ECOS recommendations for progress in assessing the greenhouse gas dynamics of forests and wood products

Review of draft ISO 13391 standard series

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I. **Contextual summary**

The ISO 13391 standard series on greenhouse gas (GHG) dynamics of wood and wood-based products was initiated by the forest and wood sectors in order to support with new data the higher environmental benefits of the forest and wood value chains compared to alternative sectors and materials (plastics, minerals, etc.). It also aims to support decision-making within the forest and wood sectors as well as policy-makers in optimising the climate mitigation performance of the sector.

With regard to these two goals, but particularly the first one, this paper seeks to warn against the oversimplification of this complex field and provide recommendations for providing useful information. Claims that the greater consumption of wood is inherently climate-friendly, or that of any other material for that matter, are generally misleading as any industrial process has definite impacts. In the case of wood, impacts on biodiversity and forest ecosystems are often omitted. Before the production of anything new, the most environmentally-friendly approach will always be the reduction of material and energy use first and foremost, the reuse of existing products, and recycling of materials.

Claims around the compensation of wood industry impacts, such as via sustained forest growth under sustainable forestry ‘recapturing’ emitted carbon dioxide (CO₂), can omit some aspects of forest GHG dynamics such as soil-related emissions or biodiversity loss from conversion of natural forests into plantations in the some of the worst cases. ISO 13391 may not solve these issues if all the flexibilities it offers are used in implementing the methodology. Nevertheless, the standard series could be a good start in the effort to explore the GHG dynamics of wood products and improved management of forests, as well as in producing more detailed and transparent claims around GHG dynamics.

**ECOS has been an active contributor to the development of ISO 13391 since its inception, providing feedback to the ISO Technical Committee 287 Working Group 3 in order to seek the best outcomes for the environment. This standardisation process involved various actors mainly from forest and wood industry sectors, as well as some academics, and ECOS as the only environmental NGO involved.**

II. **Scope and goal of this review**

In this paper, we explain what the ISO 13391 standard series on greenhouse gas dynamics of wood and wood-based products is and is not with regard to the need for better GHG information on wood products and forests. Our goal is to provide a constructive critique, based on our knowledge from participating in the process. Time will tell whether ISO 13391 has offered a good platform of progress for assessing GHG dynamics of wood products: in this paper we consider the progress it offers and its shortcomings, as well as how it can be used or misused.

This paper is mainly aimed at climate experts, the potential users of the standard series including the wood products and forestry sectors, associated sectors (finance, construction), and policy makers.

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1 In this paper, we have simplified the phrase ‘wood and wood-based products’ and instead used the shorter term ‘wood products’. This term encompasses anything that can be made from wood and wood-based products for any sector, including solid wood products, wood-based panels, paper, board, bioenergy products, etc.
III. **ECOS recommendations for practitioners:**

1. **Respect the complexity of forests’ and wood products’ GHG dynamics when conducting an analysis and reporting results.** Rather than seek to oversimplify, companies should seek out data and report complete and disaggregated results, as well as backing assumptions and related explanations. Single figures will risk confusing any reader and amount to greenwashing. Helpful decision-making will best be achieved by transparent and consistent reporting over several years.

2. **Do not make any claims about potential or real displacement until there is a better understanding of market dynamics at play.** Considering the high greenwashing risks related to the assessment of the potential of wood products to displace other products’ emissions, we strongly warn companies against making any external/marketing claims regarding displacement and instead use values for internal purposes.

3. **Provide ample information about the presumed lifespan of wood products when estimating carbon storage.** The method for calculating carbon storage in wood products leans heavily on standard assumptions concerning product lifetimes for a small number of very broad product categories. The standard can accommodate the use of more specific data about product lifespans based on evidence-based product life expectations across narrower product categories.

4. **Forest ecosystems are complex, and GHG dynamics are but one of the many aspects of their healthy functioning.** Downstream wood product users should continue to demand better information about the management of forests from which the wood is sourced, such as the age and conditions under which trees are harvested, and the impacts on forest GHG emissions and sequestrations. Information should also go beyond GHG dynamics and include the impacts of forest management regimes on often-overlooked elements such as soil carbon, biodiversity and long-term resilience.

5. **The standard enables circularity to be rewarded in various ways and should be harnessed.** Higher wood product storage figures can be achieved by reorienting timber supply to more durable and long-lived product categories. Recognition of enhanced durability and lifetimes within a product category is also possible and requires moving away from the use of default values included in the standard. Reuse and recycling should usually result in reduced supply chain emissions and a corresponding increase in displacement potential; there is also a possibility that these activities lead to reduced harvesting and improvements in forest carbon.
IV. What are the greenhouse gas dynamics of forests and wood products?

Each wood product and each forest or tree plantation presents a unique profile of greenhouse gas (GHG) emissions and of stored carbon.

- **Within forests and tree plantations**, GHG are emitted when organic matter from trees decompose or burn, while photosynthesis turns carbon dioxide (CO₂) and sunlight into solid carbon in growing trees. Trees can continue to grow into a mature forest which can store carbon for centuries in the vegetation and in soils under the right conditions. In worse scenarios, forests are cleared without subsequent regeneration, or lost to fires, pests or other large-scale disturbances, today often due to climate change.

- Forests may be harvested to manufacture wood products with various uses and lifespans (construction timber, paper, packaging, wood-based energy products, etc.), continuing to store the carbon until they are wasted, burned or decompose and released as GHG emissions.

- **Wood products sometimes substitute other products** with higher or lower GHG emission profiles, ‘displacing’ these emissions in the best case, but they also contribute to the increasing total climate footprint of the global economy in the case where these wood products do not substitute anything.

Together, these various GHG emissions, storage and displacement processes compose the GHG dynamics of wood products and forests. To make a holistic assessment of the climate impacts of wood products and of forest management practices, detailed data and analyses on the full scope of the GHG dynamics are in principle needed, however these are very difficult to quantify accurately.

Lack of transparency about wood supply chains’ impacts on the climate and on forests perpetuates both sides of the spectrum of ideas that forests are either harmed by any harvesting, or that wood is the most sustainable material of all thanks to forests’ natural GHG dynamics. The nuances need to gain clarity to better inform forest management and wood sector decision-making. A more transparent reporting of GHG dynamics would shed light on various possible situations, such as when forests are well-managed and contribute to a growing CO₂ sink and when harvested wood is used, reused or recycled at the end of its useful life; as well as the opposite, when forests are so intensively managed that the overall GHG balance is diminishing, and such that wood products do not contribute to reducing the impact of material or energy consumption and the associated GHG emissions, but in fact worsens it.

As much as robust and detailed GHG dynamics assessments are needed, there is also a risk that these studies are geared towards making crude estimates based on unsubstantiated assumptions, such as the carbon neutrality of soil GHG dynamics in the lack of specific data, which perpetuate unsustainable forest management and fast-paced consumption of wood products as key impacts get omitted. GHG dynamics may tell nothing of other forest ecosystem services, biodiversity and climate adaptation and resilience, as it can be pre-oriented to narrowly focus on indicators which support economic goals (such as harvested wood product volumes and related carbon storage and displacement effects) at the expense of ecosystem balance.

V. State of play of the field

The contribution of forestry and wood sectors to climate mitigation is currently assessed and reported at the national scale under the UN Framework Convention on Climate Change (UNFCCC) reporting mechanism. Deforestation, forest degradation, as well as forest harvest and growth, and the production of wood products from harvests, are monitored and reported in their contribution to GHG emissions and storage in forest ecosystems or in harvested wood products (HWP). This nationally-
aggregated data however does not provide sufficient detail about the GHG dynamics of specific wood products and the forest units under various forest management approaches.

At the product level, life cycle assessment (LCA) methods and standards allow us to calculate the GHG emissions and storage effect of wood products. However, these are not well equipped to quantify the GHG dynamics of forest ecosystems that provide the wood. Forest GHG dynamics are therefore currently mostly assumed as either ‘good’ if the product is certified under a responsible wood sourcing scheme (e.g. FSC/PEFC), ‘unknown’ and therefore excluded from analysis, or ‘bad’ where the wood product is known to have contributed to deforestation or conversion to a tree plantation.

Current methodologies tend to look at small parts of the total GHG dynamics of wood products and forests, and/or are used on a high level of aggregation. Encompassing methodologies which capture the GHG dynamics at the level of a forest and product value chain are still at a low level of development. In this context, ISO standardisers have decided to develop the ISO standard series ‘Greenhouse gas dynamics of wood and wood-based products’ (ISO 13391).

As we show in this paper, estimating the GHG dynamics of wood products and forests is complex and unavoidably contains uncertainties, which is why practitioners must remain humble and transparent in their analyses. Forest soil GHG dynamics, risks from climate-related hazards, potentially displaced emissions, and the duration of carbon stored in wood are particularly difficult to assess accurately. Moreover the results need to be properly interpreted and contextualised by experts.

VI. Scope of the ISO standard series 13391 ‘GHG dynamics of wood and wood-based products’

General scope

ISO 13391 allows for the calculation of GHG sequestration, storage and emissions of wood products value chains, starting from within the forest, to value chain emissions, to the end wood product and its final oxidation (burning/decomposition), and emissions potentially displaced in other sectors from the use of wood products. Altogether, these make up the GHG dynamics of forests and wood products. ISO 13391 is composed of three distinct standards which compose this standard series.

Purpose

The goals of ISO 13391 are not always clearly stated, but in practice they would likely include providing data for reporting and external communication, such as corporate sustainability reports and claims, as well as company/value chain knowledge acquisition to improve decision-making. The standard also intends to be a basis to influence policy making.

Methodological basis

This standard series is based on a combination of lifecycle thinking, carbon accounting tools from United Nations Framework Convention on Climate Change (UNFCCC) reporting mechanism for the agriculture, forestry, and land use (AFOLU) and harvested wood product sectors, and methodologies which had not been standardised until now (displacement).

- This standard does not address the methodology for lifecycle assessment (LCA) or environmental product declarations (EPD) concerning wood-based products, instead relying entirely on existing standards and product category rules (PCRs) for that.
- Forest carbon and biogenic carbon storage in wood products are both recorded and reported at national level in UNFCCC annual GHG inventories, following IPCC guidelines.
- Potential displacement effects are based on methodologies found in the literature.
Scope of reporting

The results are in principle only reported at the level of organisations or at more aggregated level (multiple organisations, entire supply chains, whole countries or regions). For forest GHG dynamics, the data is reported at the level of one forest management units (FMU), the definition of which is at the discretion of the user. Product-level data does not need to be reported.

Time scope

The GHG dynamics assessment is intended to be backward-looking, with no further limitation on the timespan.

VII. ECOS review of ISO 13391

The ISO 13391 standard series is at the same time a useful and ambiguous tool to produce information regarding forest and wood value chains. It is going to be difficult to work with in a sector where granular data about forests, particularly their soil carbon dynamics and possible trade-offs between GHG mitigation and other environmental impacts such as on biodiversity are generally lacking today. As regards its scope, we anticipate that studies using ISO 13391 will struggle to provide clarity as to the effects of different policy and management scenarios due to the nature of the results being backward-looking and based on averages rather than marginal effects.

Considering these key general challenges, we make six critical observations and propose ways in which they might be resolved.

1. GHG dynamics are complex and must not be oversimplified.

The ISO 13391 standard series is a valuable effort at capturing the complexity of measuring the GHG dynamics of wood and wood-based products in various product applications. It is essential to reflect this complexity and not attempt to arrive at results which obscure the full ‘GHG dynamics’ of wood products and forests. After long deliberation, standardisers agreed to keep separate the results of GHG calculations at the level of the forest, wood products, and potentially displaced emissions. ECOS believes this must be maintained, as the opposite—reducing all positive, negative and avoided emissions to one single number—would seriously discredit the forest and wood sectors as the sum would be equal to adding up ‘apples and oranges’. The various constituents of GHG dynamics covered by the standard have different system boundaries. Any attempt to represent the GHG ‘balance’ in a single number would be invalid and amount to a marketing exercise rather than science-based reporting. What is more, a unique figure would hide all of the emissions from fossil fuels in the value chain, likely to show a good-looking negative figure, and it would mix up real emissions and removals with the potentially displaced emissions in other sectors. Indeed, as opposed to the theoretical assessment of potentially displaced emissions, forest carbon, value chain emissions and wood product carbon are tangible in that they refer to physical carbon susceptible to direct measurement.

2. To better inform decision-making, disaggregated results should be collected and reported as trends over time.

The standard must be used to inform choices that lead to improved GHG dynamics (less emissions and more or longer carbon storage). To achieve this, users of the standard must be patient in building their databases. Results from trend data observed consistently over time are likely to be more informative than absolute values, as a single snapshot in time would not be useful to support forest management, wood production or policy-level decisions. For instance, knowledge of the impact year-on-year of different forest management practices in multiple areas on the forest’s GHG dynamics could be assessed, or the changes in value chain emissions resulting from process optimisation, and
the effects of longer carbon storage from the reorientation of wood production from one sector to another.

However, the potential for this standard to inform downstream wood product users or policymakers about the GHG dynamics of (groups of) products is unclear due to the scope of the reporting, which may still be too aggregated to offer valuable insight. Note that there is no agreed way for GHG dynamics of the forest to be allocated to wood-based products, and a solution to the problem is not attempted in the standard, likely avoiding a thorny subject lacking scientific consensus. The forest GHG dynamics will therefore only be reported separately as interesting additional information rather than computed into products’ own GHG footprint.

3. Calculations of emissions potentially displaced in other sectors from the marketing wood products lack scientific backing.

The standard opens very controversial doors, which should be closely monitored to ensure it is not misused. The largest risk relates to the assessment of potentially displaced emissions, i.e. the emissions which could be avoided due to the use of wood products replacing non-wood products. In other words, displacement is an account of the emissions avoided if wood products could replace all other non-wood products fulfilling the same function.

Generally speaking, displacement is assessed by determining a displacement factor, which reflects the difference between a wood product’s GHG profile and that of its equivalent non-wood counterpart with functional equivalence, based on comparative lifecycle assessment results for both products. ISO 13391 allows users not to determine displacement factors for their own product(s) and instead use generic factors provided in an annex. These generic values are derived for broad product categories and therefore lack specificity.

ISO 13391 chooses to assess displacement potential. As such, it does not answer the critical question of whether the production and marketing of wood products actually prevents emissions in other sectors from the substitution of more emission-intensive products. Displacement effects can thus be grossly overstated and disconnected with reality with no supportive market analysis. Considering the complexity of displacement as a concept, we believe that any external communication of the results (e.g. for marketing) would likely amount to greenwashing.2

By contrast, a methodology for calculating real displaced emissions would have to be based on a set of assumptions of ‘what happens’ when a HWP is placed on the market and other actors make the choice not to market another product as a result, with associated theoretical emission reductions. Such a methodology is difficult to establish due to important data requirements.

Box: Challenges with estimating displacement effects

If a real estate company decides to change its future projects towards more timber structures and less steel and concrete, that company can make an assessment comparing different designs and estimate GHG savings from avoided emissions of using timber. In this case, the scenarios can be rather well defined as there is a clear baseline (concrete and steel buildings, no timber buildings) to a new situation (plans for future buildings will now use timber), and therefore displacement potential can be based on detailed LCA of the alternative scenarios.

However, calculating displacement potential according to ISO 13391 is generally less well defined, as they are more likely to occur at the level of the wood value chain such that product end-uses will

likely not be known by the analyst. For instance, when wood is placed on the market as an intermediate product (such as plywood, particle board, or wood chips), it may be used in very different applications including packaging, furniture, construction panels, or wood pellets.

The new ISO standard also entirely omits to factor in the market conditions that would determine the share of wood-based products which would realistically substitute non-wood alternatives. In other words, when assessing real displacement, an analyst would need to know in which markets and for which applications wood products are used, as well as whether such products are relatively innovative and actually substitute existing non-wood products (e.g. plastics, concrete, steel, etc.), whether they create a new market entirely, or whether they are already widespread, thus only contributing to overall market growth as opposed to taking over existing markets. Actual displacement will therefore greatly vary based on pre-existing market conditions, which are very difficult to capture.

Displacement calculations inherently are problematic, as they posit that other sectors’ choices to substitute a product for wood—and the supposed emission reduction—should be attributed back to the wood sector. In the worst possible deviation from ISO 13391, displaced emissions are then deducted from the forest and wood sectors’ carbon accounts (see point 1 above). In other words, displacement calculations allow the forest and wood sectors to attribute theoretical emission reductions to their own sector based on the supposed choice made by other actors not to produce another product as a result of a higher demand for wood products.

Furthermore, in the context of global economic growth, market dynamics (including prices) lead to more supply and demand for products, not less. As a result, increased production of wood-based products may simply be additional to existing production of all materials, with little impact on the quantities of other materials used and their associated GHG emissions.

In the absence of a robust understanding of market effects, displacement calculations could suggest that the more wood is added to the market, the less emissions in other sectors. This is concerning, as methods that imply that more consumption of anything—without limit—leads to climate mitigation are in opposition to the principles of sustainable resource management.

There is a high risk of greenwashing with displacement calculations, as the method provided by ISO 13391 for assessing displacement potential will apply in situations where a wood product has long been the preferred market option in given geographical contexts, with no innovation or effort required from the wood sector.

To be credible, a methodology to assess real displacement would need to take very complex market dynamics into account to assess the additional climate benefit of HWP placed on the market. In other words, the theoretically avoided emission should be proven with a demonstrated reduction in production elsewhere, yet such dynamics are not well assessed in the scientific literature and are omitted in ISO 13391. Unfortunately, instead of improving the assessment of real displacement effects, the Working Group developing ISO 13391 opted for the simple route of only assessing displacement potential, which will, by definition, appear larger than any actual displacement value and induce confusion for the uninformed audience due to the complexity of the concept.

4. By design, lack of detail, or due to its flexibility, the standard allows users to overlook forest ecosystem health.

Depending on the scope of the analysis, and due to the flexibility which the standard allows in reporting information about the FMU, the impacts on GHG dynamics of different forest management practices (including on soils) may be improperly captured, hindering learning about the variations of impacts across plots over time. The standard also allows very general data to be used to assess forest
GHG dynamics, and also allows coarse conclusions about the GHG neutrality of forests, or about changes to the soil carbon pool. In that respect, the standard fails where it could have provided more incentive for producing finer-grained forest data.

There is a risk that the drive to improve the sequestration, wood product storage and displacement leads to higher rates of timber extraction and more intensive forest management, raising real concerns around broader environmental sustainability from decreased biodiversity, water pollution, soil degradation, and reduced resilience. By focusing on GHG, users of ISO 13391 may omit aspects related to these wider sustainability issues.

The standard series offers little practical guidance to help users improve climate change adaptation and resilience of forests, which can have direct consequences on the GHG dynamics if forests are lost to fires, droughts, and other climate-related hazards. Intensively managed monocultures might suggest rapid short-term GHG sequestration, but they come with risks associated with the changing climate such as locally novel pests and diseases, higher drought and fire risks, flooding and windthrow.

ECOS therefore calls for additional consideration to be made of these wider sustainability risks when considering forests and wood products’ GHG dynamics.

5. ISO 13391 offers a new way of counting carbon storage with interesting potential applications.

The ISO standard would have been remiss not to address the question of temporary carbon storage of the various types of wood products which would be in the scope of forest and wood sectors’ production. Due to the level of analysis of the standard (organisations, up to entire value chains), the standard looks at carbon storage at an aggregated level, borrowing from IPCC guidelines for national-level reporting on harvested wood products (the production approach). More specifically, the standard proposes a calculation based on the flow of carbon stored in new products entering the storage ‘pool’, and the flow of carbon exiting the storage pool as previous generations of products reach end-of-life.

Long-lived products (e.g. construction materials) perform better in the assessment than shorter-lived products (e.g. packaging), while wood for energy via incineration provides no storage benefit. As such, the use of the standard could encourage a shift from shorter to longer-lived products, although the value of the displacement potential may sometimes push in the other direction. Generally speaking the standard does not provide guidance for weighing or interpreting results from the different calculations, i.e. the carbon stored, the emissions potentially displaced in other sectors, and carbon stored in the forest, leading to unanswered questions about the relative significance of one tonne of carbon dioxide reported in different parts of the standard.

The standard offers default ‘half-lives’ of product categories based on IPCC, for instance 25 years for wood-based panels. Half-lives suppose that half the total set of wood-based panels placed on the market reach end-of-life disposal after 25 years. IPCC default half-life values have existed for decades and little work has been done to contest them, which is why users of the standard may also choose the option of providing evidence to support the use of different half-life assumptions. Consequently, innovations and changes within a product category which increase their durability can be modelled as contributing to increasing carbon storage time.

The carbon storage calculation may be based on insubstantial logical foundations and will not stop debate about how (and if) to reward carbon storage or delayed GHG emission. The standard provides indicative coefficients for carbon storage in different product categories, but offers no detail about how they have been derived. A forthcoming technical report, still currently in development, links these coefficients to market volume growth, with an example based on an assumption of exponential growth at a rate of 1% per annum. ECOS fundamentally disagrees with this assumption, as forest
harvests cannot continue growing indefinitely and are in fact already pushing the risk boundaries of forest ecosystems\(^3\).

ISO 13391 also includes landfill as a form of biogenic carbon storage. **ECOS warns future users of the standard that the inclusion of landfilling must not become an 'easy way out' of having to report an end-of-life emission in cases where it is an unlikely waste disposal route** (such as in the European Union, where landfill has been mostly phased out as a disposal practice). While landfill can be an appropriate solution for a small fragment of wood waste which has become unusable for material applications, it can also be a loss for circular uses of wood waste. Furthermore, there are risks around the preservation of wood products in landfill and therefore the actual carbon storage duration, particularly considering the wide range of possible contexts across the world.

6. **ISO 13391 includes the GHG benefits of reuse and recycling**

The clearest direct benefit when assessing reused and recycled wood products will be the lower supply chain emissions compared to new products year-on-year. Taking a hypothetical example, a product value chain which increases this year the share of reused/recycled wood products compared to new wood would present lower GHG emissions compared to the previous year, all else being equal.

Furthermore, overall displacement potential can be enhanced by increasing the supply of material for reuse and recycling (e.g. diverting material from landfill or incineration for energy).

**In terms of forest carbon, reuse and recycling could, in theory, result in less timber extraction if the reused and recycled products substitute virgin wood products.** This might result in forest carbon increases as harvests may diminish due to lower demand. The opposite may also be true, where reuse and recycling increase and timber extraction as well, denoting no reduction in demand and a ‘circularity rebound’.\(^4\) Whether a benefit emerges when reuse and recycling is scaled up therefore depends on whether it is additional to new products with no reduction in demand for those new products, or whether it is substituting for new products and leading to reduced demand.

**Recycled products will also present the advantage of extending the duration of carbon storage in products, postponing the end-of-life emission.** In that case, the standard allows the analyst to assume the recycled product’s half-life to be the same as that of a new product in a given category (e.g. 25 years for a wood-based panel from recycled wood material).

The extended lifespan of products which are designed for reuse can be recognised as enhancing carbon storage if the analyst diverges from the default IPCC half-lives the standard proposes and provides estimates of the likely half-lives instead.

**VIII. Final remarks**

While the standard makes some headway towards integrating GHG dynamics into a single framework, a lot is left to the analyst in terms of assumptions, depth of the analysis and interpretation of the results. Unfortunately, instead of strongly encouraging data collection, the simpler routes of using generic values, some directly offered by ISO 13391, may not improve knowledge of the realities of forest and wood supply chains in the pursuit of ‘green’ marketing claims.

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Furthermore, there remains challenges related to ISO 13391’s usability. According to the standard, any actor or group of actors from the forest and wood value chain may in principle assess the GHG dynamics of the value chain for the past year(s). In practice however, it will be difficult for individual supply chain actors to produce a complete and accurate overview of the GHG dynamics of their supply chains (from the forest to the end product), as data must be collected and computed consistently at each link of the chain. The standard rather benefits vertically integrated wood product supply chains covering for instance forest land ownership and management, sawmills, and product manufacturers.

Until data collection becomes more routine and widespread at the necessary scale (e.g. GHG dynamics of forest plots and LCA of wood and non-wood products), analyses will remain crude and will not allow fair comparisons of wood products between themselves and with non-wood products. Significant progress in the field may be achieved once the market starts making a robust and transparent use of the tools at hand to provide information about the true sustainability value of different wood products and associated forest management regimes.

As always with quantitative methods, the highest level of transparency should be required as regards the data used, the assumptions made, and calculations performed, as the results can be skewed by analysts in any way they wish into a ‘creative accounting’ exercise. With sufficiently transparent reporting, the standard has the potential to encourage improved assessment of overall GHG dynamics of forests and wood products.

Going beyond ISO 13391, ECOS believes these recommendations are key:

1. Research into the development of unified frameworks to assess the GHG dynamics of forests and their associated wood products should continue to improve the methodologies. Frameworks should in particular focus on producing accurate data and passing it along the value chain to create robust and complete assessments of the forest and wood value chain.

2. Policy should require and facilitate the production of data about forests in order to fill key knowledge gaps, including as regards forest climate adaptation and resilience, soil carbon dynamics, forest health and biodiversity, as well as how that affects ecosystem functions.

3. Sustainability assessment frameworks need to be more integrated and include not only GHG dynamics but also forest ecosystem services and biodiversity aspects, to prevent approaches which seek to maximise climate mitigation benefits at the expense of long-term ecosystem health from scoring deceivingly well.

IX. Relevant ECOS publications