Annex 2

Working Group Reports

Evaluation of the atmospheric-flow approach

Co-chairs: Gert-Jan Nabuurs, Abdul Rahim Nik
Rapporteur: Kay Abel

Summary

In its simplest form, this approach includes import and export data in addition to production data on forest products. Greater degrees of disaggregation of product pools enable an increase in confidence in emissions estimates for a given year. Country-specific data may be required on the disaggregation of the products pool and the wood product decay rates.

Description of the approach

This approach accounts for emissions and removals where and when they occur. In the simplest form (default approach), the assumption is that all emissions occur within the first year. Increasing the complexity through the multiple tiers, by introducing disaggregation of the product pool and product decay rates, allows refinement of the time when emissions occur.

The default method is based on the current IPCC default approach, with the addition of import/export data of wood products. International FAO data on roundwood, fuelwood and charcoal production are recommended as default activity data.

The Tier 1 method disaggregates the production data and import/export data into categories of wood fuels, slash, and short and longer-term roundwood production and products. Two categories of decay are distinguished. Emissions from the short-lived product pool are released in the first year and a single decay rate is applied to all longer-lived products. For this purpose the *Guidelines* could recommend an agreed default decay rate and countries could apply this or develop their own. Again, FAO data are available to support this method.

Tier 2 follows a similar approach to Winjum et al. (1998). Production data for fuelwood and charcoal, industrial roundwood, and commodities are further disaggregated and different default decay rates are developed for each long-lived product pool. This tier also incorporates inherited emissions, from previous inputs to the wood-products pool.

Tier 3 extends beyond Tier 2 by using additional research and survey within a country to improve estimates of quantities in different product pools and default decay rates.

Summary of key features

Feasibility. The default method follows similar principles to the current IPCC approach, but adds imports and exports of wood products. It uses readily available, international data (e.g. FAO trade and production data).

Accuracy and potential for improvement. The majority of assumptions are made for the default and Tier 1 methods. An increasing national effort, in developing better data on the wood-products pool and

better decay rates, leads to an improvement in estimates in Tiers 2 and 3. There is potential to improve the estimates as a country's capacity increases.

Consistency of approach and reporting. This approach follows the principle of accounting for emissions when and where they occur. The accuracy of emissions estimates will increase by applying higher tiers. Verification of the estimates is simple for the default method, because the activity data and emission factors are available internationally. More detailed in-country research will be needed to verify the higher tiers. The default method has a limited ability to gauge effectiveness of national measures, since there is little disaggregation, but this improves with the higher tiers. The approach is consistent with the way emissions from fossil fuels are accounted for in the *Guidelines*.

Policy relevance. Emissions from exported wood are not accounted for in the country of production. This is similar to the accounting approach used for fossil fuels. There is also no credit for using imported biofuels.

Table A2-1: Evaluating the atmospheric-flow approach for estimating emissions from harvested wood products: advantages and disadvantages

Criteria	IPCC default method	Tier 1	Tier 2	Tier 3
Feasibility				
Complexity of approaches	Simple	More complex	More complex	Highly complex
Availability of data	Data are available for all countries	Data are available for countries on activity and default decay rates	Data are not available for all countries and there are limited data for decay curves	Data are only available for a few countries
Cost and ease of data collection	Low	Low	Intermediate	High
Availability of national expertise	Low	Low	Intermediate	High
Applicability at various spatial scales	In principle, this is possible			
Accuracy of Approaches				
Assumptions in the approach	Immediate decay	Products are split, one default decay curve	Several decay curves, possibly based on national expertise	Many decay curves
Quality of underlying data	Depends on the quality of FAO statistics	Depends on the quality of statistics and minimal assumptions	Depends on the quality of survey data and research results	Depends on the quality of survey data and research results
Applicability at various spatial scales	All methods are potentially accurate at all scales, depending on the quality of the underlying data			
Precision of definitions	High, method is simple	Lower, more complexity	Lower, increasing complexity	Lowest, highest complexity
Completeness of accounting	Poor	Higher	Higher	Highest
Uncertainty of emission estimates	The uncertainties in all methods is small, relative to rest of LUC&F			
Scientific acceptability	Poor, many assumptions	Intermediate, relies on detailed research	Good, better research on decay rates	Very good, detailed research on product pool and decay rates
Repeatability of estimates	Easy, method is simple	Harder, increasing complexity	Harder, increasing complexity	Hardest, most complex
The potential for continued inventory improvement	This is good for all the methods, but depends on the quality of the research			
Consistency of approaches at various spatial and temporal scales, and across tiers	The temporal consistency changes between the default method and other tiers, since different decay rates are introduced			

Relevance to the reporting needs of the UNFCCC and the Kyoto Protocol				
Verification and transparency	Easy, simplest method	Harder, increasing complexity	Harder, increasing complexity	Requires more information, most complex
Consistency with other sectors of the *Guidelines*	All methods follow the principle of accounting for emissions where and when they occur			
Ability to gauge the effects of national measures	Limited, least disaggregated	Better, more disaggregation	Better, increasing disaggregation	Good, most disaggregated
Promotion of sustainable forest management	Emissions from exported wood products are taken out of the national balance in this approach			
Ability to use for projections	Poor, least disaggregated	Better, more disaggregated	Better, increasing disaggregation	Good, most disaggregated
Applicability at various spatial scales	As above			
Policy relevance				
Usefulness for national planning	Poor, least disaggregated	Better, more disaggregation	Better, increasing disaggregation	Good, most disaggregated
Ability to track the effects of measures	Poor, least disaggregated	Better, more disaggregation	Better, increasing disaggregation	Good, most disaggregated
Wood fuels	No credit for using imported fuel wood in any of the methods			

Evaluation of the stock-change approach

Co-chairs: Bernhard Schlamadinger, Risaldi Boer
Rapporteur: Peter Frost

Summary

The *stock-change* approach accounts for changes in forest carbon and wood product stocks by country, including exports and imports of roundwood and wood products. Actual emissions or uptake of CO_2 are estimated from the overall net change in carbon stocks (in both biomass and long-lived wood products), including those of imported wood, but excluding those produced in the country but which are exported. Likewise, in the case of exported wood, any increases in the stocks of long-lived wood products are credited to the importing country.

This approach is conceptually similar to the current IPCC approach but is extended to cover estimates of stock changes from wood products, as provided for in the *Guidelines*. For the purpose of evaluating the stock-change approach (Table 1), however, it was assumed that the current IPCC approach excludes this option.

Description of the approach

The following question was posed to the Working Group:

What methods of assessment can be proposed in terms of the stock-change approach?

Participants felt that stock changes could be estimated from either national or international data on both stocks and flows, the latter to account primarily for imports and exports, though some end uses are measured nationally as flows. For example, in Norway, end-product flows such as roundwood use and number of houses built are used to calculate the disposition of wood products and, by extrapolation, the changes in stocks. These data emphasise consumption rather than production.

In devising appropriate approaches, data are needed on removals, imports and exports. The following equation was assumed to represent all harvesting:

Harvesting = Roundwood production + Bark + Slash + Imports - Exports

After some discussion, two methods were proposed, one using fluxes to estimate stock changes and the other based on direct measurement of stocks over time. In reality, any estimate of stock changes will include a mix of data on both stocks and flows (see the Norwegian example above), but the relative weight of these sources of data in an assessment can vary. Moreover, to calculate stock changes by measuring fluxes still requires an inventory of stocks at the beginning and periodic follow-up surveys to re-calibrate the stocks, otherwise small inaccuracies in the estimate of fluxes can accumulate to produce significant errors in the estimates of stocks. Ideally, the aim should be to move towards full accounting of all forest and wood product stock changes through periodic surveys. Therefore, estimating changes in stock through measurement of fluxes must represent a lower-tier method, despite its greater complexity in some instances (e.g. more flows than stocks).

The two methods require different kinds of data, not all of which are equally readily available. For example, data on stocks are not available internationally, therefore flux data have to be used instead. Participants were asked:

What types of data are available on fluxes from the wood-products pool, and what problems are there with the existing data?

Winjum et al. (1998) use assumptions on the lifetimes of wood products. These need to be explored further, perhaps to develop region- and product-specific default values. Data on waste wood (scrap wood) could be used. Better estimates are needed of the loss of material at each step in the production process, and of the associated emissions through decomposition and combustion. More information is needed on what happens to retired wood (wood in commodities that have reached the end of their product lifetime). How much of this wood is retired to landfills is poorly known, as is its fate once in the landfill. Models of landfill functioning could be used to estimate this, though there are open-air dumps where the rate of decomposition is different. In both cases, the rate will be influenced by the amount and quality of the retired wood, as well as by the prevailing environmental conditions at the site. All need further quantification.

Summary of key features

Participants evaluated the IPCC default and *stock-change approach* (both flux and stock methods) against the criteria in three categories: feasibility of the approaches, accuracy of assessment, and relevance to the reporting needs of the UNFCCC.

Feasibility. Within this category the key criteria were agreed to be complexity of data and calculations, data availability, cost and ease of data collection, the national capacity needed to conduct the assessment, and the extent to which the approaches could be applied at various spatial scales.

Complexity. The IPCC default approach ignores the change in the wood-products pool and is therefore relatively simple. The complexity of both the flux and the stock methods is higher, with the flux method generally being more complex because more calculations are needed to estimate stock changes from flux data than from stock data. Moreover, there are potentially many more fluxes than stocks to account for in an assessment. Therefore, if data on stocks are available, fewer and less complex calculations are needed to estimate the changes in stocks. If there are few or no data on stocks, calculating stock changes from stock data alone will be more complex if not impossible.

Data availability. For the IPCC default approach, in which the wood product pool is assumed to be constant, the data requirements are minimal. Data on roundwood production, and on forest area and growth, are available both from national data sources and, internationally, from FAO statistics (themselves usually derived from national data). Conversely, only a few countries have adequate data on wood product stocks, limiting the potential for application of the stock method. For the flux method, more data are available at a national level. Data are also available internationally through FAO on imports and exports of wood products (flux data) but, again, there are no data on stocks.

Cost and ease of data collection. For the IPCC default approach general statistics are available at both national and international levels (FAO statistics), making the approach relatively cheap and easy to apply. The cost and ease of data collection is somewhat higher for the flux method, if the data are available, otherwise it becomes expensive, particularly if a high level of resolution and low level of uncertainty in the estimates are required. For the stock method, data collection could be even more expensive and difficult if no basic data are available, but relatively cheap if they are. Again, the cost will depend on the scale of resolution of the assessment, and on the degree of uncertainty in the estimates that can be tolerated.

National expertise and capabilities. The IPCC default approach requires the least national expertise and capability, and is therefore the easiest approach to apply. The flux method requires more expertise and ability, while the stock method the most, primarily because new data and programmes for providing these at regular intervals are required.

Applicability at different scales. All three methods (default, stock and flow) are applicable at a range of spatial scales from sub-national to international, provided that the necessary data are available at those scales. Moreover, the results can be aggregated from the finest to the coarsest of these scales and, depending on the scale of resolution of the original data, able to be disaggregated as well.

Accuracy of approaches. In statistical terms, *accuracy* is a measure of how well an individual estimate approximates the real value of the parameter being estimated. It differs from *precision*, a measure of how close an estimate is to the value of the estimator, and *bias*, a measure of the difference between the value of the estimator and the value of parameter being estimated. Here it is used in the somewhat more general sense of 'reliability', incorporating elements of accuracy, in the statistical sense (through consideration of the criteria of data quality and completeness of accounting), precision (repeatability), and bias (partly a product of the assumptions inherent in each method).

Assumptions in the approaches. In the IPCC default approach the simplifying assumption is made that the change in harvested wood product pools is insignificant and can therefore be ignored. This assumption is clearly wrong in some cases (Winjum *et al.*, 1998), and therefore produces a biased estimate of the contribution of the land-use change and forestry sector to the global annual emissions of CO_2. The flux method involves more assumptions than the IPCC default method and *stock-change* method (lifetimes of products, conversion rates etc.). These might also produce biased estimates. For the *stock-change* method, fewer assumptions are made and therefore the estimates are likely to be less biased.

Quality of underlying data. This criterion does not apply to the IPCC default approach because of the assumption of no significant change in the product pool. Conversely, the flux method, which requires considerable amounts of data and involves a number of assumptions, is highly sensitive to the quality of data used. The stock method, in contrast, requires less data and involves fewer assumptions, and is therefore likely to be less sensitive to variations in data quality. Questions were raised about the accuracy and completeness of some of the international data sets that are being used in preliminary assessments; these data sets need to be cross-checked against more restricted, but perhaps more accurate, independent data sources.

Applying approaches at various spatial scales. The discussion focused on whether the approaches vary in accuracy at different spatial scales. This is obviously not applicable for the IPCC default approach, but for the other two methods accuracy is likely to be greater at finer spatial scales. No conclusion was reached as to which method might be better in this regard.

Potential for precise and unified definitions. Again, this criterion is not applicable to the IPCC approach. Of the other two methods, the stock method has more potential for unified definitions because of fewer measurement categories and less complex calculations.

Completeness of accounting (comprehensiveness). Both the flux and stock change approach have the potential for complete accounting and are more comprehensive than the IPCC approach which, by not considering harvested wood products, is incomplete.

Repeatability. Repeatability is taken here to mean reproducibility, the potential to obtain the same or closely similar results through repeated measurement at one time. In this sense, repeatability is related to the statistical concept of precision. For obvious reasons, the IPCC default approach is highly repeatable. The flux and stock methods are also repeatable, with the stock method perhaps being more so because fewer assumptions have to be made in applying it. For both methods, however, repeatability will increase with increasing clarity of definition.

Consistency. Consistency is a measure of the degree to which the method used is the same at different spatial scales or at one scale over time. High consistency is a necessary condition for comparability of data sets among countries or some other spatially-defined unit, or within such units through time. For obvious reasons, the IPCC default approach is consistent – changes in the stock of harvested wood products (HWP) are assumed to be negligible and are therefore not counted. An inconsistency will arise if it is later decided to include accounting of HWP. The flux and stock methods are both also consistent, spatially and through time, though the flux method is currently probably more so because of the greater availability of data at a range of scales.

Relative uncertainty of emissions estimates. This criterion refers to the degree of uncertainty in emissions estimates, calculated from changes in harvested wood product stocks, relative to emissions from the rest of the Land-Use Change and Forestry (LUCF) sector. The criterion does not apply to the current IPCC default approach. Uncertainty in emissions estimates from wood products is probably lower than for the rest of LUCF, but a larger question is whether taking harvested wood products into account will increase overall uncertainty in this sector. It is also important to consider whether uncertainty in the calculated changes in the harvested wood products is likely to be higher than the overall change in the pool itself. No conclusions were reached.

Scientific acceptability. The scientific acceptability of the IPCC default approach is questionable because known changes in HWP stocks are omitted. Obviously, this is likely to be of more concern in those countries where large stock changes are occurring than in those where the stock change is minimal. The question is whether including HWP, but with a lot of assumptions and uncertainties, is more acceptable than excluding them on the grounds that the changes in stocks are insignificant. But until there is consistent full accounting across all countries through time, the overall importance of these stock changes will not be known. To the extent that both the flux and stock methods can account for changes in HWP stocks, they are scientifically more acceptable, though the credibility of the results will depend on the scale of resolution of the assessments, the balance of assumptions in each method, their importance in influencing the outcome, and the degree to which they are tested. In the long term, the extent to which the issue of HWP penetrates the scientific literature will be the test of its acceptability.

Potential for continued improvement. Given the lack of accounting of harvested wood products in the IPCC default approach, there is no potential to improve it other than to take HWP into account, which then transforms it into one of the stock-change methods. Both of these methods can be improved by increasing the precision and accuracy of the estimates; by refining or reducing the number of assumptions; and by further elaboration of the stocks and flows in HWP. The potential for making such improvements depends of their cost and ease of doing so. There may be a greater cost in improving the flux than the stock method because of the greater number of assumptions involved. Conversely, for many countries, there is a paucity of data on stocks. Rectifying this will cost money.

Relevance to reporting under the UNFCCC. In addition to the issue of the relevance of the different approaches to the reporting needs of the UNFCCC, the potential contribution to policy and planning was also considered.

Types of approaches. The stock-change approach overall is relevant to the needs of the UNFCCC by providing fuller accounting of the changes in terrestrial carbon stocks, where and when they are occurring, and (partly) why. All three methods are therefore applicable, though in the case of the IPCC default approach, only to a degree. Because harvested wood products are not currently considered in the Kyoto Protocol none of these methods are relevant to reporting in terms of Article 3.3 of that protocol.

Transparency and verifiability. Both the flux and stock methods are transparent, to the extent that the data sources and calculations can be made explicit, but both are difficult to verify, more so in the case of the flux method because of the greater number of assumptions involved. The criterion does not apply to the IPCC default approach because HWP stocks are assumed to be unchanging.

Consistency with other parts of the Guidelines. The principles underlying the stock-change approach are similar to those underpinning the estimation of emissions from agriculture but different to those in the energy sector, which are based on an energy balance approach.

Understandability. The current IPCC approach is easy to understand. The details of flux and stock methods are more difficult to comprehend but could be considerably simplified by the development of a standardised spreadsheet. Again, because of the greater number of calculations and assumptions involved in the flux method, it is the least easy to understand.

Potential for adaptability. The IPCC default approach can be adapted by inclusion of a harvested wood-products module, something that is provided for in the basic principles of the *Guidelines*, though the approach of doing so is not agreed. The other two methods are likewise adaptable, in the sense of being modifiable to accommodate new circumstances and perspectives, but at a much greater level of complexity.

Usefulness as a national planning tool. The IPCC default approach has no potential to serve as a national planning tool with regard to national policies and planning aimed at enlarging the stock of long-lived wood products, extending their life spans, and increasing the amount of recycling. The other two methods can contribute in this regard, though only to a limited extent in the case of the stock method. Effective planning requires monitoring of the impacts of policies and management on the processes involved. Only the flux method provides data at this scale of resolution.

Ability to gauge the effects of national measures. This capacity is lacking under the current IPCC default approach. The flux method can produce detailed information on, for example, flows and lifetimes of material, to be useful in gauging the effects of national policies designed to promote the use of long-lived wood products. In contrast, the stock change approach provides much less detailed information on the processes involved, and is therefore less useful in this respect.

Ability to track the effects of measures. This criterion assesses the extent to which the different approaches demonstrate cause-and-effect relationships in the implementation of policies. The criterion does not apply to the IPCC default approach, for obvious reasons, but is applicable to both the other methods because changes in HWP stocks can be monitored over time. The flux method may be better in this regard because it reflects changes in the actual flows, and it is the processes regulating these flows, rather than the stocks themselves, that are the target of management.

Consistency with sustainable forest management. The IPCC default approach is consistent with the goal of sustainable forest management but is of limited utility. The other two methods are also consistent, but the flux method can be used to monitor the effects of measures designed to promote this goal, and so is the most useful. The stock method allows monitoring of HWP stocks but in the absence of information on the processes involved in change, reflected in the fluxes, it is of limited value in promoting sustainable forest management.

Ability to be used as a basis for projections. The IPCC default approach cannot be used for projections. Data provided by the flux method can be used to make projections because the processes involved are reflected in the data on flows (where, when, and at what rate). The utility of the stock method is limited in this regard because only the net effect of the processes is reflected in the data. This is not sufficient for making anything other than crude projections.

Table A2-2: Evaluating the stock-change approach for estimating emissions from harvested wood products: advantages and disadvantages

Criteria	IPCC default method	Stock-change approach	
		Flux data method	Stocks data method
Feasibility			
Complexity of approaches	Simple: assumes no wood products	More complex	Less complex
Availability of data	Yes	Data available for most countries (but quality is the question)	Data available for a few countries
Cost and ease of data collection	General statistics, relatively cheap	Free, available from FAO or can be collected nationally (which can be expensive, depending on uncertainty)	If new data are needed, can be expensive depending on degree of uncertainty that can be tolerated, otherwise inexpensive
Availability of national expertise	Simplest method, level of expertise needed is minimal	More complex method, level of expertise increases	Most capacity needed, if new data are required, national expertise needed is high
Applicability at various spatial scales	All methods can be applied at various spatial scales, if data are available		
Accuracy			
Assumptions in the approaches	Insignificant change in wood-products stocks	More complex assumptions about fluxes to and from the product pool	Not as many assumptions since stocks are measured
Quality of underlying data	Not applicable here because the method assumes insignificant change	Highly sensitivity to the quality of flux data used	Lower sensitivity to the quality of the stock data used
Applicability at various spatial scales	Not applicable, as above	Better accuracy at finer scales with respect to current IPCC method	
Precision of definitions	Not applicable, as above	Less potential, since method is more complex	More potential, since method relies on measured stocks
Completeness of accounting	Incomplete, since method assumes insignificant change	More comprehensive than the current IPCC method. There is the potential for complete accounting	
Uncertainty of emission estimates	Not applicable, since no estimate is made	Lower uncertainty but it depends on the quality of the assumptions (difficult to decide)	
Scientific acceptability	The assessment depends on the balance of assumptions that are being made in each approach, the weight attached to each assumption, and the scale of resolution involved in the assessment		
Repeatability	Yes	Yes (less repeatable than stock method)	Yes (more repeatable than flux method)
Potential for continued inventory improvement	No	Yes (more potential than stock method)	Yes (somewhat less potential for overall improvement)
Consistency of approaches at various spatial, temporal scales and across tiers	Inconsistent if the product pool changes	Consistent both temporally and spatially. There was no discussion across tiers	

Relevance to reporting needs of UNFCCC and the Kyoto Protocol			
Types of approaches • UNFCCC • Kyoto	All the methods are relevant to the reporting needs of the UNFCCC, but since harvesting is not mentioned in the Kyoto Protocol, they are not relevant for that purpose.		
Verification and transparency	Not applicable, since an insignificant change is assumed	Both methods are transparent but difficult to verify, because of a lack of third party data	
Consistency with other sectors of guidelines	All the methods are consistent with the principles of the agricultural sector for attributing emissions, but they differ from the principle of the accounting for emissions from fossil fuels		
Understandability	Easy	More difficult, need to consider input and output fluxes	Less difficult, only need to add up stocks
Potential for adaptability	Yes, can include wood products	Yes, but more complex	Yes, but more complex
Ability to gauge effects of national measures	Not applicable, since an insignificant change is assumed	Yes, this method has the greatest ability, since it accounts for fluxes in processes	Yes, but less so because only stocks are measured.
Consistency with sustainable forest management	Yes, but this is limited by the assumption of little change in the product pool	Yes (most consistent)	Yes (but somewhat less than flux methods)
Ability to use as a basis for projections	Not applicable, since no estimate of emissions is made	Yes, future fluxes in processes can be projected	No (does not provide sufficient information)
Policy relevance			
Usefulness as a national planning tool	No	Yes, as above for national measures	Limited, as above for national measures
Ability to track effects of measures (cause & effect relationship)	Not applicable, no estimate made	Yes, as above for national measures	Yes, as above for national measures
Applying approaches at different scales	See above		

Evaluation of the production approach

Chair: Bill Hohenstein
Rapporteur: Tony Weir

Summary

The philosophy of this approach is: "What does our national forest industry/production contribute to global emissions?"

Description of the approach

The default method in the Production approach would be equivalent to the current IPCC *Guidelines*. Emissions in a given year would be equal to the amount harvested from the forest for that year.

$$\sum Harvesting_{National} = \sum Emissions_{National}$$

The Tier 1 method, referred to as a potential emissions method, would assume that the emissions in the base year are equal to the sum of emissions from all the wood-products classes minus the fraction which would be permanently sequestered

> Tier 1 method = Potential emissions, that is everything that is not "permanently" sequestered. Permanently sequestered, e.g. lignin in landfills lasts at least 50 years.

$$\sum_{\text{Pr}oducts} Harvest_{1990} * (1 - \%Sequestered_{Permanently}) = Emissions_{1990}$$

The Tier 2 method, referred to as an actual emissions method, would take account of inherited emissions. The emissions in the base year would be equal to the sum of emissions over the product classes in that year plus the sum of emissions from release of stored carbon in the products pool from the previous 30 years.

> Tier 2 method = "Actual emissions, allowing for inherited emissions"

$$\sum_{Time}^{\text{Pr}oduct} Harvest_{\text{Pr}oduct,Time} (\%Sequestered_{time(1990)} - \%Sequestered_{Time(30\,years)}) = Emissions_{1990}$$

> Note: In Tiers 1 and 2, the percent decays are those values of the harvesting country regardless of where the wood product actually decays.

In the Tier 3 method, country-specific decay rates would be used, so the decay of exported wood products in other countries would be considered. Emissions in the base year would be equal to the sum of emissions from that year plus the sum of inherited emissions from the previous 30 years which have been multiplied by country-specific decay rates.

> Tier 3 method = Actual emissions, allowing for inherited emissions, with country-specific decays. This is Tier 2 but with the decay rates being those of the country where the product actually decays. This could also include a greater disaggregation of product classes than in Tier 2.

$$\boxed{Tier2 + DecayFunctions_{CountrySpecific} = Emissions_{1990}}$$

Note: Tier 3 is an idealisation for comparison. It would be very difficult to apply and is unlikely to be used in practice.
For Tiers 1, 2 and 3 product classes might be: long-lived and short-lived forest products; or an expanded set such as: long and short-lived, landfilled forest products and biofuels. In all cases, the entire harvest must be covered.

Summary of key features

- We have established a clear set of tiers with the potential for adaptability and continued improvement.
- This approach would be relatively inexpensive with respect to data collection.
  ⇒ it does not require import/export data for the default and Tier 1 methods
  ⇒ it does not require decay rates for the default and Tier 1 methods.
- Compared to the current IPCC approach, the effect on the national inventories:
  ⇒ changes in time
  ⇒ does not change very much in space (i.e. the permanent sequestration)
- This approach can be seen as a transitional approach between the current IPCC *Guidelines* and the full atmospheric-flow approach or the stock-change approach.
- A drawback of this approach is the exporting country remains responsible for the ultimate fate of emissions from exported wood products. This means an importing country may have little incentive to improve the management of imported wood products.
- Another drawback of the approach is that measures to minimise waste may not be detectable in the inventory of a wood importing country. This means an importing country may have little incentive to improve the waste management of imported wood products.
- With regard to estimating the effects of measures - exports may scale on domestic, but importers have no incentive to improve the use of forest products.
- The verifiability, accuracy and other technical criteria are similar to the other approaches.
- This approach is consistent with how stored carbon in plastics is treated in the IPCC *Guidelines*.
- This approach can easily be applied at different scales (project, national level).

Table A2-3: Evaluating the production approach for estimating emissions from harvested wood products: advantages and disadvantages

Criteria	IPCC default method	Tier 1	Tier 2	Tier 3
Feasibility				
Complexity of approach	Ranked 1	Ranked 2	Ranked 3	Ranked 4 (most complex)
Availability of data	Needs only the harvest, always available (FAO)	Harvest, and decay coefficients (latter available for many Annex 1 countries)	As for Tier 1 but need decay rates over time.	As for Tier 2 but need decay functions in importing countries as well
Cost and ease of data collection	Easy	Easy	More difficult	Most difficult
Availability of national expertise	Already in place	Decay coefficients could be put in IPCC *Guidelines*	Time series of past harvest either available or not	Time series of past harvest either available or not
Applicability at various spatial scales	Easy	Easy	Difficult to scale globally but easier at the project level	In principle scaleable but may not be practical
Accuracy of approaches				
Assumptions in the approach	Probably overestimates emissions	Slightly more precise	Increasing precision, assuming decay functions are correct	Best precision if all data are available, but could be worse if bad assumptions made
Quality of underlying data	Reasonable	Decay functions fair	Decay functions worse, landfill composition important	Decay functions worst
Applicability at various spatial scales	Adequate	Adequate	Best at national scale	Best at national scale
Precision of definitions	This is good for all the methods			
Completeness of accounting	Only accounts for domestic wood			
	Good	No international double counting, except potential overlap with waste module	No international double counting, except potential overlap with waste module	No international double counting, except potential overlap with waste module
Uncertainty of emissions estimates	For all methods, this depends on data quality			
Scientific acceptability	Fair, as it does not account for emissions when and where they occur	Slightly better, gives where but not when	Better, when correct but where still inaccurate	Better than Tier 2 for when.
Repeatability of estimates	This is good for all methods, if underlying data are published			
Potential for continued inventory improvement	No	Better, more product classes	Even better, better decay functions	Best
Consistency of approaches at various spatial and temporal scales, and across tiers	The spatial and temporal consistency for all methods is good. The consistency across tiers is good between countries, but single country cannot switch between methods at random			

Relevance to the reporting needs of the UNFCCC and the Kyoto Protocol				
Types of approaches	All methods appear consistent with the Kyoto Protocol, Article 3.3			
Verification	Easy	No independent estimates		
Transparency	Good	Good		
Applicability at various spatial scales	Simple but may be inaccurate at project level	Simple but may be inaccurate at project level		
Consistency with other sectors of the *Guidelines*	Not with fossil fuels	Not with fossil fuels		
Understandability	Good for all			
Potential for adaptability	Ability to move up the tiers and introduce new product classes			
Ability to gauge the effects of national measures	Only domestically	Importer has no incentive to improve	Importer has no incentive to improve	Yes, in principle
Consistency with sustainable forest management	All methods appear consistent with sustainable forest management in Annex 1 countries			
Ability to use as basis for projections	As above, for national measures			
Policy relevance				
Applying approaches at various spatial scales	As above			
Usefulness as national planning tool	---	Gives incentive for import substitution	Gives incentive for import substitution	Gives incentive for import substitution
Effect on national inventory totals compared to current approach	No change	Small (% permanent sequestration)	Mainly in time (small effect in place)	Mainly in time (small effect in place)