Methodology in IPCC’s GPG-LULUCF

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Method 1 (also called the **default method**) requires the biomass carbon loss to be subtracted from the biomass carbon increment for the reporting year (Equation 3.2.2).

EQUATION 3.2.2
ANNUAL CHANGE IN CARBON STOCKS IN LIVING BIOMASS IN FOREST LAND REMAINING FOREST LAND (DEFAULT METHOD)

$$\Delta C_{FF_{LB}} = (\Delta C_{FF_G} - \Delta C_{FF_L})$$

Where:

$\Delta C_{FF_{LB}}$ = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr^{-1}

ΔC_{FF_G} = annual increase in carbon stocks due to biomass growth, tonnes C yr^{-1}

ΔC_{FF_L} = annual decrease in carbon stocks due to biomass loss, tonnes C yr^{-1}

Revised 1996 IPCC Guide lines for National Greenhouse Gas Inventories, Reference Manual, Chapter 5: Land-use Change &Forestry

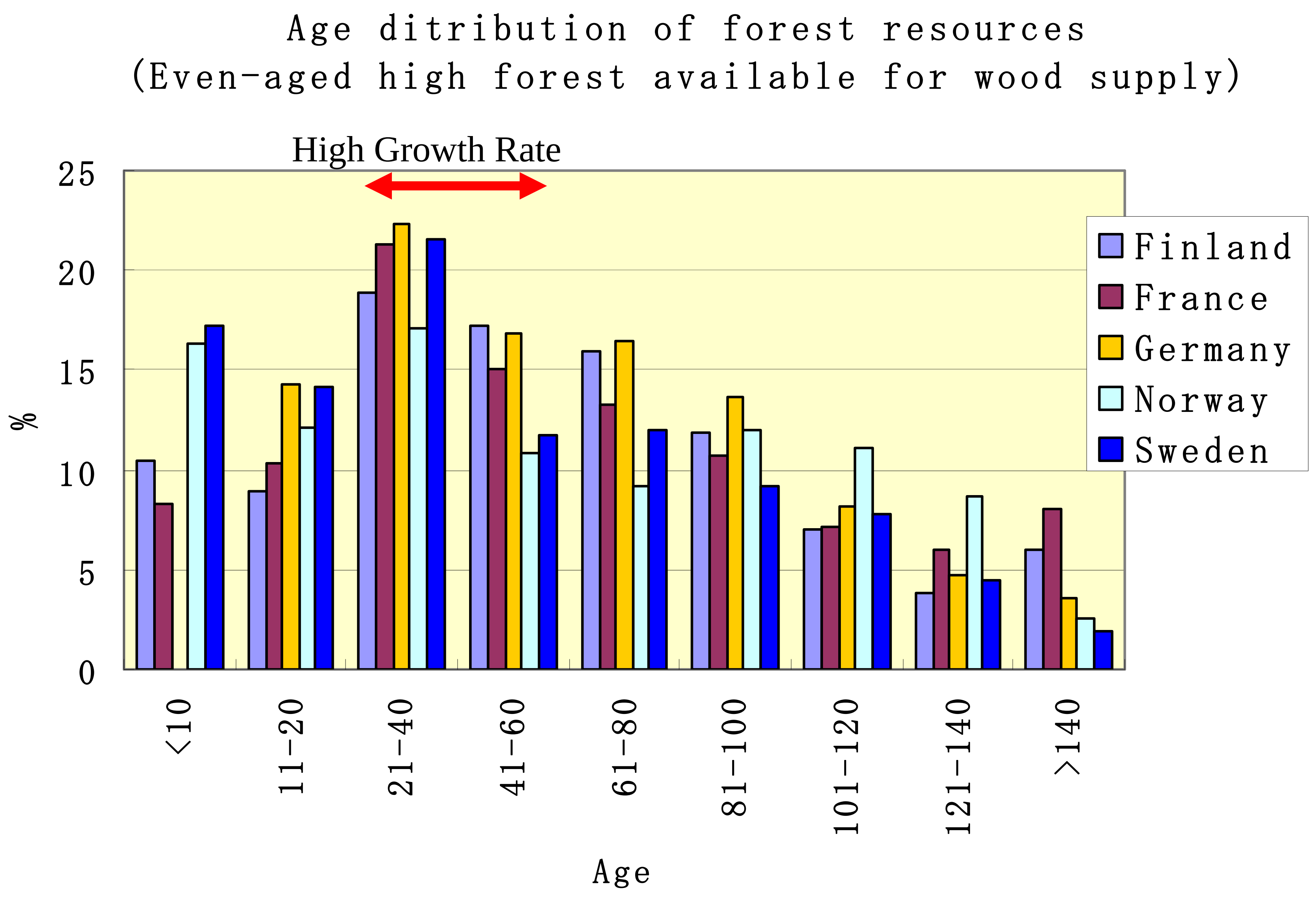
- page 5.17
- Changes in forest and other woody biomass stocks may be either a source or a sink for carbon dioxide for a given year and country or region. The simplest way to determine which, is by comparing the annual biomass growth versus annual harvest, including the decay of forest products and slash left during harvest. Decay of biomass damaged or killed during logging results in short-term release of CO2. For the purposes of the basic calculations, the recommended default assumption is that all carbon removed in wood and other biomass from forests is oxidised in the year of removal. This is clearly not strictly accurate in the case of some forest products, but is considered a legitimate, conservative assumption for initial calculations. Box 5 provides some further discussion of this issue.

Box 5
The Fate of Harvested Wood

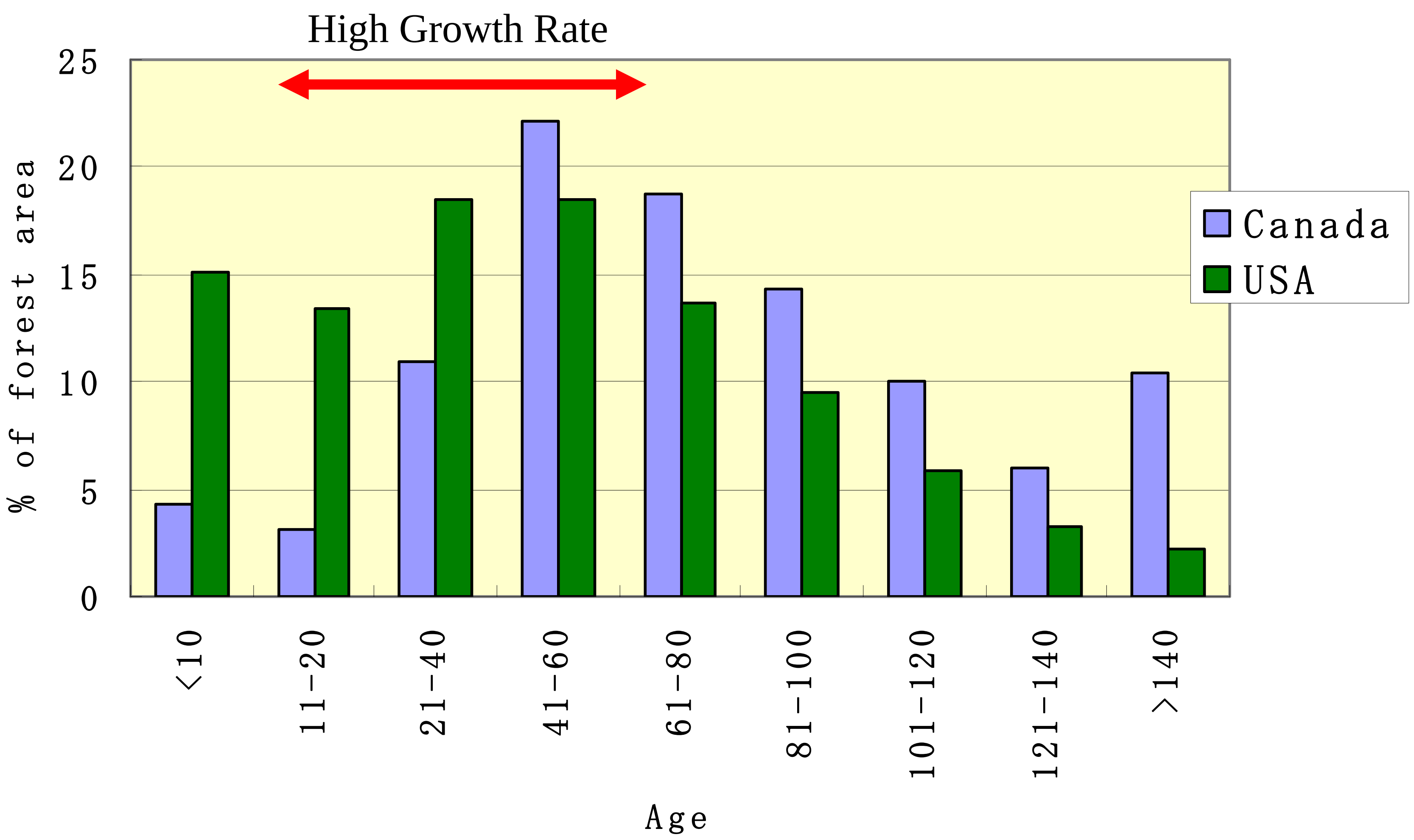
Harvested wood releases its carbon at rates dependent upon its method of processing and its end-use: waste wood is usually burned immediately or within a couple of years, paper usually decays in up to 5 years (although landfilling of paper can result in longer-term storage of the carbon and eventual release as methane or CO), and lumber decays in up to 100 or more years. Because of this latter fact, forest harvest (with other forms of forest management) could result in a net uptake of carbon if the wood that is harvested is used for long-term products such as building lumber, and the regrowth is relatively rapid. This may in fact become a response strategy.

For the initial calculations of CO_2 emissions from changes in forest and other woody biomass stocks, however, the recommended default assumption is that all carbon in biomass harvested is oxidised in the removal year. This is based on the perception that stocks of forest products in most countries are not increasing significantly on an annual basis. It is the net change in stocks of forest products which should be the best indicator of a net removal of carbon from the atmosphere, rather than the gross amount of forest products produced in a given year. New products with long lifetimes from current harvests frequently replace existing product stocks, which are in turn discarded and oxidised. The proposed method recommends that storage of carbon in forest products be included in a national inventory only in the case where a country can document that existing stocks of long term forest products are in fact increasing.

If data permit, one could add a pool to Equation 1 (1) in the changes in forest and other woody biomass stocks calculation to account for increases in the pool of forest products. This information would, of course, require careful documentation, including accounting for imports and exports of forest products during the inventory period.

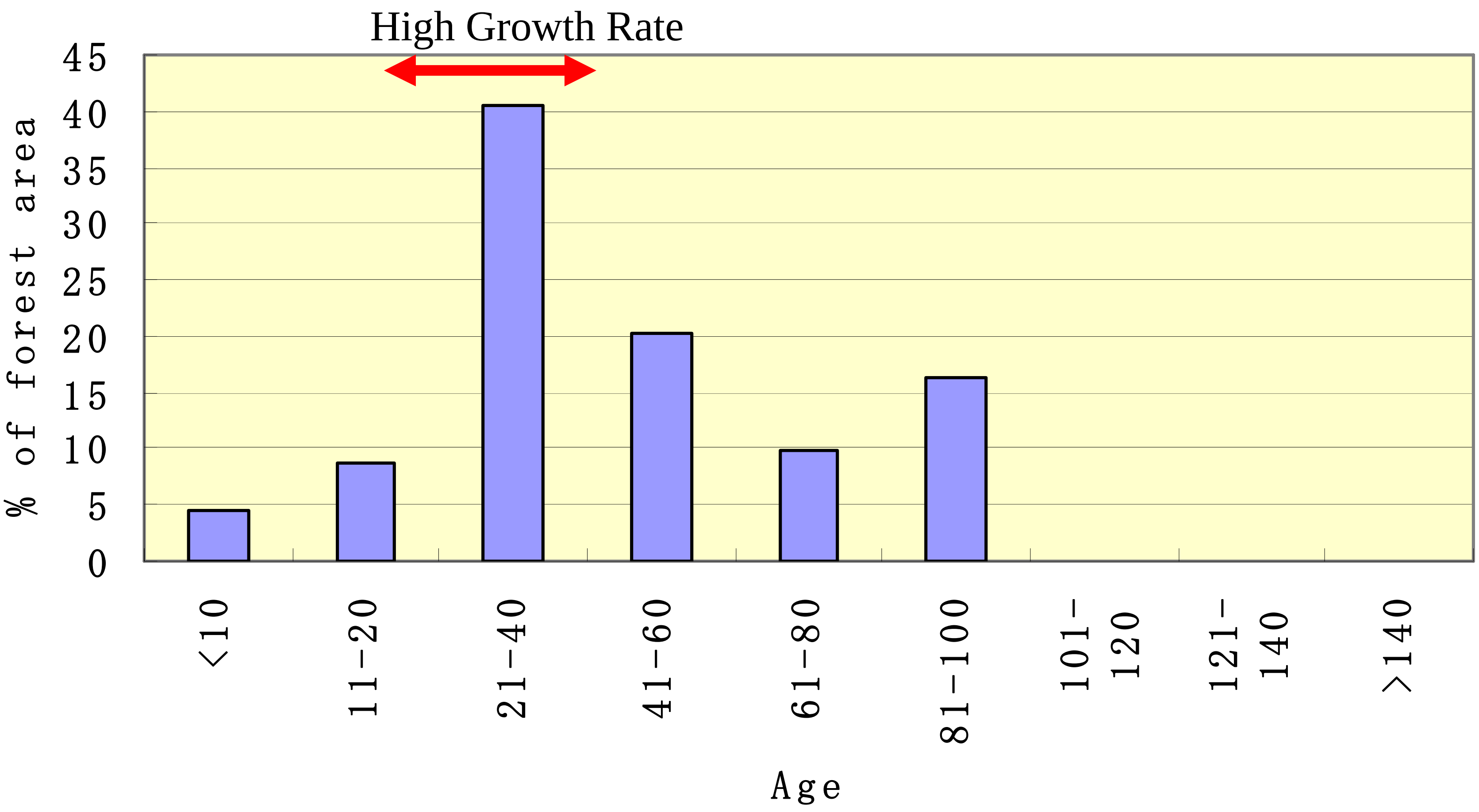

Age ditribution of forest resources
(Even-aged high forest available for wood supply)
High Growth Rate
25
20
15
10
5
0
%
Finland
France
Germany
Norway
Sweden
<10
11-20
21-40
41-60
61-80
81-100
101-120
121-140
>140
Age

Age distribution of forest resources (Even-aged high forest available for wood supply)

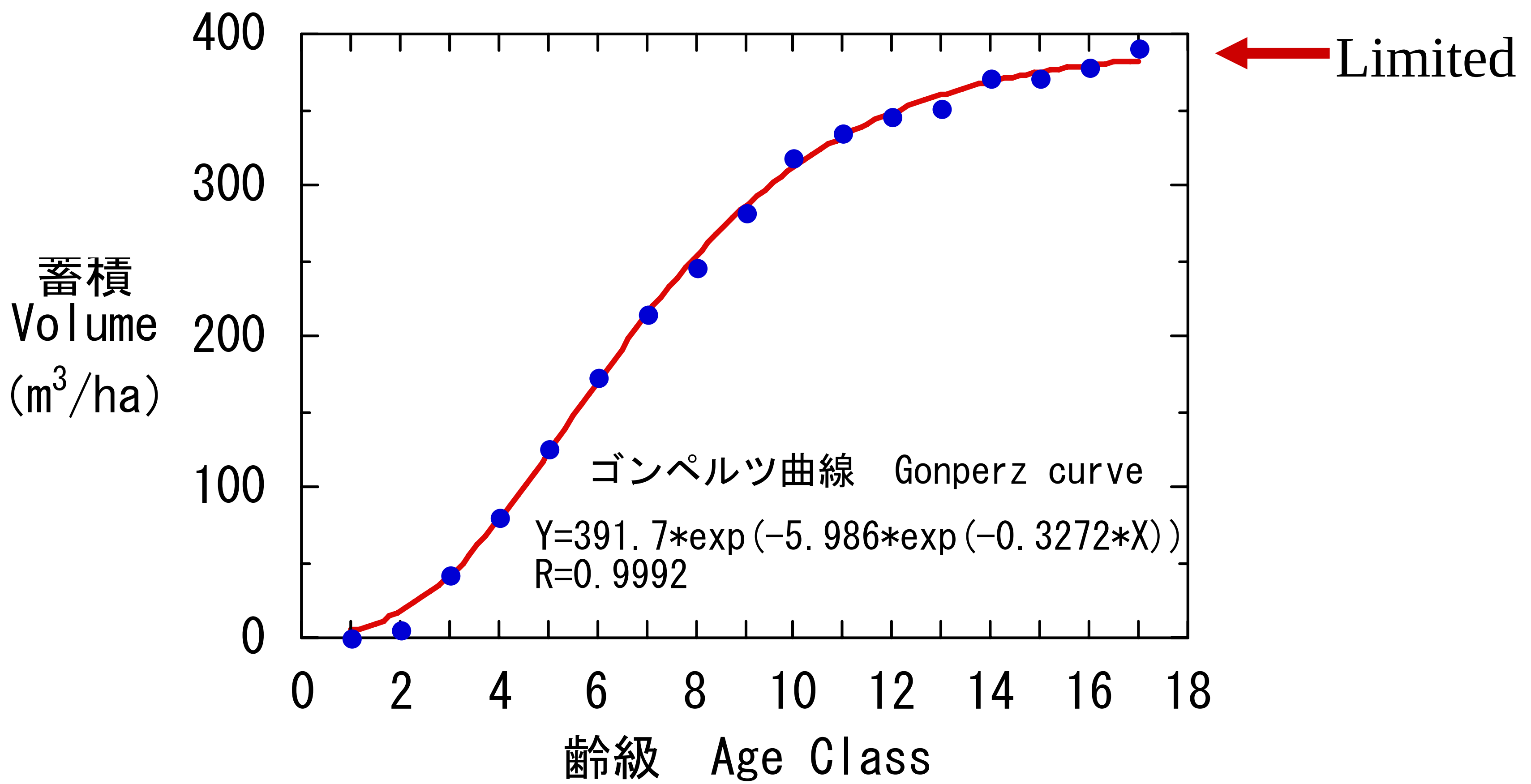


Source: TBFRA2000

Age distribution of Japanese forest resources
(Even-aged high forest available for wood supply)



Growth Pattern of Forests



Method 2 (also called the **stock change method**) requires biomass carbon stock inventories for a given forest area at two points in time. Biomass change is the difference between the biomass at time t_2 and time t_1, divided by the number of years between the inventories (Equation 3.2.3).

EQUATION 3.2.3
ANNUAL CHANGE IN CARBON STOCKS IN LIVING BIOMASS IN FOREST LAND REMAINING FOREST LAND (STOCK CHANGE METHOD)

$$\Delta C_{FF_{LB}} = (C_{t_2} - C_{t_1}) / (t_2 - t_1)$$

and

$$C = [V \bullet D \bullet BEF_2] \bullet (1 + R) \bullet CF$$

Where:

$\Delta C_{FF_{LB}}$ = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr^{-1}

C_{t_2} = total carbon in biomass calculated at time t_2, tonnes C

C_{t_1} = total carbon in biomass calculated at time t_1, tonnes C

V = merchantable volume, m^3 ha^{-1}

D = basic wood density, tonnes d.m. m^{-3} merchantable volume

BEF_2 = biomass expansion factor for conversion of merchantable volume to aboveground tree biomass, dimensionless.

R = root-to-shoot ratio, dimensionless

CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

EQUATION 3.2.4

ANNUAL INCREASE IN CARBON STOCKS DUE TO BIOMASS INCREMENT IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_G} = \sum_{ij} (A_{ij} \bullet G_{TOTAL_{ij}}) \bullet CF$$

Where:

ΔC_{FF_G} = annual increase in carbon stocks due to biomass increment in forest land remaining forest land by forest type and climatic zone, tonnes C yr^{-1}

A_{ij} = area of forest land remaining forest land, by forest type (i = 1 to n) and climatic zone (j = 1 to m), ha

$G_{TOTAL_{ij}}$ = average annual increment rate in total biomass in units of dry matter, by forest type (i = 1 to n) and climatic zone (j = 1 to m), tonnes d.m. ha^{-1} yr^{-1}

CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

EQUATION 3.2.6

ANNUAL DECREASE IN CARBON STOCKS DUE TO BIOMASS LOSS IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_L} = L_{fellings} + L_{fuelwood} + L_{other\ losses}$$

Where:

ΔC_{FF_L} = annual decrease in carbon stocks due to biomass loss in forest land remaining forest land, tonnes C yr^{-1}

$L_{fellings}$ = annual carbon loss due to commercial fellings, tonnes C yr^{-1} (See Equation 3.2.7)

$L_{fuelwood}$ = annual carbon loss due to fuelwood gathering, tonnes C yr^{-1} (See Equation 3.2.8)

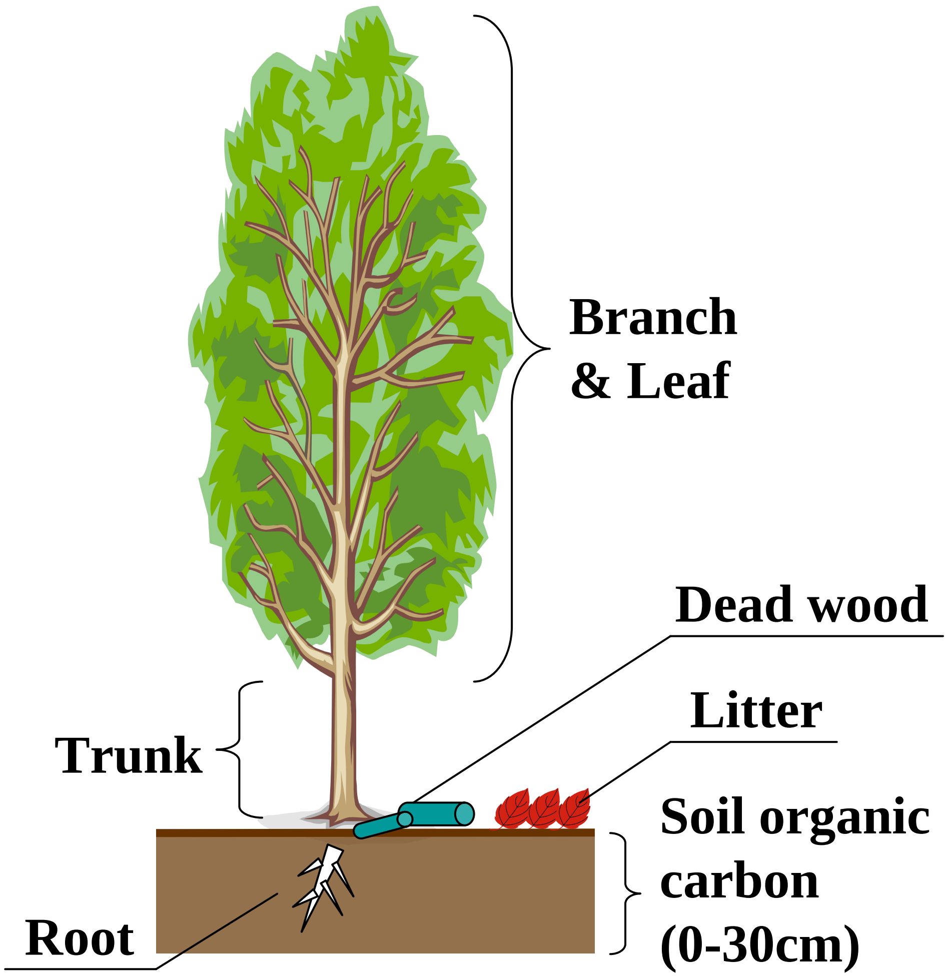
$L_{other\ losses}$ = annual other losses of carbon, tonnes C yr^{-1} (See Equation 3.2.9)

Default method <<<>>> Stock change method

IPCC GPG-LULUCF

- In general the stock change method will provide good results relatively where very accurate forest inventories are carried out.
- The stock change method has a risk of the inventory error.
- Under some conditions incremental data may give better results.
- The choice of using default or stock change method at the appropriate tier level will therefore be a matter for expert judgment, taking the national inventory systems and forest properties into account.

Carbon pools defined by IPCC

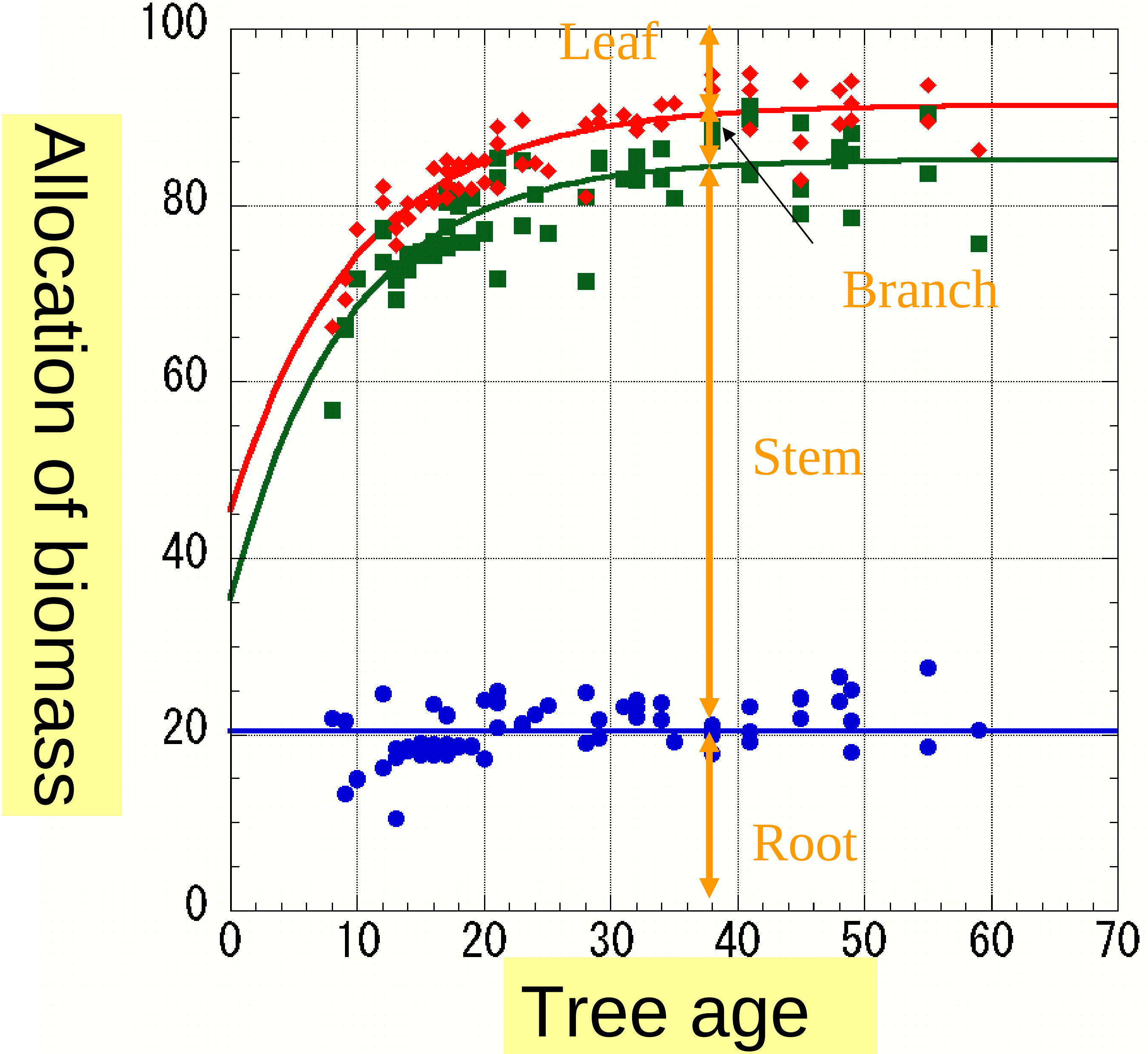


Carbon pools		Method for measurement	Feasibility (Cost)
Above ground biomass	Branch & Leaf	Use of parameter	○
	Trunk	Direct measurement	◎
Below ground biomass	Root	Sampling survey & model	△
Dead wood		Sampling survey & model	△
Litter		Sampling survey & model	△
Soil organic carbon		Sampling survey & model	△

COP9 decision paper

- **Projects participants shall account for all changes in the following carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon.**
- **Projects participants may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that the pool is not a source.**

Proportion of stem, branch, leaf and root of a single layer conifer biomass



Relationships between age and expansion ratios

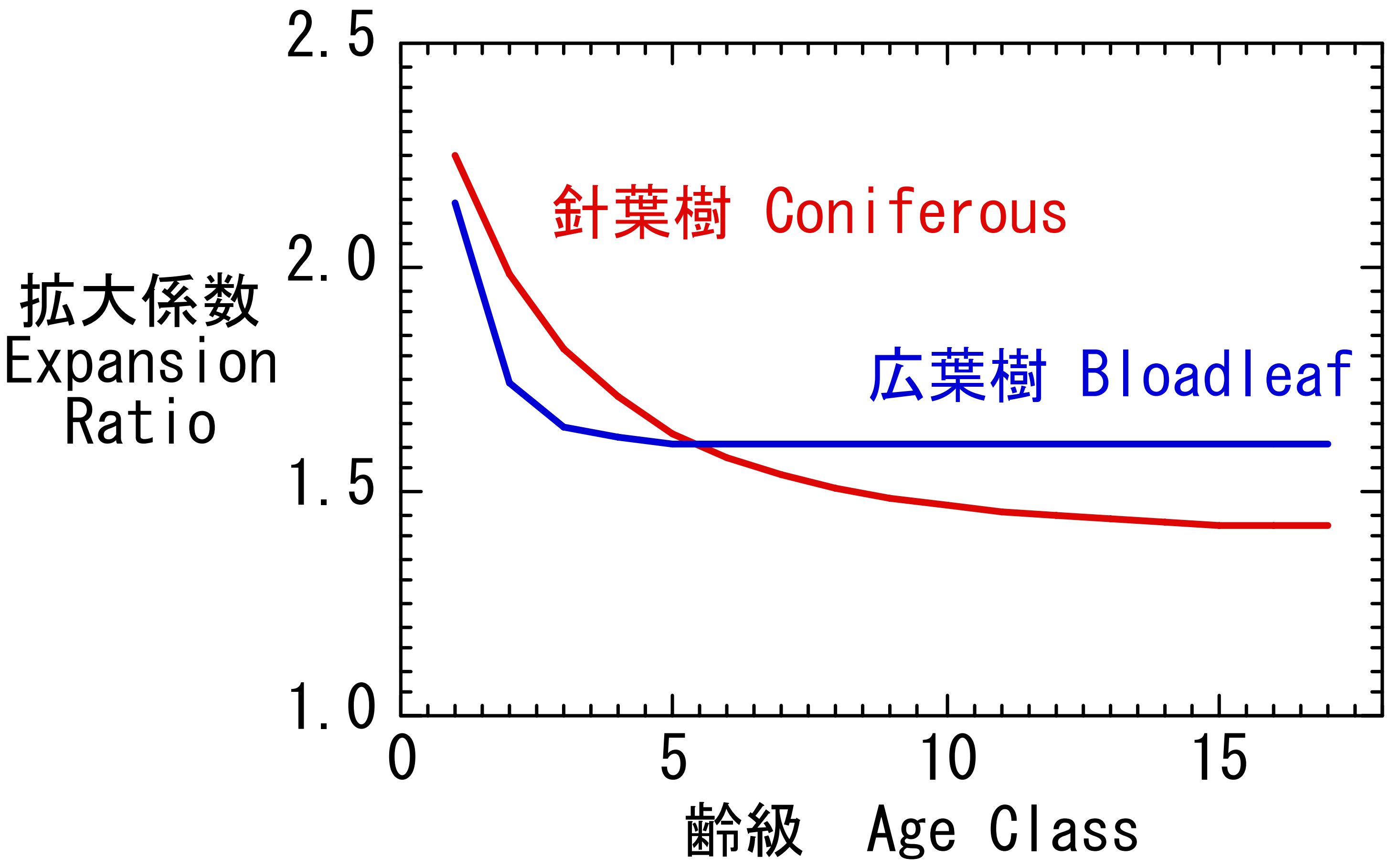


TABLE 3A.1.2

ABOVEGROUND BIOMASS STOCK IN NATURALLY REGENERATED FORESTS BY BROAD CATEGORY (tonnes dry matter/ha)

(To be used for Bw in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in Cropland section and for $L_{conversion}$ in Equation 3.4.13. in Grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3)

Tropical Forests [1]						
	Wet	**Moist with Short Dry Season**	**Moist with Long Dry Season**	**Dry**	**Montane Moist**	**Montane Dry**
Africa	310 (131 - 513)	260 (159 – 433)	123 (120 - 130)	72 (16 - 195)	191	40
Asia & Oceania:						
Continental	275 (123 - 683)	182 (10 – 562)	127 (100 - 155)	60	222 (81 - 310)	50
Insular	348 (280 - 520)	290	160	70	362 (330 - 505)	50
America	347 (118 - 860)	217 (212 - 278)	212 (202- 406)	78 (45 - 90)	234 (48 - 348)	60

TABLE 3A.1.5
AVERAGE ANNUAL INCREMENT IN ABOVEGROUND BIOMASS IN NATURAL REGENERATION BY BROAD CATEGORY
(tonnes dry matter/ha/year)

(To be used for G_W in Equation 3.2.5)

Tropical and Sub-Tropical Forests						
Age Class	**Wet**	**Moist with Short Dry Season**	**Moist with Long Dry Season**	**Dry**	**Montane Moist**	**Montane Dry**
Asia & Oceania						
Continental						
≤20 years	7.0 (3.0 – 11.0)	9.0	6.0	5.0	5.0	1.0
>20 years	2.2 (1.3 – 3.0)	2.0	1.5	1.3 (1.0 – 2.2)	1.0	0.5
Insular						
≤20 years	13.0	11.0	7.0	2.0	12.0	3.0
>20 years	3.4	3.0	2.0	1.0	3.0	1.0

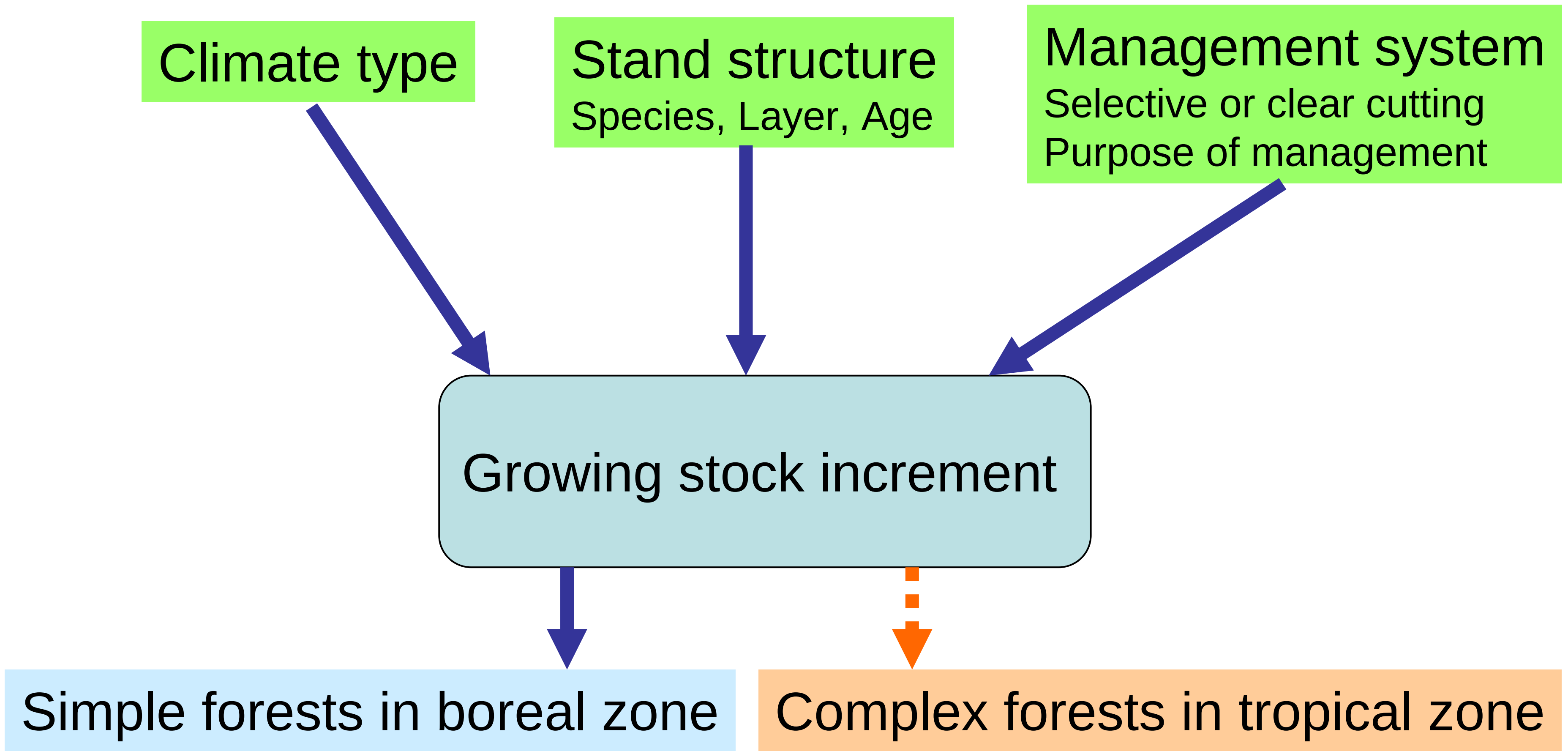
Table 3A.1.6

ANNUAL AVERAGE ABOVEGROUND BIOMASS INCREMENT IN PLANTATIONS BY BROAD CATEGORY (tonnes dry matter/ha/year)

(To be used for G_W in Equation 3.2.5.
In case of missing values it is preferred to use stemwood volume increment data I_V from Table 3A.1.7)

Tropical and sub-tropical Forests							
	Age Class	**Wet**	**Moist with Short Dry Season**	**Moist with Long Dry Season**	**Dry**	**Montane Moist**	**Montane Dry**
		R >2000	**2000>R>1000**		**R<1000**	**R>1000**	**R<1000**
Asia							
Eucalyptus spp	All	5.0 (3.6-8.0)	8.0	15.0 (5.0-25.0)	-	3.1	-
other species	-	5.2 (2.4-8.0)	7.8 (2.0-13.5)	7.1 (1.6-12.6)	6.45 (1.2-11.7)	5.0 (1.3-10.0)	-

Various types of forests with various management system



Conclusion

- Boreal and temperate zone
  - There are small differences of MAI between natural/plantation and among species.
  - Many stands have been composed of one or a few species.
  - There are a lot of man-made forests
- Tropical zone
  - There are big differences of MAI between natural/plantation and among species generally.
  - Many stands have been composed of various species.
  - There are a lot of natural regenerated forests and natural forests.

⬇

Forest Inventory in tropical zone requires more task than Temporal and boreal zone.