be increased when it comes to acoustic performance by further reducing sound transmission. This can be achieved by appropriate design and construction, which increase the sound insulation of a building's rooms: double thickness of gypsum board, insulation of wall and floor cavities, striated wood finish, joint covers, etc.[78]

To evaluate the ability of floors and walls to absorb airborne sound that travels between the housing units, there is the sound transmission class (STC) and the impact insulation class (IIC) for impact noise. In both cases, the higher the class, the better the floor or wall attenuates the noise. With an STC of 50, loud music from an adjoining room can be barely heard, but low frequencies remain perceptible. At 60, loud music cannot be heard except for very deep low frequencies. However, floor assemblies with wood joists can reach an STC of up to 70 and an ICC of up to 60, depending on the assembly configuration and choice of materials.[79]

68. **http://www.artandlutherieguitars.com/intro.htm**

69. **http://www.marcsaumierluthier.com/index.html**

70. Dugot, Joël (2008) “Les bois dans la facture des instruments de musique en Europe, XVI^e et XVII^e,” presentation during the day Le bois : instrument de patrimoine musical – Cité de la musique, May 29, 2008

71. Dermoncourt, B. (2010) “ Les mystères des Stradivarius révélés,” *L’Express,* February 18

72. Palais Montcalm site: **http://www.palaismontcalm.ca/location/salle-raoul-jobin-1**

73. Bois.com constructions durable – website hosted by European organizations: **http://www.bois.com/particuliers/mieux-connaitre/bois-materiau/caracteristiques-acoustiques/bois-son**

74. Cecobois (Undated) “Le bois et le confort acoustique,” in *Le bois : un choix d’avenir,* Series of factsheets and brochure

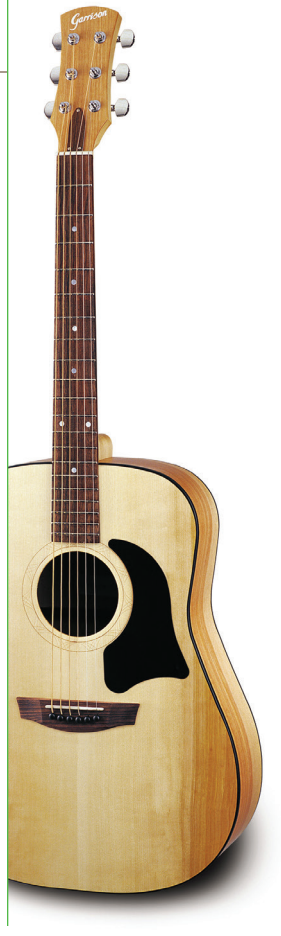
75. American Hardwood Export Council and Indian Plywood Industries Research & Training Substitute (Undated) “American hardwoods and their suitability for the Indian market”

76. Pradier, É. “Acoustique du bâtiment, Online: **http://www.ac-nancy-metz.fr/enseign/batiment_pro/Ressources/TechnoConstructions/Acoustique%20du%20B%C3%A2timent.pdf**

77. Canadian Wood Council (Undated) *Fire Resistance and Sound Transmission in Wood-Frame Residential Buildings,* International Building Series, No. 3 **http://www.cwc.ca/documents/IBS/IBS3_Fire_SMC_v2.pdf**

78. National Research Council of Canada (2006) *Guide for Sound Insulation in Wood Frame Construction.* Available online at **http://publications.gc.ca/collections/collection_2007/nrc-cnrc/NR24-11-2006E.pdf**

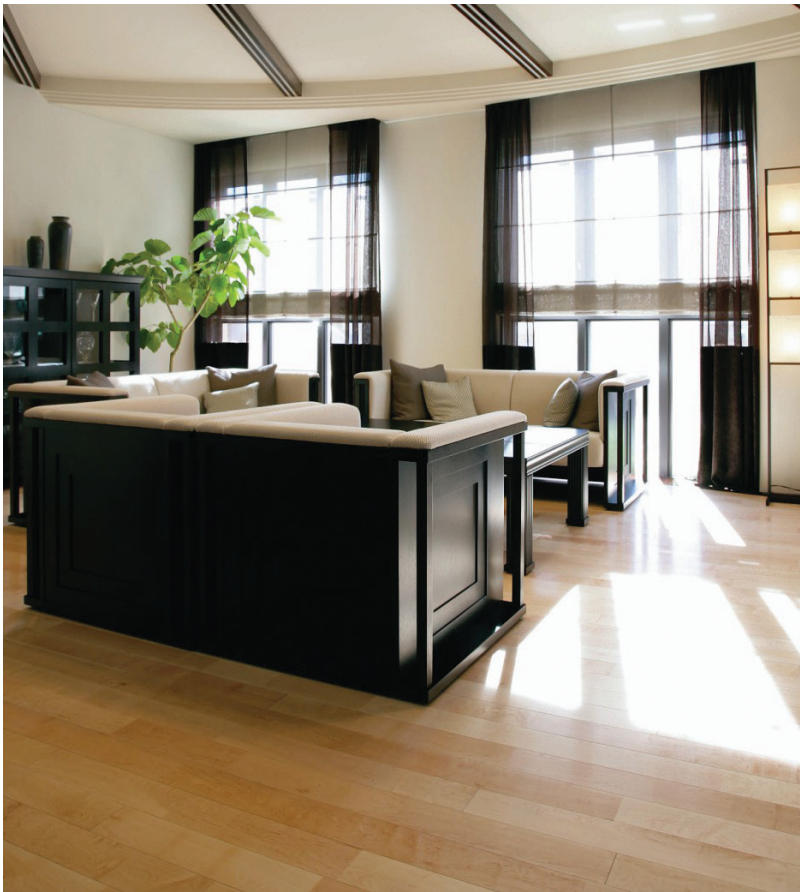
79. Cecobois (Undated) “Le bois et le confort acoustique,” in *Le bois : un choix d’avenir,* series of factsheets and brochure



A sustainable material

Several other characteristics make wood a valuable resource for construction, both for professionals and users. Wood is a sustainable material, as can be seen in certain centuries-old wood buildings, in many still used ancestral homes and in... floors. Wood flooring can sometimes last over a century, making it very economical compared with other types of floors with a shorter service life.

Wood is also a regulating element in buildings. It not only serves as a humidifier in an indoor environment that is too dry, but also as a dehumidifier in a room that is too damp. Furthermore, due to its thermal inertia, it acts as a thermostat by regulating, to a certain extent, the indoor temperature.



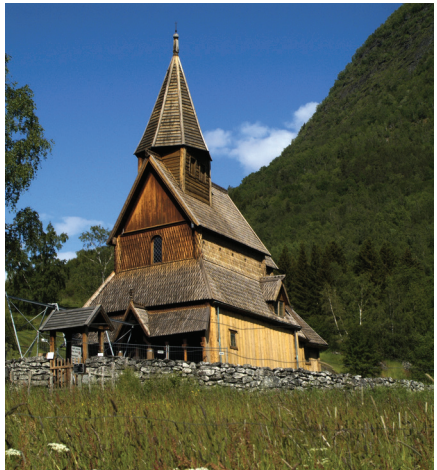
Durability

Wood is sustainable. This is apparent with one look at all thee wooden homes built some 100 years ago, and sometimes even 200 years ago, including some very fine examples that are still in good shape and used around the globe. There are also centuries-old buildings that are now part of part of UNESCO's world heritage, such as the Tôdai-ji Buddhist temple in Japan, erected in the 8th century, and the Urnes Stave Church in Norway, built in the 12th century. Wood buildings can last a very long time provided they are well designed and maintained.

The same can be said for wood flooring. All types of wood floors can easily last over 25 years, even 100 years if they are not changed simply as a matter of taste or design preference. By comparison, vinyl or ceramic tile coverings can last a maximum of 30 to 50 years, those of linoleum, more or less 25 years, cork coverings for about 30 years and carpeting, about 10 years at the most.[80]

In addition, wood floors maintain their value over time. Whereas other types of flooring appear faded and outdated after a few years, wood floors keep their charm and are a valuable asset when selling a house. In a survey of real estate agents in the United States, 90% of respondents said that houses with wood floors sell faster and at a higher price that those without them.[81]

Their durability compared with other types of flooring along with their lower maintenance costs over 15 years make them the least expensive of all floor coverings, claims the Fédération française du bâtiment.[82] Also, the author of an American study on floor materials[83] wrote that "carpet, for example, typically has the lowest purchase price of any option, but expensive maintenance and low durability make its life span cost highest of all option considered."



80. National Association of Home Builders / Bank of America Home Equity (2007) “Study of life expectancy of home components” ; and FP Innovations (2011) “A Comparative Life Cycle Assessment of Canadian Hardwood Flooring Types”

81. National Wood Flooring Association, “Benefits of wood floor”, **www.woodfloors.org**

82. Fédération française du bâtiment and Centre technique du bois et de l’ameublement (2004) *Guide parquets. Un guide pratique et complet*

83. Gilmore, Frances (Undated) «Health Considerations when Choosing School Flooring. Asthma Regional Council of New England.” Available online: **http://asthmaregionalcouncil.org/uploads/IAQ/HealthConsiderationswhenChoosingSchoolFlooring.pdf**

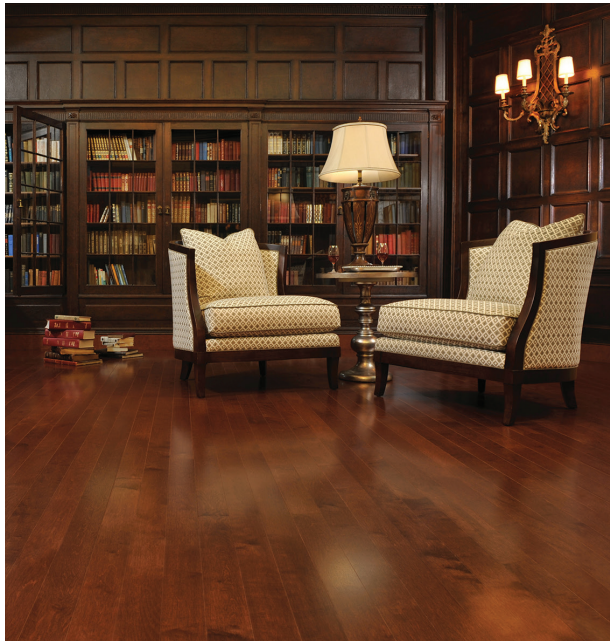
Versatile and visually appealing

Wood is a versatile and visually appealing material that can be used in almost all types of buildings, from single-family dwellings to large stadiums, with office buildings, small retail shops and industrial buildings in between. It is used both for structural purposes and interior finishing, including decorative panels cabinets and, of course, floors.

Panels can be made of solid hardwood, but are more often made of plywood consisting of a low quality core covered with a quality hardwood veneer such as oak, maple, ash or cherry.[84] Very economical, hardwood plywood is used for an attractive interior finish, in areas where aesthetics are important.

As for floor coverings, they are also available in a wide range of wood species with a multitude of colours, designs and streaks, which make them a natural decorative element, offering beauty and brightness to create a luxurious and warm atmosphere.[85] The many options available can satisfy all preferences, from a rustic and comfortable look, to a modern and cutting edge design.[86]

In addition to its visual qualities, wood is, in the case of flooring, easy to maintain. "You just need to sweep or vacuum regularly and, if necessary, use a cotton mop dipped in a cleaning product."[87] Moreover, if the flooring is damaged, as it happens sometimes because of its longevity, the damaged parts can most often be replaced.



Moisture and temperature regulator

One of the qualities of wood in a building is its role in regulating moisture.

Wood is a hydroscopic material, explained researcher Jerrold E. Winandy, of the USDA Forest Service, on the site of the International Union of Forest Research Organizations (IUFRO – Global Network for Forest Science Cooperation).[88] This means that in a damp environment, wood absorbs moisture from the air, and it gives it back in a dry environment. This adjustment is continuous and around an equilibrium point where the material neither gains nor loses moisture. Wood elements in a house therefore serve as a natural humidifier in a room that is too dry and as a dehumidifier in a room that is too damp, an important attribute for occupants sensitive to extreme levels of moisture. According to a study by the Forintek division at FPInnovations, interior wood panelling alone makes it possible to reduce peak moisture loads in a typical Canadian house by 10-25%.[89]

Furthermore, the thermal inertia of wood, attributable to its honeycomb like structure, enables the wood to store heat, before slowly restoring it. Floors and walls made of solid wood therefore help regulate indoor temperatures somewhat despite outdoor temperatures, thus contributing to the comfort of the room.[90]

84. Cecobois, "Les avantages du bois." Online: **http://www.cecobois.com/**
85. Cecobois (Undated) "Le bois... chaleureux et esthétique," in *Le bois : un choix d'avenir,* series of factsheets and brochure
86. Fédération française du bâtiment and Centre technique du bois et de l'ameublement (2004) *Guide parquets. Un guide pratique et complet*
87. Idem
88. In Division 6 devoted to social aspects: **http://www.iufro.org/science/divisions/division-6/ http://www.iufro.org/science/divisions/division-6/**
89. Canadian Wood Council (Undated) Quick Facts – Sustainable Building Series # 7; and Available online: **http://feel-good.ca/library/publications-building/sbs6_fr.pdf**
90. Cecobois Le bois (Undated) "Le bois... isolant thermique," in *Le bois : un choix d'avenir,* series of factsheets and brochure

7 Wood for health

Nature has always been associated with health. Whether for taking advantage of the healing virtues of plants and trees or simply enjoying a sense of well-being in the presence of natural elements, humans have consistently made a place for nature in their lives. And today we know they have good reason to do so.

In addition to the countless plant-based medicines whose effectiveness has been proven, the relationship between nature and human health has been scientifically confirmed. Studies have shown that the mere presence of natural elements such as wood – floors, furniture, etc. – in an indoor environment has a beneficial impact on health, both physiologically and psychologically.

But the health virtues of wood in an indoor space do not stop there. They also act indirectly, somewhat from the opposite direction, by not causing health problems brought about by other products used for the same purpose (e.g. carpet or vinyl rather than wood for a floor). Whereas wood is both sanitary and hypoallergenic, carpets, rugs and vinyl coverings can be the source of a variety of health issues caused by the toxic fumes that may be given off or by biological contaminants such as mites and moulds.

Confirmed benefits

Throughout history, human contact with nature and natural elements has been associated with health, whether physical or psychological. Among the Greeks, Aristotle attributed therapeutic virtues to the colour green and philosophers found inspiration in olive tree-filled gardens, a tree considered miraculous. Among the Celts, druids used mistletoe to brew healing potions and venerated old oak trees. In the Middle Ages, poultices were made using birch buds and alder leaves. These are but a few examples.[91] Last but not least is aspirin, one of the most used drugs in the world, which is a derivative of salicylic acid and once extracted from willow bark.

Apart from the development of medications, it was not until the 20th century that science confirmed the benefits of nature on human health. For some forty years, several studies in environmental psychology have revealed what people have always known intuitively. Contact with nature or merely with natural elements has a beneficial impact on human health.

In a literature review for his own study on the topic, David Robert Fell, a professor at the University of British Columbia, cites the results of several studies in this area, such as better recovery after surgery for patients with a hospital room window overlooking a green space, higher pain threshold among patients in a room with plants, more creativity in the presence of plants, increased attention span and reduced stress in a natural environment.

Three studies[93] cited by Fell even suggested that natural elements do not need to be alive to provide a sense of physical or psychological well-being. For instance, the mere presence of wood in an indoor environment not only promotes creativity, but also relaxation, by lowering blood pressure and heart beat rate of those in the room.

This is also what Fell showed in his research. He found that visible wood surfaces in a room contributed to lowering activity in the sympathetic nervous system (SNS) of persons in this room. The SNS controls the physiological response to stress (e.g. heart rate, blood pressure, sweating, adrenaline).

Less stress because of wood

For his experiment, the researcher set up two identical offices – one with a wood environment (furniture and blinds in a light colour – birch) and the other without (white furniture and blinds) – and then gave 120 students in succession a stressful mathematics test while they sat at the desk in one of the two rooms. During the three phases (mental preparation, test and recovery period) of the 40-minute test, devices continuously measured two SNS activation indicators of the students, therefore of their stress: pulse rate and skin conductance.

The results revealed that the stress measured by activating the sympathetic nervous system was lower among students who took the test in the wood environment. Furthermore, stress was lower during all three phases of the experiment. "This study shows that the effects of wood in helping to reduce stress are similar to those, well documented, of exposure to a natural environment," wrote the researcher. Based on the fact that prolonged and ongoing periods of stress affect a person's psychological and physical health, he concluded that the visible presence of wood surfaces in an indoor environment is a health factor for occupants. For him, wood could therefore become an additional tool when seeking healthy interiors for buildings.

The results measured during Fell's experiments and those he cites corroborate what people intuitively believe or feel about the virtues of wood indoors, particularly images of a calm and elegant environment conjured up at the sight of this material, as shown in other studies.[94] In one of these studies,[95] people were asked to choose a company for which they would like to work, based on photographs of the reception areas of the companies in question. Some had a wood finish, others had none. Most often, people chose companies with a reception area with wood, and used qualifiers such as "energetic," "innovative" and "comfortable" to explain their choice.

This concurs with the results of a survey conducted in eight European countries by the market research firm InSites Consulting for the European Federation of the Parquet Industry.[96] According to this 2009 survey, people associate wood flooring with "natural" and "warm." American environmental psychologist Sally Augustin spoke of psychological comfort. In her blog called "People, Places, and Things,"[97] she wrote that

"Working more daylight and wood into a home is psychologically desirable."

A contrario

Wood also has *a contrario* health virtues, so to speak. It does not have the problems of the other products used for the same purposes, carpet instead of wood floor, for example.

One of the aspects often overlooked by green building evaluation programs is the air quality inside houses. This air is often contaminated by a host of substances that are released not only because of the use of a variety of household products, but also from furniture and home finishing materials. The consequences on occupants' health can be even worse considering that North Americans spend on average over 90% of their time indoors. The problem is compounded by the fact that more efficient houses are being built – tighter houses that do not 'breathe' as well – and the amount of glues going into these houses becomes ever more important.[99]

Rugs and carpets are likely to present several problems in this regard.[100] They are one of the largest sources of pollutants, both chemical and biological, in indoor air.[101] Glues, fibre bonding agents and treatments (e.g. stain-resistant, anti-static, anti-odour) all release volatile materials.[102] The dust that accumulates between rug and carpet fibres is also a source of many allergies.

Some carpets are coated with a pesticide – a voluntary toxic product – by the manufacturer. Others contain brominated flame retardants, which belong to a large family of chemicals that can be toxic for the liver and thyroid gland, disturb the endocrine system and cause fertility problems. Some others are treated with perfluorooctanoic acid (PFOA), a synthetic chemical used in kitchen utensils (Teflon™) and whose molecules persist in the blood and breast milk of exposed persons.

Risks for health, namely that of newborns, are well documented.[103] It should be pointed out that young children are particularly vulnerable to chemicals contained in carpets. Not only do they spend more time indoors, they are also often on the ground, sitting or lying down, with their face very close to the carpet.[104]

VOCs

Rugs and carpets can also release (by evaporation) several types of volatile organic compounds (VOCs),[105] i.e. gases and vapours found in the composition of fuels and several commonly used products: paints, glues, stain removers, solvents, etc. used, among other things, to manufacture and treat carpets. Studies have shown that VOCs from carpets contribute substantially to indoor air pollution.[106] They can be released from all carpet layers, but the major part comes from the structural material made out of polymer.[107]

Some VOCs can have mild effects (e.g. headaches, irritation, nausea) on the health of the people exposed. Others, however, can have serious effects and be mutagenic, for example, or even carcinogenic. Moreover, VOCs contribute to the formation of ozone in the lower atmosphere, thereby contributing to global warming.[108]

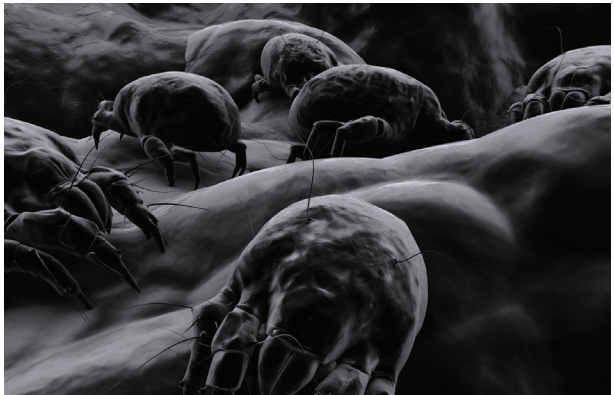
Allergy problems

In addition to all these health issues caused by substances used to manufacture and treat carpets and rugs, is perhaps the most common problem of all these covering – allergies attributable to dust mites that accumulate in the fibres of a poorly maintained carpet. Whereas a wood floor is a sanitary and hypoallergenic covering, since it does not provide a support to the development of allergens, carpeting is associated with a number of allergies and respiratory illnesses, including asthma, caused by dust, mould and mildew. These biological contaminants are captured and grow in carpeting before being released into the air and inhaled by occupants.[109]

According to the American Industrial Hygiene Association, carpets are possibly the largest reservoir of airborne allergens and other dusts in homes and commercial buildings.[110] In a New Zealand study,[111] researchers found that levels of one of the most common dust mites (*Dermatophagoides pteronyssinus* or Der p 1) were significantly higher in homes with old carpets than in homes without carpet or with new carpet. A Dutch study[112] established that levels of this dust mite were 6 to 14 times higher in dust from carpeted floors than in dust from smooth floors. Results from other studies were similar for several other species of dust mites[113] and with samples taken from school classrooms.[114] And even if carpeting is properly maintained by regular vacuuming, there is no guarantee that the problem will be avoided. This often only moves the

dust mites without lowering levels (if the vacuum cleaner is not equipped with a proper filter).

As is the case for VOCs, young children are more exposed to dust mites in carpets. It is therefore important to prevent this exposure, since contact with these allergens early in life can predispose them to asthma around the age of seven to nine, explained New Zealand researchers in an article published by the European Society of Pediatric Allergy and Immunology.[116] Also, specialists recommend discouraging the use of carpeting in schools and daycare centres, where children spend a lot of time.[117] A number of health organizations [118] outright recommend removing carpets from bedrooms and replacing them with wood or linoleum floors.



Lastly, in addition to helping dust mites proliferate, carpets can become mouldy when wet. If they stay wet for more than 24 hours, it is very hard to prevent spores from multiplying (mould are fungi), so much so that it is better to remove and throw out the affected carpets.[119]

Vinyl also

Vinyl coverings are not without health risks themselves. Like carpets, the underside of vinyl can become mouldy if installed on a damp surface (e.g. concrete without a vapour barrier) or if water seeps underneath. Vinyl can also produce fumes (e.g. VOCs) when exposed to heat or the sun, as can the adhesives used to install the covering,[120] whose strong odours can last for a long time.

Furthermore, these coverings often contain phthalates – a derivative of phthalic acid – used as plasticizers to soften vinyl (and carpet tiles). Known as a major indoor air pollutant,[121] phthalates can affect the development and reproduction of humans, increase the risks of infertility and cause testicular damage.[122] Among children, they are associated with asthma and various allergies. A higher prevalence of bronchial obstruction

was diagnosed in children living in houses with polyvinyl chloride (PVC) floor coverings compared with others who lived in houses with wood floors.[123]

It is also worth mentioning that vinyl is a floor covering whose manufacturing and disposal practices are the most toxic.[124]

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8 Not so green substitutes

Bamboo for floor coverings and composite wood for exterior finishing are not the ideal substitutes for wood as it is often reported.

Many people choose bamboo flooring because they believe this product offers more or less the same benefits as wood flooring. In some respects, this is true. But in several other respects, this is far from the case. Firstly, bamboo floor coverings are not always without any health effects and secondly, their environmental footprint is not at all negligible. The ecological impact of harvesting bamboo forests and the intensive cultivation of this plant in several countries should also be pointed out.

As for composite wood, which is a relatively new material composed of wood and plastic, analyses reveal that it is much less “green” than suggested.

Bamboo – not so green

In terms of health, bamboo flooring represents a risk due to the amount of formaldehyde that goes into the glue, reported an article in *Hardwood Matters*,[125] a magazine published by the National Hardwood Lumber Association (United States). According to this article, formaldehyde is constantly released and is a "silent killer" just like second-hand smoke in a room of smokers.

Moreover, with regard to the environment, bamboo products leave a non-negligible footprint. The manufacturing of bamboo floors "is high-energy consuming and pollutes more than processes used for solid wood floors," according to the Québec magazine *La Maison du 21e siècle*.[126] To clean the bamboo strips, they are soaked in boiling water containing hydrogen peroxide and then assembled using a petrochemical-based adhesive. *Evergreen Magazine* pointed out that bamboo floor manufacturing processes use various potentially toxic chemicals and produce considerable solid waste.[127] In addition, plants that manufacture these floors most often use coal to heat their boilers, therefore resulting in highly polluting emissions and contributing to global warming.

The *Hardwood Matters* article also highlights various aspects related to sometimes dubious practices used to cultivate the resource: "It is unclear if the bamboo comes from a well-established plantation or otherwise placed on a clearcut in the rainforest. We do not know what chemicals were used in the culture, or whether children worked in factories for its processing," pointed out one of the people interviewed for the article (Al Whitson Jr of the Whitson Lumber Company).

Moreover, according to the United Nations Environment Programme (UNEP) and the International Network for Bamboo and Rattan,[129] deforestation endangers a third of the 1200 animal species living in the world's bamboo forests. Furthermore, it directly threatens rare animals such as the giant panda (Asia), the mountain gorilla (Africa), the Himalayan black bear and other rare species that depend on bamboo. The over-cutting of this resource has considerably reduced bamboo stocks in Asia, noted R. L. Banik of the Bangladesh Forest Research Institute.[130]

The demand for this product is such that close to "half of the bamboo in the world is harvested illegally and a lot of farmland and tropical forests have been replaced by monoculture bamboo plantations," revealed a survey by the Switzerland World Wildlife Fund.[131] These plantations have an environmental impact. Among other things, weeding, whether manual or chemical – and periodical ploughing are responsible for soil erosion. And along with herbicides is the intensive use of pesticides and fertilizers.[132] Finally since bamboo is an invasive species, due to its vegetative propagation, the biological diversity of neighbouring forest stands is threatened.[133]

Composite wood – not so green

Composite wood is another (relatively new) product that consumers prefer over wood, namely for outdoor landscaping projects such as terraces, garden furniture or edging for lawns. It is not wood per se, but a material composed of wood fibres and plastic resins, in varying proportions, generally 50–50.

In a performance comparison study of composite wood products and solid wood products,[134] researchers at Dovetail Partners (an environmental information organization) urge caution before believing everything manufacturers say about the qualities of composite wood. They point out, based on a literature review, that composite wood is itself affected by certain problems traditionally attributed to wood, such as mould, rot, degradation due to UV rays and discoloration. They also point out that this material is not as "green" as suggested.

Citing the results of a comparative life cycle assessment carried out by FPInnovations in 2009, the authors of the study showed that, of the three products compared (solid red cedar, composite wood using 100% recycled polyethylene and composite wood using virgin

polyethylene), the solid wood had, by far, the lowest environmental impact. These results apply to the potential of global warming (-100% compared with virgin composite and -60% compared with recycled composite), the acidification potential (-97% and -47%), eutrophication (-90% and -80%), smog (-65% and -50%), fossil fuel consumed (-98% and -40%) and total energy (-97% and -40%).

They also concluded that it is first necessary to thoroughly examine all environmental attributes of each option before being able to carry out an outdoor landscaping project that is environmentally friendly.

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An informed choice based on facts

Québec hardwood products come from an abundant forest that is sustainably managed. They provide part of the solution to the problem of climate change. They have characteristics valued by industry and consumers. They promote health, especially when compared with similar products made with other materials. In short, they combine all the qualities required for making an informed chose for those who seek an environmentally friendly, practical and logical solution for flooring or interior or exterior finishing.

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