GHG emissions estimation from LULUCF sector

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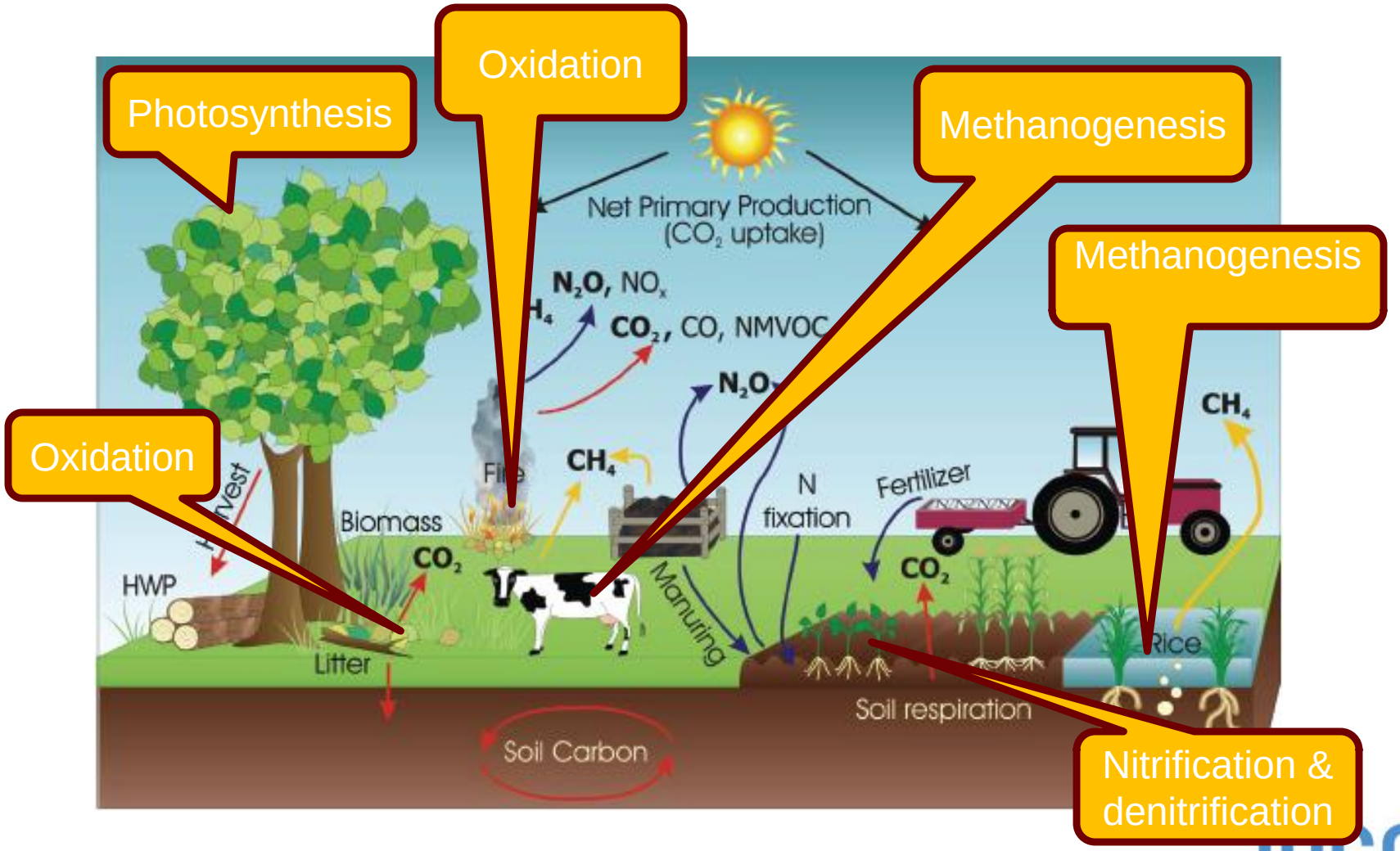
INTERGOVERNMENTAL PANEL ON climate change

Introduction

- Changes due to land use change and management of the biosphere have a significant influence on the greenhouse gas concentrations in the atmosphere.
- Processes accounting for emissions and removals in the biosphere are: photosynthesis, respiration, decomposition, nitrification/de-nitrification, enteric fermentation, and combustion that are driven by the biological activity and physical processes.
- Agriculture and land-use emissions and removals account for a very significant proportion of GHG emissions/removals in developing countries.

Terrestrial sources/sinks of GHGs



IPCC Guidelines for National Greenhouse Gas Inventories

- *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*
- *2000 Good Practice Guidance and Uncertainty Management (GPG2000)*
- *Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF)*
- *2006 IPCC Guidelines for National Greenhouse Gas Inventories*

Land-based emissions and removals

- Changes in land-use and management cause complex patterns of net fluxes that vary across space and time.
- Inventory methods have to be operational, practical and globally applicable while being scientifically sound
- IPCC Guidelines have taken the approach of defining anthropogenic greenhouse gas emissions by sources and removals by sinks as all those occurring on 'managed land'
- '*Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions*'
- Managed land has to be nationally defined and classified transparently and consistently over time
- GHG emissions/removals need not be reported for unmanaged land

A simple first order approach in the IPCC Guidelines

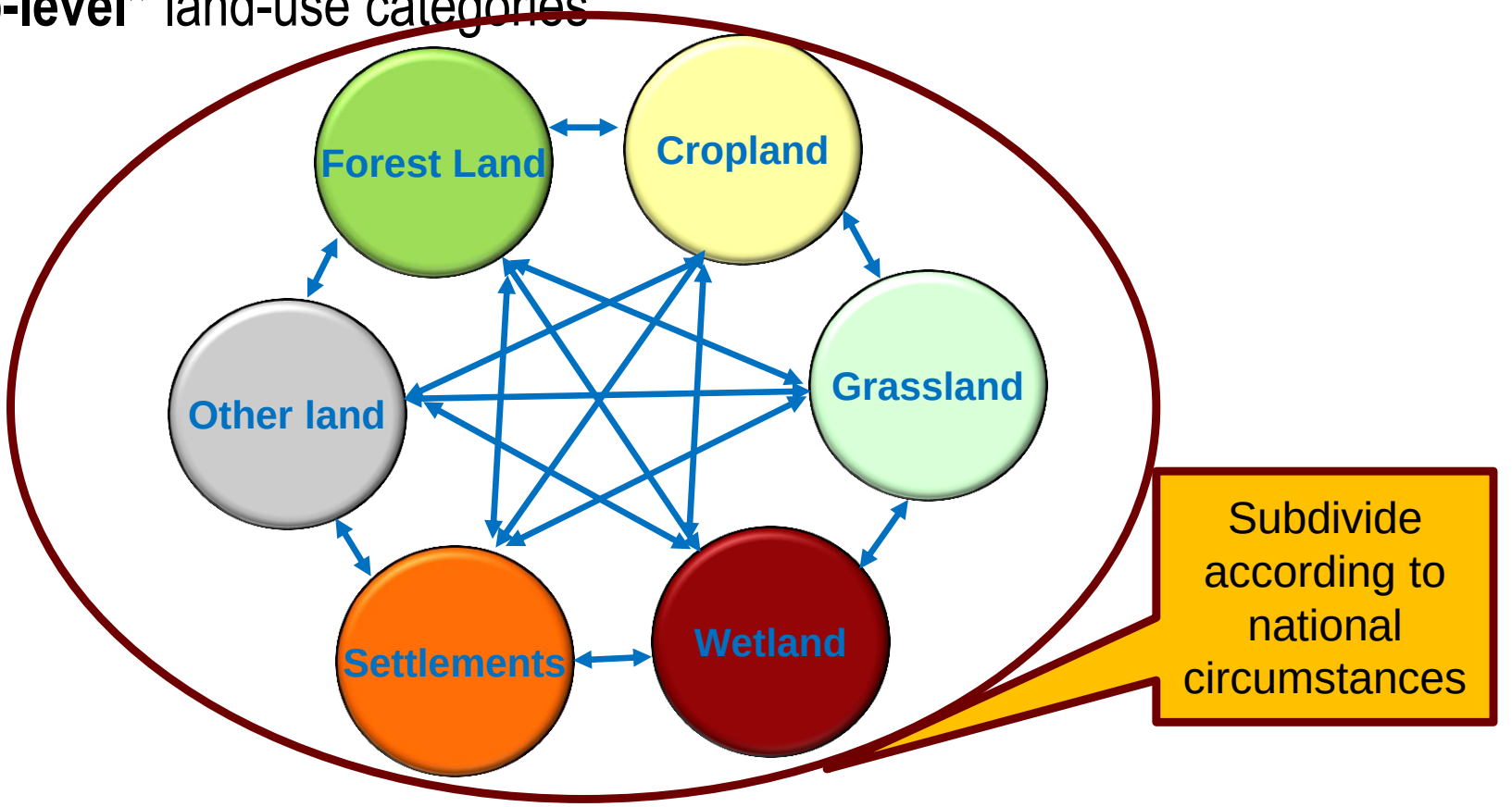
The IPCC Guidelines make two assumptions:

A) $C_{flux} = \Delta C_{stocks}$

B) Change in carbon stocks can be estimated from land use/change and management at various points in time, their impacts on carbon stocks and the biological response to them.

Six land-use categories

Stock changes of C pools are estimated and reported for the six "**top-level**" land-use categories



Carbon Pools

Living biomass

Above ground biomass

- All living biomass above the soil incl. stem, stump, branches, bark, seeds & foliage

Below ground biomass

-All living biomass of live roots, often excl. fine roots of less than (suggested) 2 mm dia.

Dead Organic Matter

Dead wood

-All non-living woody biomass not litter either standing, lying on the ground, or in the soil;

-Incl. surface wood, dead roots, stumps larger than dia. used by country to distinguish from litter (e.g., 10 cm).

Litter

-All non living biomass of dia. < chosen by the country (e.g., 10 cm) lying dead above soil;

- Incl. litter, fumic and humic layers & live fine roots > dia. used to distinguish below ground biomass (e.g., 2 mm).

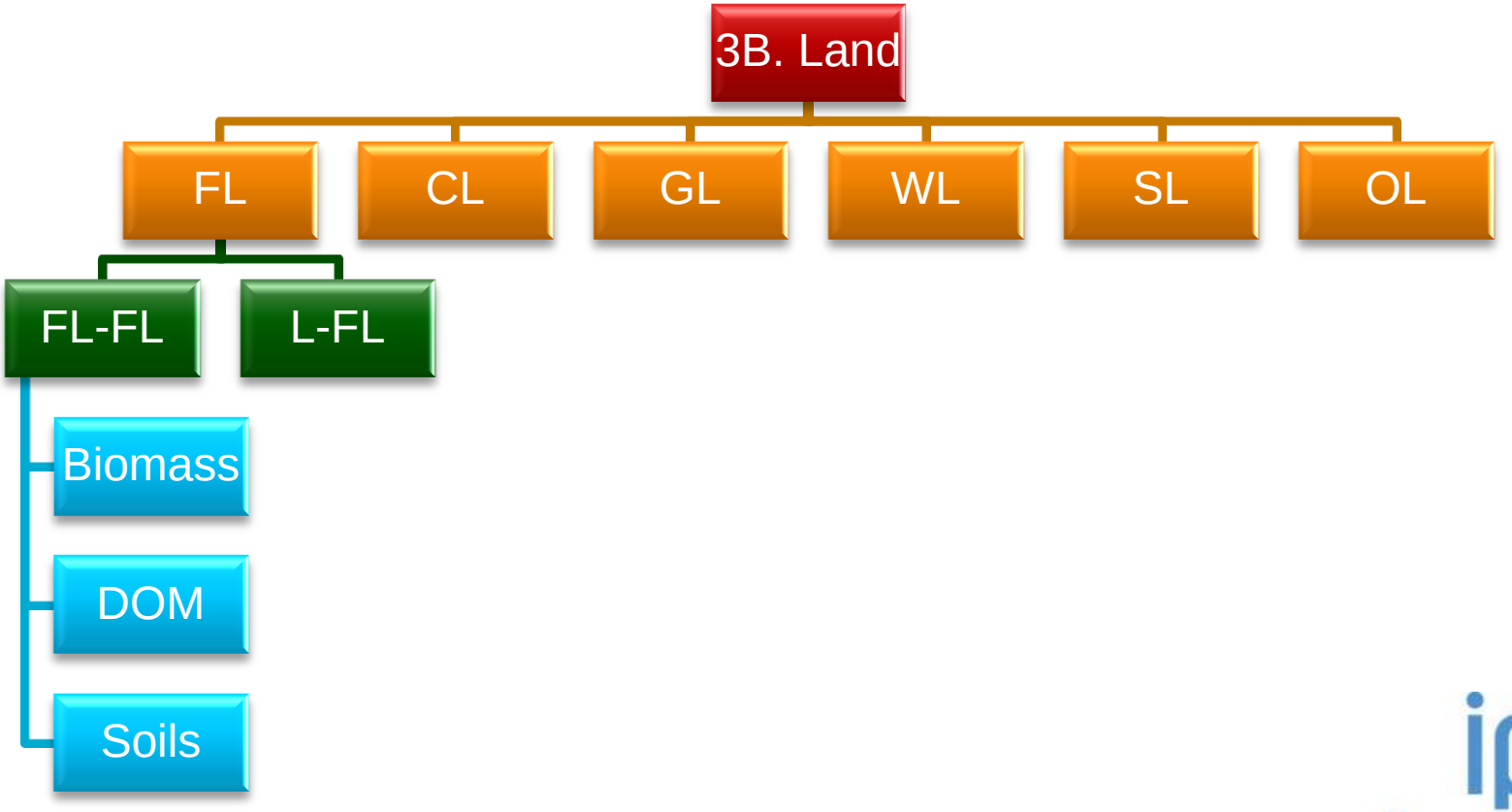
Soil C

organic C in mineral and organic soils (including peat) to a specified depth chosen by country (default depth 30 cm for Tier 1 & 2 methods)

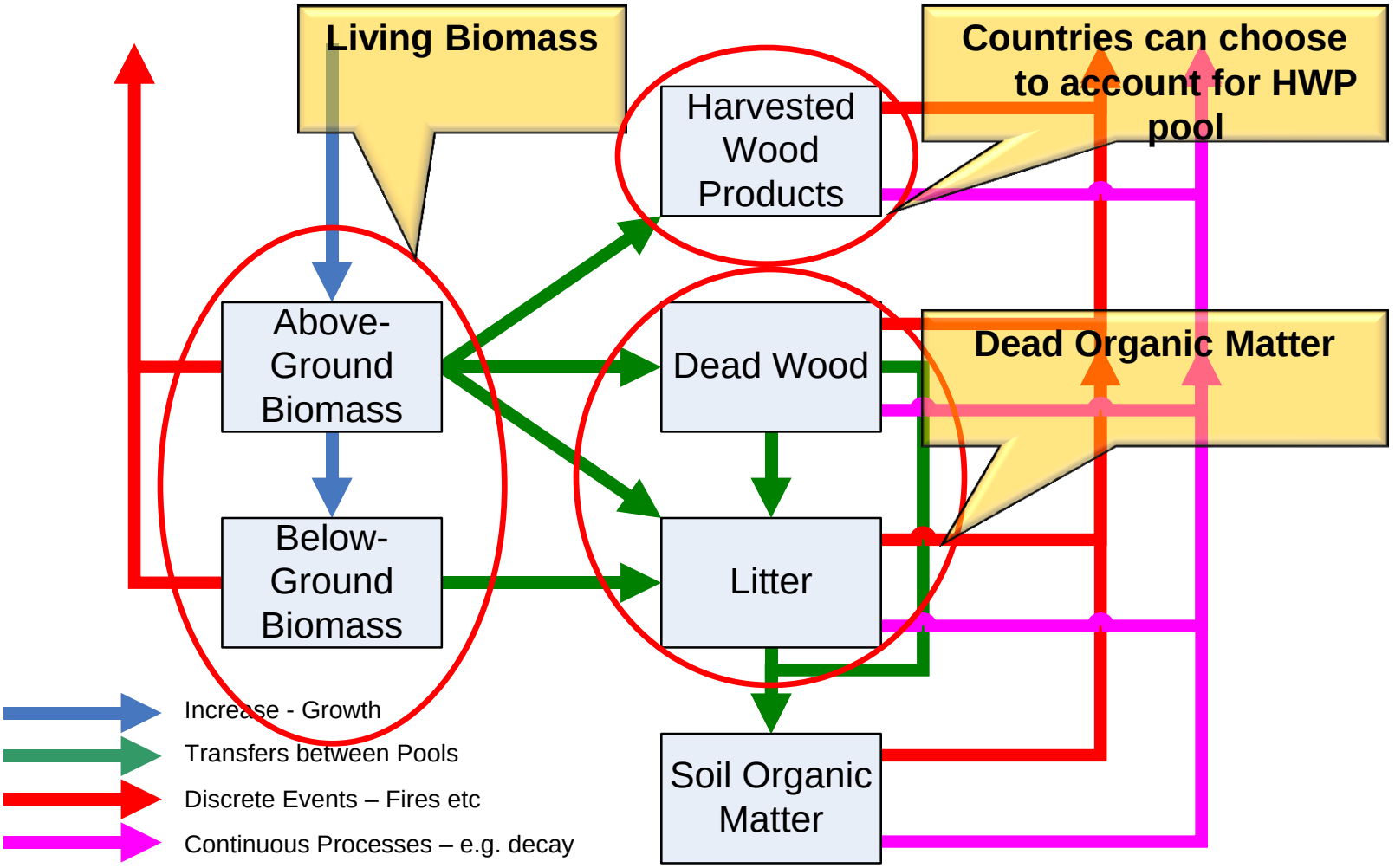
incl. live fine roots if cannot be distinguished empirically

Land-use subcategories and carbon pools

Each land-use category is further subdivided into **land remaining in that category** (e.g., FL-FL) and **land converted from one category to another** (e.g., FL-CL) for estimation of C stock changes The total CO2 emissions/removals from C stock changes for each LU category is the sum of those from these two subcategories.

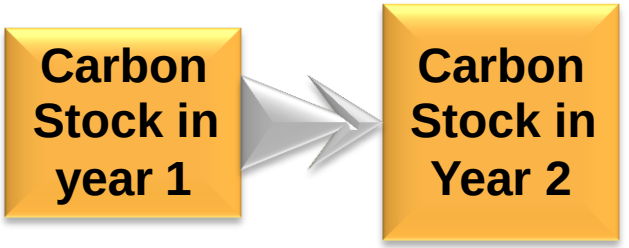


C pools


Living Biomass
Countries can choose to account for HWP pool
Harvested Wood Products
Above-Ground Biomass
Dead Wood
Dead Organic Matter
Below-Ground Biomass
Litter
Soil Organic Matter
Increase - Growth
Transfers between Pools
Discrete Events – Fires etc
Continuous Processes – e.g. decay

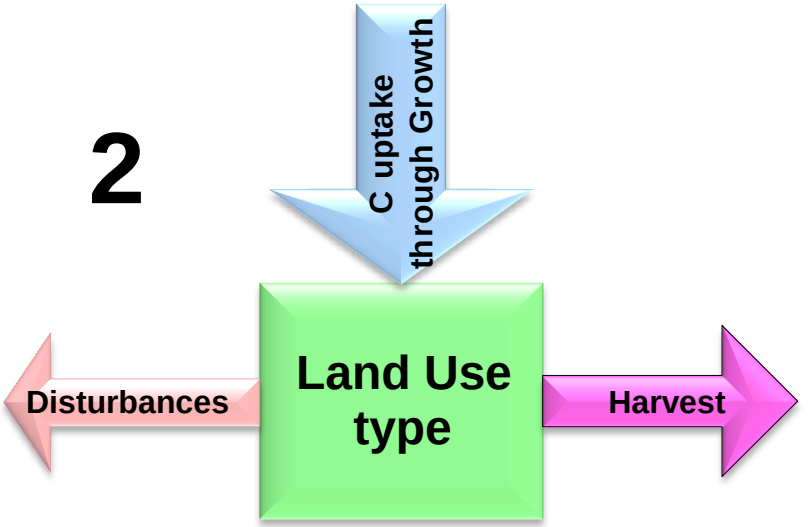
Estimating C stock changes

1



Difference between carbon stocks (Stock-Difference Method)

2



Sum of gains and losses (Gain-Loss Method)

Stock-Difference Method

- Stock-Difference Method can be used where carbon stocks in relevant pools are measured at two points in time to assess carbon stock changes

$$\Delta C = (C_2 - C_1)/(t_2 - t_1)$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

C_1 = carbon stock in the pool at time t_1, tonnes C

C_2 = carbon stock in the pool at time t_2, tonnes C

Gain-Loss Method

- Gains-Loss Method involves tracking inputs and outputs from a C pools: e.g., gains from growth (increase of biomass) and transfer of carbon from another pool (e.g., transfer of carbon from the live biomass carbon pool to the dead organic matter pool due to harvest or natural disturbances) and loss due to harvest and mortality.

$$\Delta C_{DOM} = \Delta C_G - \Delta C_L$$

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

ΔC_G = annual gain of carbon, tonnes C yr^{-1}

ΔC_L = annual loss of carbon, tonnes C yr^{-1}

Non-CO_2 Emissions

- The Non-CO_2 emissions rate is generally determined by an emission factor for a specific gas (e.g., CH_4, N_2O) and source category and an area (e.g., for soil or area burnt) that defines the emission

$$\textit{Emission} = A \bullet EF$$

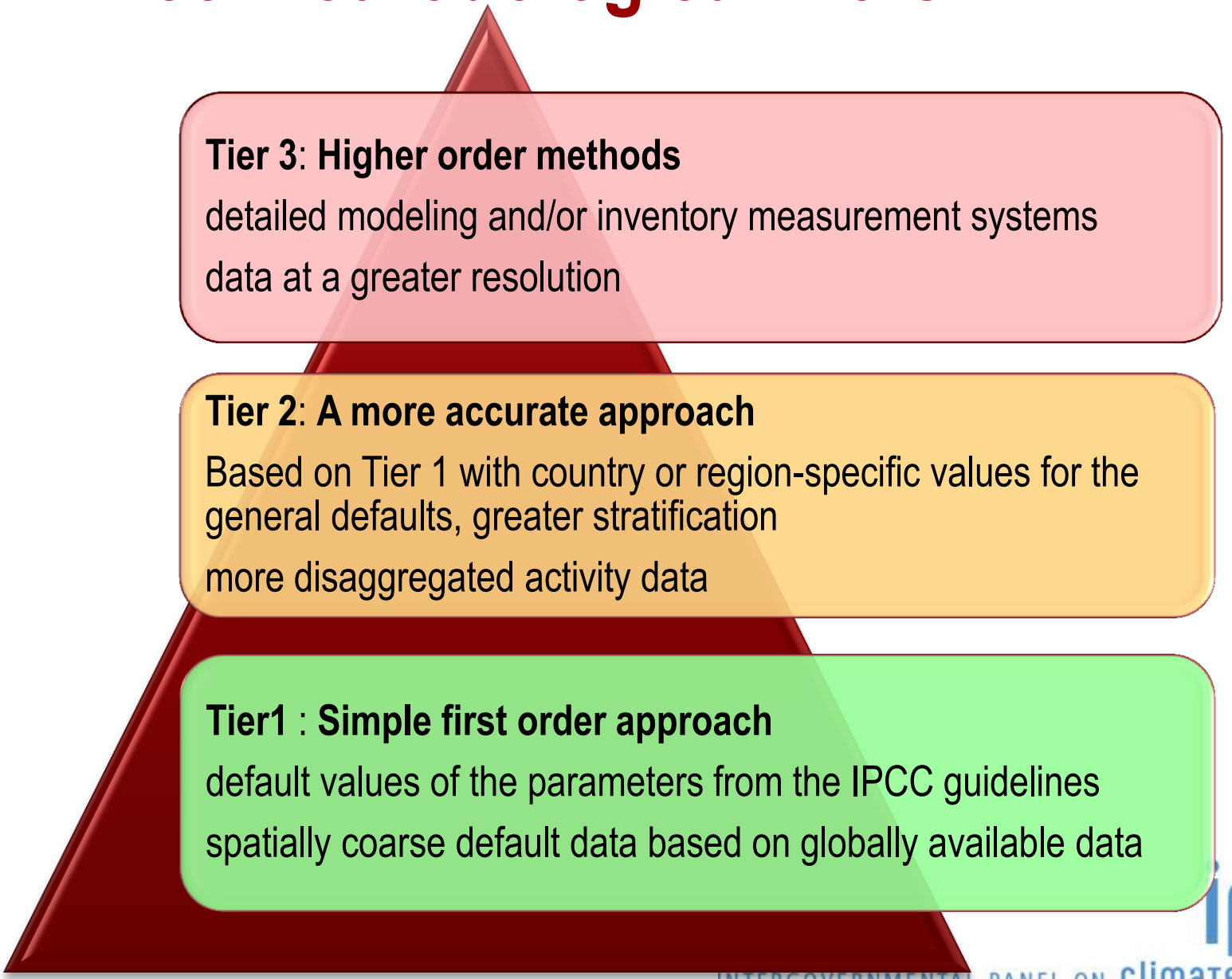
Where:

Emission = non-CO_2 emissions, tonnes of the non-CO_2 gas

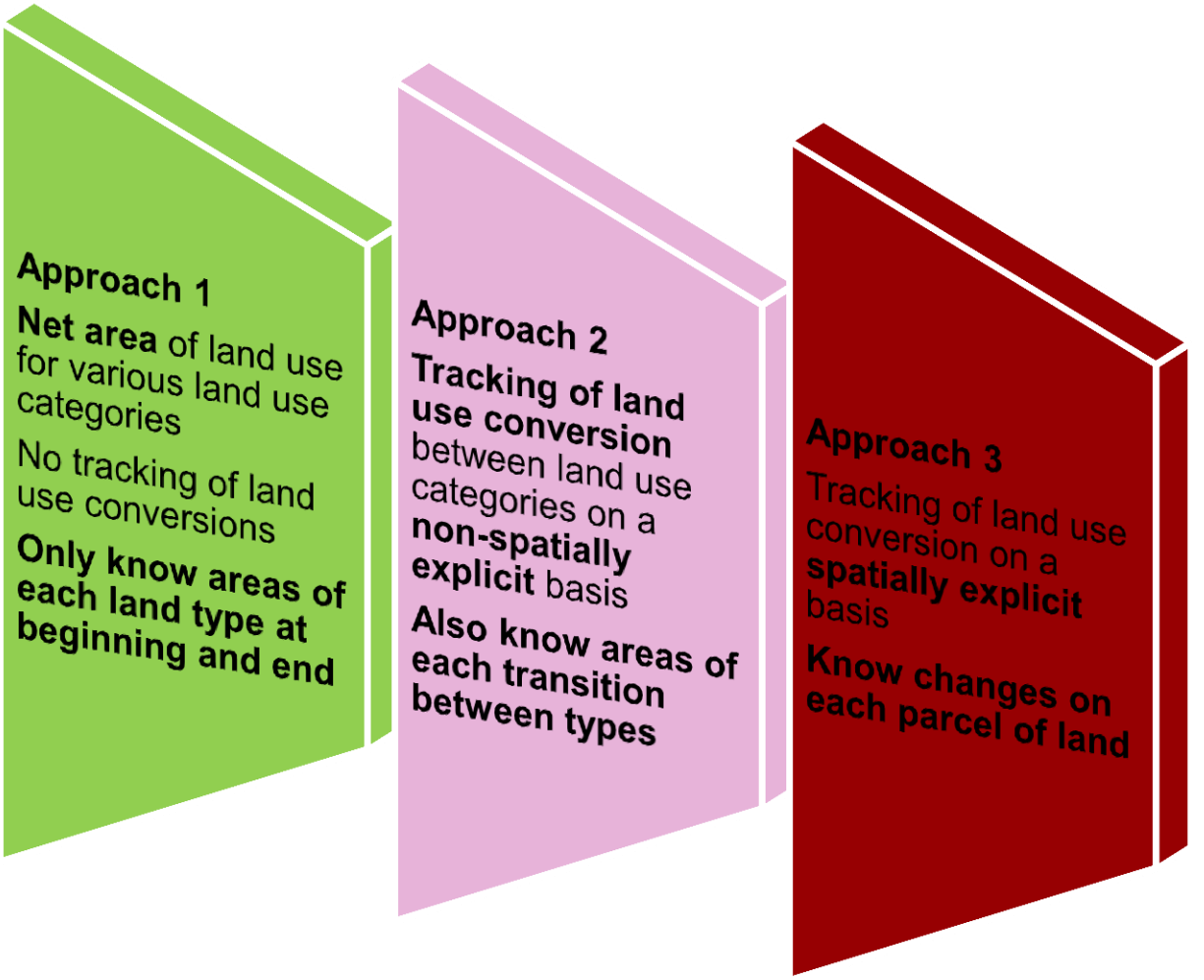
A = activity data relating to the emission source (can be area, or mass unit, depending on the source type)

EF = emission factor for a specific gas and source category, tonnes per unit of a source

Three methodological Tiers



Three approaches for Land Representation



Approach 1

TABLE 2.3.1
EXAMPLE OF APPROACH 1:
AVAILABLE LAND -USE DATA WITH COMPLETE TERRITORIAL COVERAGE

Time 1			Time 2			Land-Use Change between Time 1 and Time 2		
F	=	18	F	=	19	Forest	=	+1
G	=	84	G	=	82	Grassland	=	-2
C	=	31	C	=	29	Cropland	=	-2
W	=	0	W	=	0	Wetlands	=	0
S	=	5	S	=	8	Settlements	=	+3
O	=	2	O	=	2	Other land	=	0
Sum	=	*140*	*Sum*	=	*140*	*Sum*	=	*0*

Note: F = Forest land, G = Grassland, C = Cropland, W = Wetlands, S = Settlements, O = Other land. Numbers represent area units (Mha in this example).

Approach 2

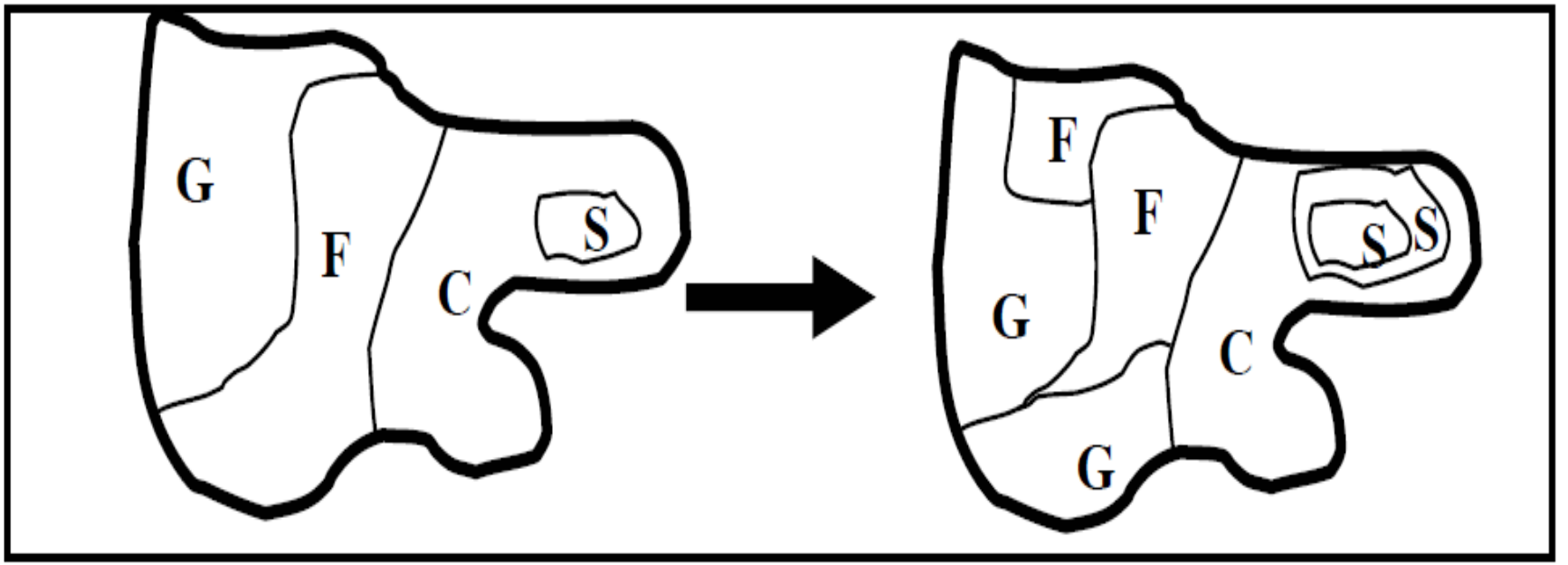
TABLE 2.3.5
SIMPLIFIED LAND-USE CHANGE MATRIX FOR EXAMPLE APPROACH 2

Land-Use Change Matrix

Final \ Initial	F	G	C	W	S	O	*Final sum*
F	**15**	3	1				***19***
G	2	**80**					***82***
C			**29**				***29***
W							
S	1	1	1		**5**		***8***
O						**2**	***2***
Initial sum	***18***	***84***	***31***		***5***	***2***	*140*

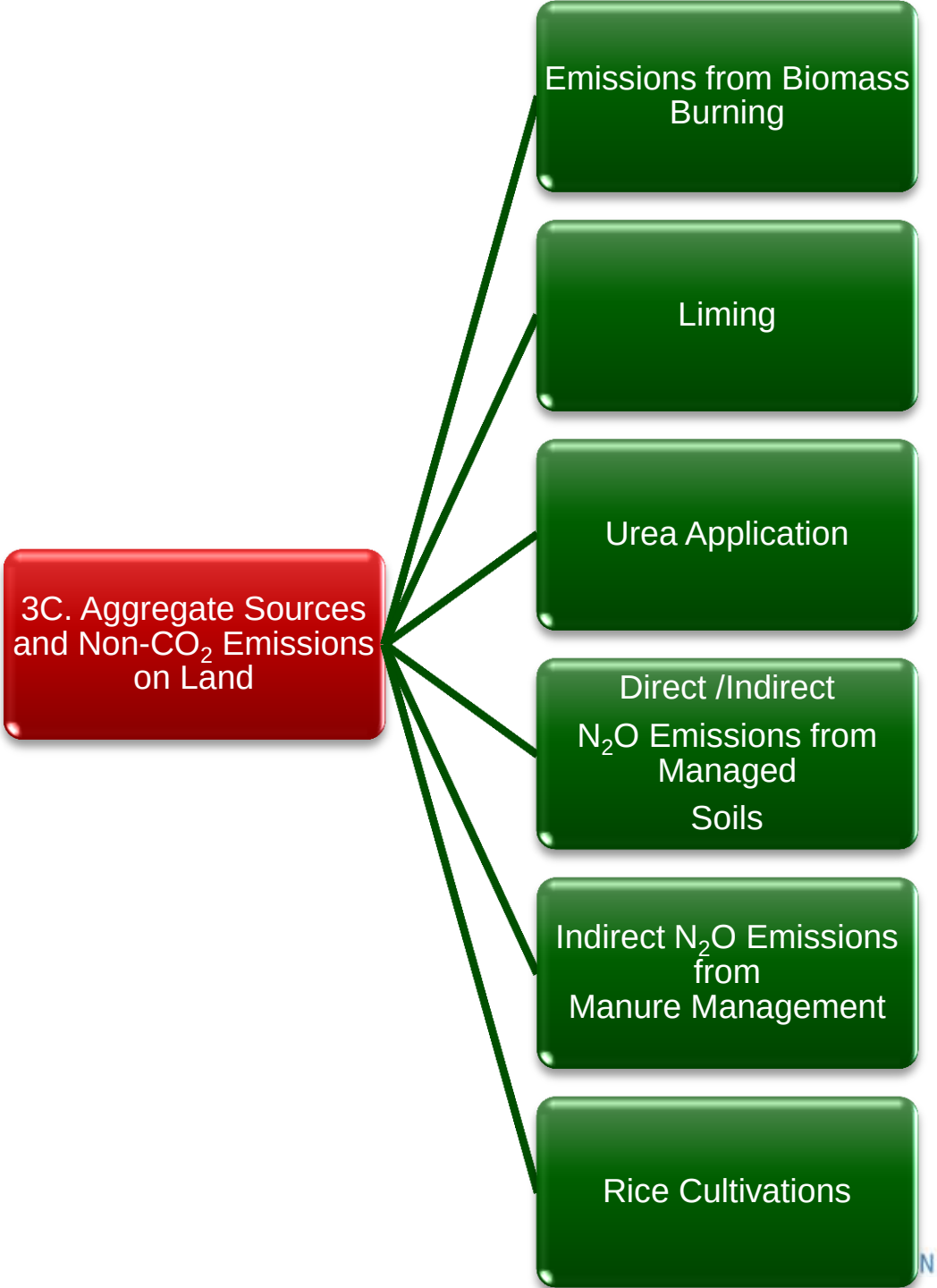
Note:
F = Forest land, G = Grassland, C = Cropland, W = Wetlands,
S = Settlements, O = Other land
Numbers represent area units (Mha in this example).
There is no Wetlands in this example. Blank entry indicates no land use change.

Approach 3: Spatially Explicit



Uncertainty Assessment

- Broad sources of uncertainty are:
  - Uncertainty in land-use and management activity and environmental data (land area estimates, fraction of land area burnt etc.)
  - Uncertainty in the stock change/emission factors for Tier 1 or 2 approaches (carbon increase and loss, carbon stocks, and expansion factor terms)
  - Uncertainty in model structure/parameter error for Tier 3 model-based approaches, or measurement error/sampling variability associated with a measurement-based inventories
- Uncertainty can be reduced by: using higher tier methods; more representative parameter values; and AD at higher resolution.


3C. Aggregate Sources and Non-CO_2 Emissions on Land
Emissions from Biomass Burning
Liming
Urea Application
Direct /Indirect N_2O Emissions from Managed Soils
Indirect N_2O Emissions from Manure Management
Rice Cultivations

Thank you !!
Any Questions?

Guidelines in all UN languages can be downloaded from:
http://www.ipcc-nggip.iges.or.jp/

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