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# UNDERSTANDING THE 2006 IPCC GUIDELINES REQUIREMENTS FOR THE CREATION OF CONSISTENT TIME SERIES OF IPCC LAND USE CATEGORIES AND LAND USE CHANGE MATRIX

**PATPA Asia Regional Group**

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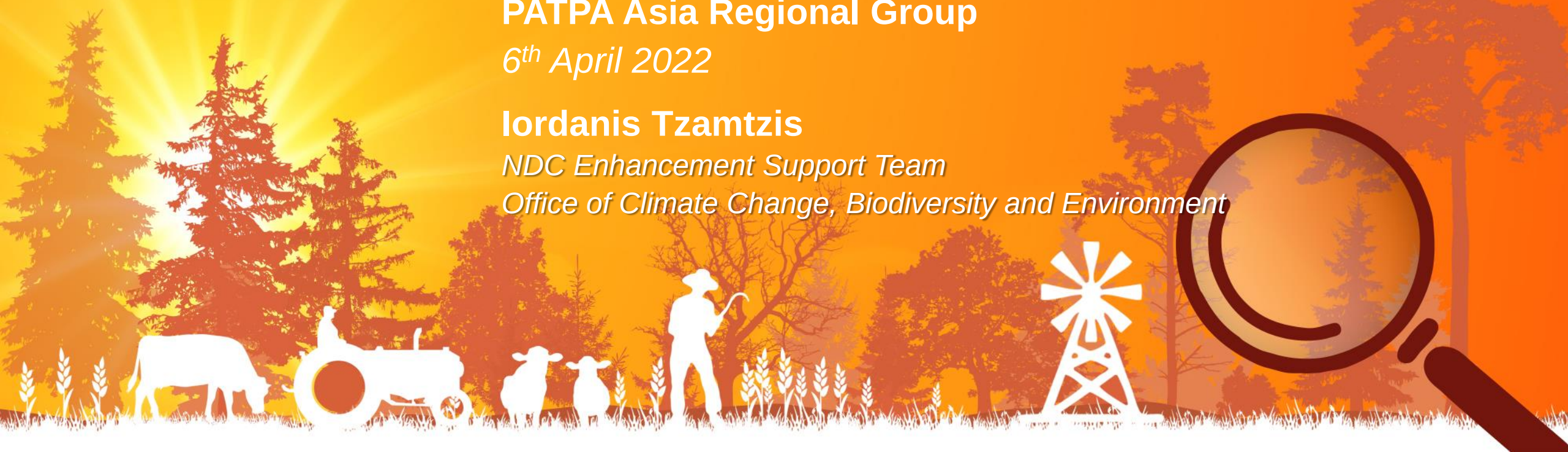
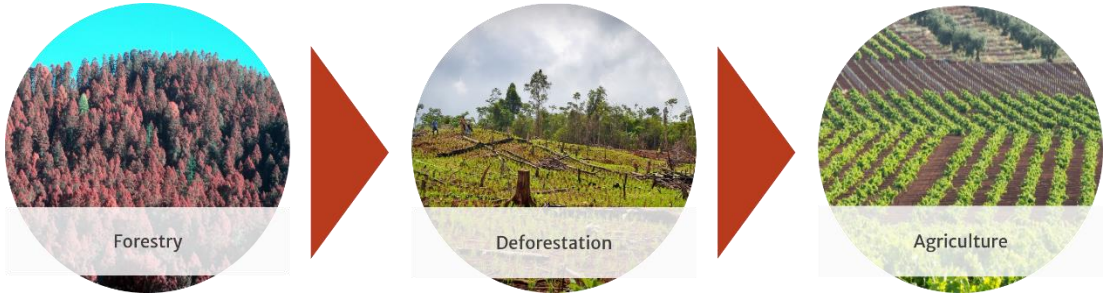


# Land representation | introduction

**Land representation** is the analysis undertaken to identify & quantify human activities on land & to track their changes over time

Results in a **stratification** of the total country area



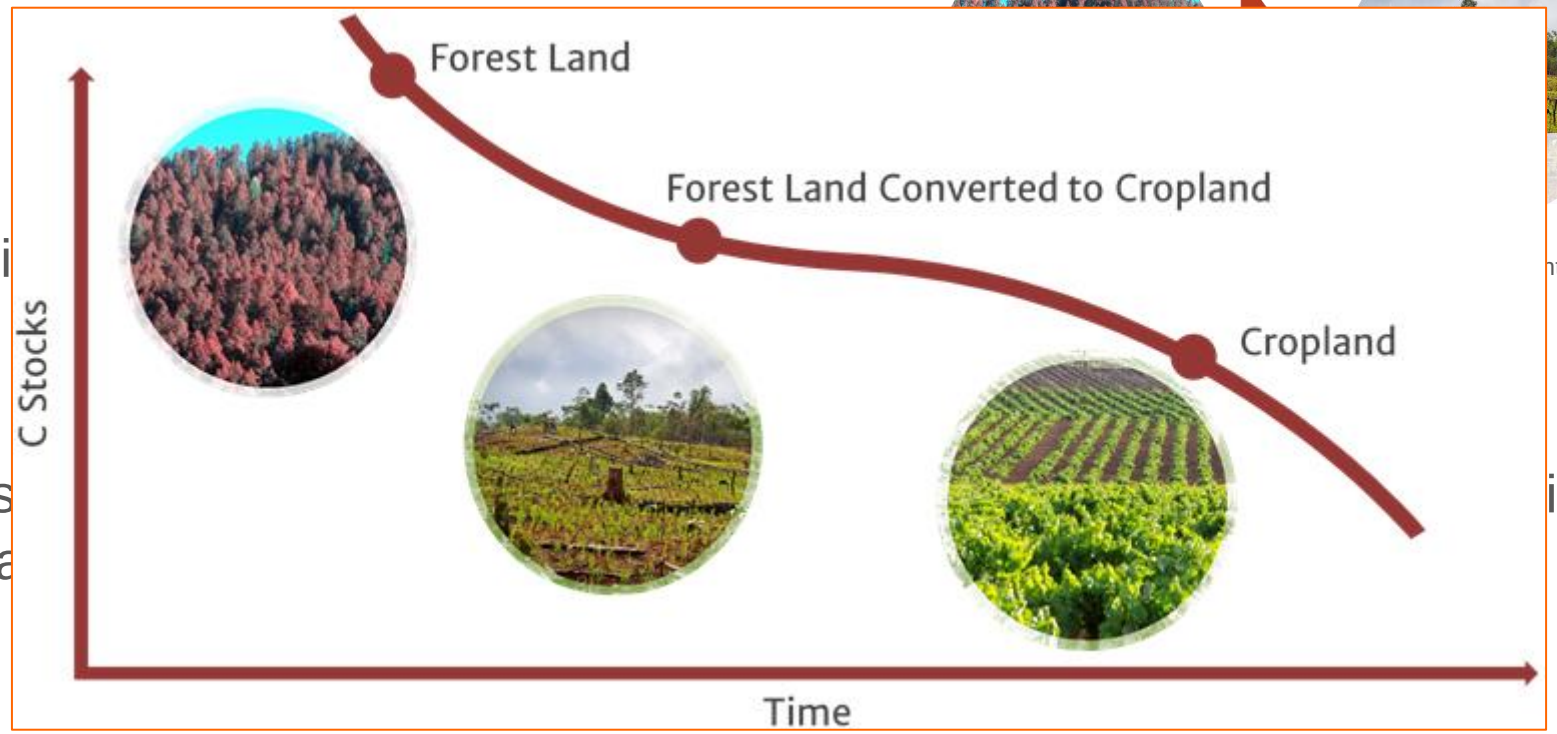

Source: FAO e-learning course: The national GHG inventory for land use

Division of country into units of land (strata) homogeneous for a number of variables

Explanation of current level & dynamic of C stocks within the stratum, with the purpose of making the GHG inventory development practicable & enhance accuracy of GHG estimates

# Land representation | introduction

**Why** land representation information is important?





When estimating
area information i

ntory for land use

Recall: AD repres
removals during a

ions and/or

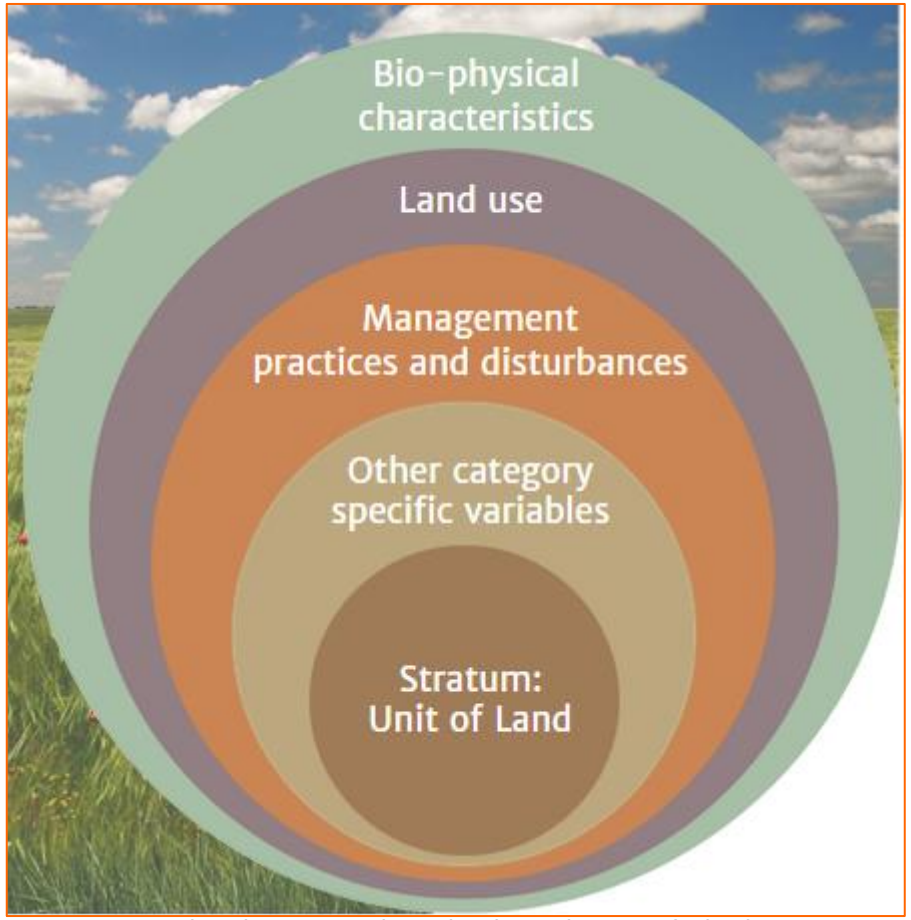
# Land representation | stratification

Land is characterized by **bio-physical variables** and various **human activities**

Land use & management influence a variety of ecosystem processes (e.g. photosynthesis, decomposition, etc.) that affect GHG fluxes

These processes involve removing & emitting GHGs

Human activities cover all impacts caused by human activities including disturbances



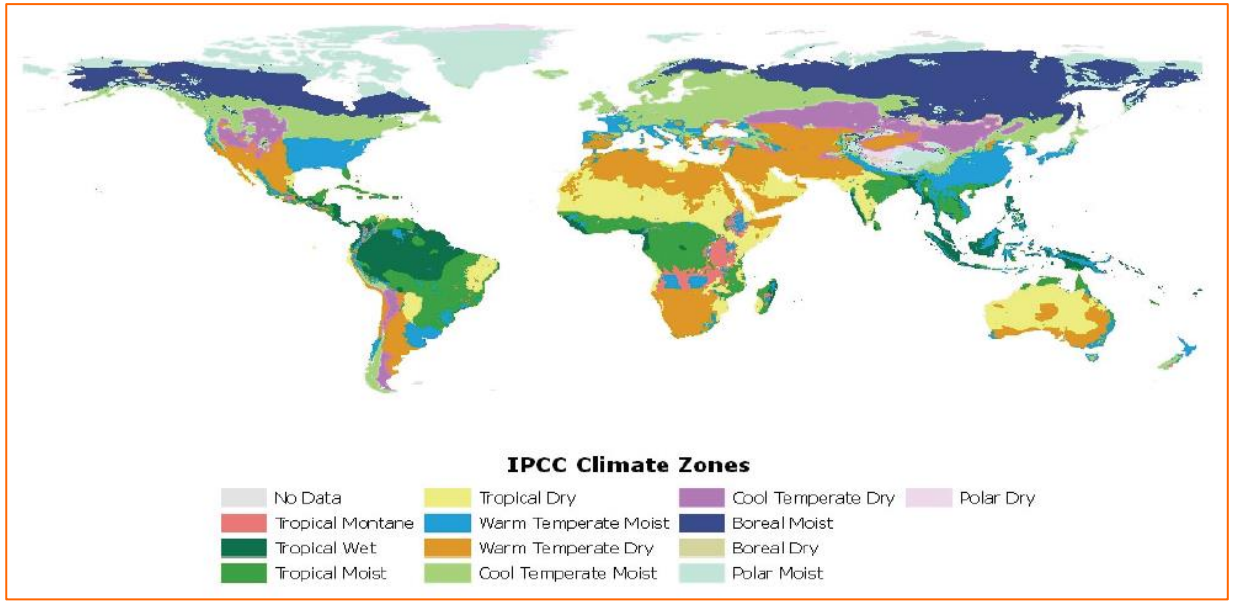

Source: FAO e-learning course: The national GHG inventory for land use

# Land representation | stratification | climate

- stratification by climate is important because temperature & water are the two main parameters determining accumulation of biomass & decay of organic matter

List of climate zones covering most managed lands

- Boreal
- Cold temperate dry
- Cold temperate wet
- Warm temperate dry
- Warm temperate moist
- Tropical dry
- Tropical moist
- Tropical wet




Source: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_03_Ch3_Representation.pdf#page=38

Potential data sets

https://www.ipcc-nggip.iges.or.jp/public/2019rf/corrigenda1.html

https://philipaudebert.users.earthengine.app/view/ipcc-climate-zones

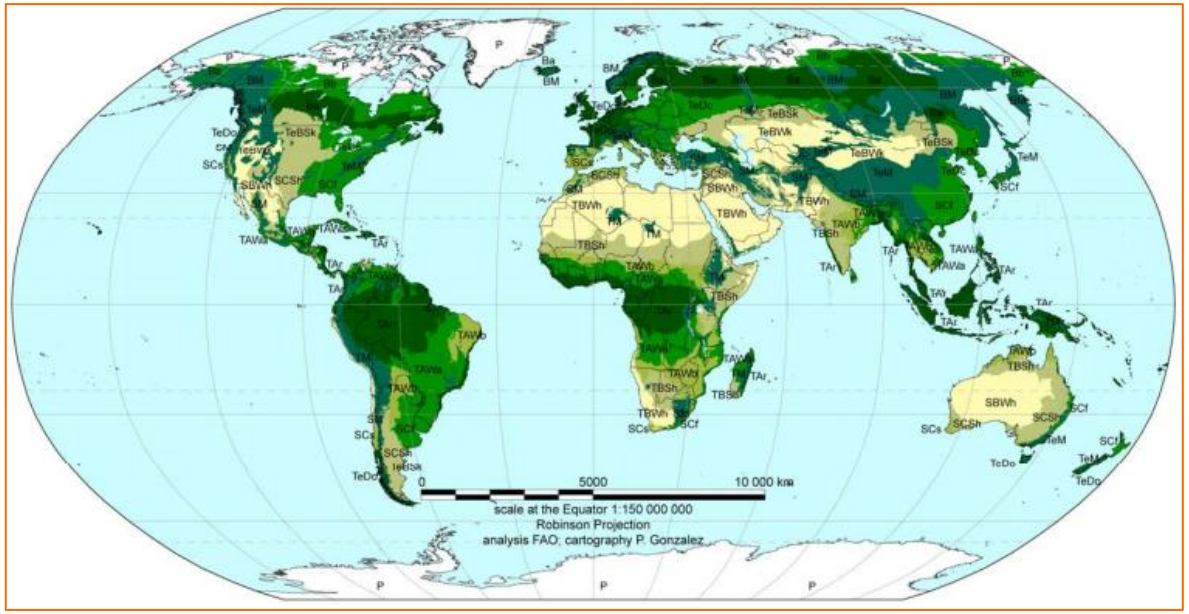
https://esdac.jrc.ec.europa.eu/content/support-renewable-energy-directive#tabs-0-description=1

# Land representation | stratification | ecological zone

- stratification by ecological zone is important since woody biomass is the 2nd largest terrestrial C pool after soil
- IPCC uses the FAO Global Ecological Zone (GEZ) classification

List of GEZ

- Tropical rainforest
- Tropical most deciduous forest
- Tropical dry forest
- Tropical shrubland
- Tropical desert
- Tropical mountain systems
- Subtropical humid forest
- Subtropical dry forest
- Subtropical steppe
- Subtropical desert
- Subtropical mountain systems
- Temperate oceanic forest
- Temperate continental forest
- Temperate steppe
- Temperate desert
- Temperate mountain systems
- Boreal coniferous forest
- Boreal tundra woodland
- Boreal mountain systems
- Polar




Source: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf#page=9

Potential data sets

https://www.fao.org/3/ap861e/ap861e00.pdf

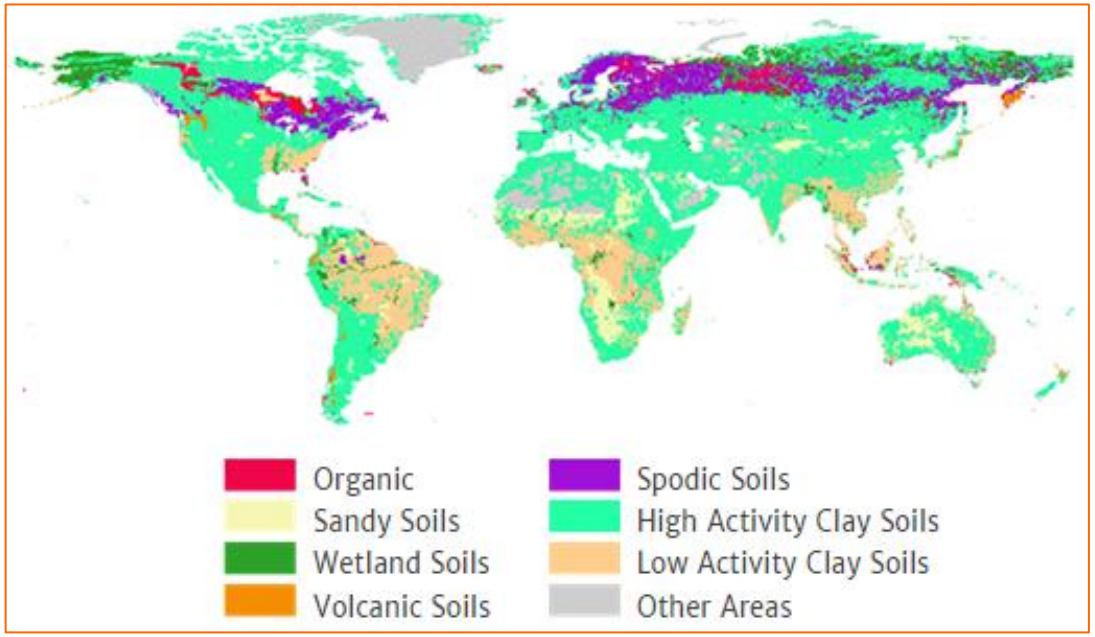
https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/2fb209d0-fd34-4e5e-a3d8-a13c241eb61b

# Land representation | stratification | soil type

- stratification by soil type is important because soil contains the largest portion of terrestrial C stocks in SOM carbon pool
- 2006 IPCC Guidelines classify country's soils in default types derived from the World Harmonized Soil Database

**Mineral soils**

**Organic soils**




Source: European Commission: Soil Projects, Support to Renewable Energy Directive

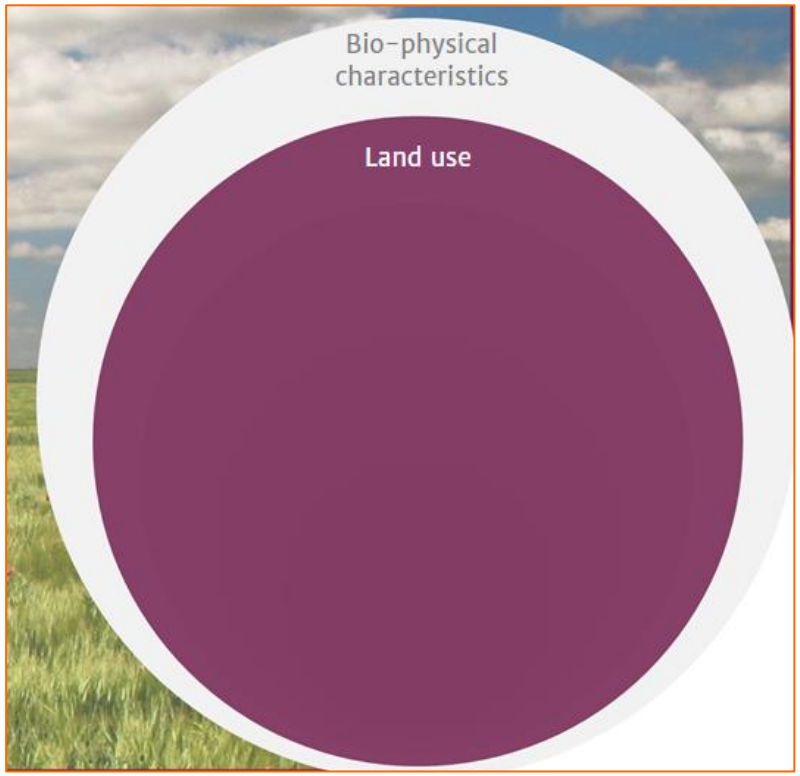
Potential data sets

https://esdac.jrc.ec.europa.eu/content/support-renewable-energy-directive#tabs-0-description=1

http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/

# Land representation | stratification | land use

- Stratification by land use is one of the most laborious steps in land representation
- It requires national data
- The more detailed data available, the more detailed stratification can be applied
- 2006 IPCC Guidelines as applied through MPGs require that countries stratify their land for the following
  - Managed & unmanaged land
  - Six IPCC top-level (main) land use categories
  - History of land use
  - Land conversion categories




Source: FAO e-learning course: The national GHG inventory for land use

# Land representation | stratification | land use

**Managed land**

Source: FAO e-learning course: The national GHG inventory for land use

2006 IPCC GLs maintain the managed-land proxy

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

current land use & changes in use over time

**Unmanaged land**

Source: FAO e-learning course: The national GHG inventory for land use

Area quantification & tracking over time, in order to maintain consistency in area accounting (since land-use changes occurs)

- Forest land
- Grassland
- Wetlands
- Other land

current cover

# Land representation | stratification | land use

**Can countries apply their own country specific land use definitions?**

**YES**

- a hierarchy must be established among the country specific definitions. Note that the IPCC embedded hierarchy is: 1) Forest land, 2) Cropland, 3) Grassland, 4) Settlements, 5) Wetlands, 6) Other land
- Country specific definitions need to cover the entire range of land uses represented in the country's territory & avoid mixing areas with very different C stocks and C stock dynamics together in the same category
- When country-specific definitions are based on land cover classes, they need to be reconciled with IPCC land use categories
- Definitions must be applied consistently across space & time

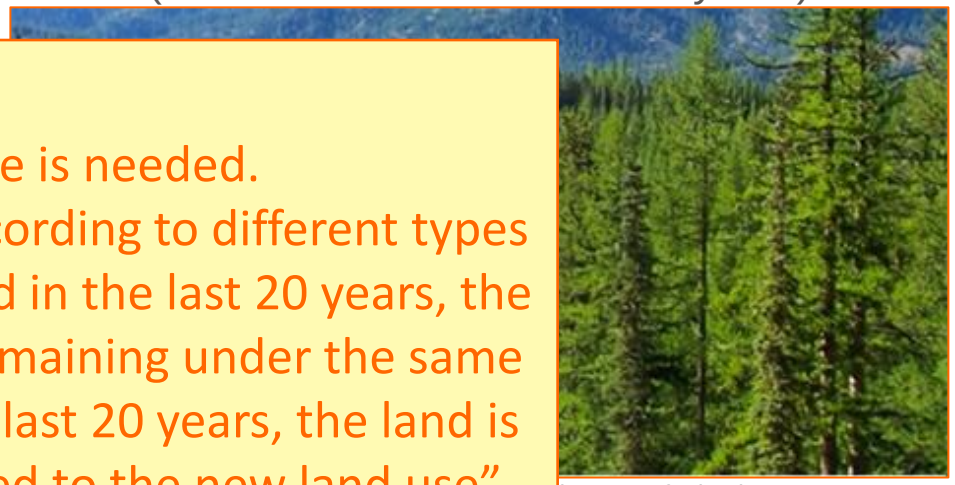
# Land representation | stratification | land use

land under conversion in the new land use category
(conversion within the last 20 years)

IPCC default

land remaining in the same land use category
(no conversion in the last 20 years)

Source: FAO e-learning cours



inventory for land use

Information on historical land use is needed.
It allows the application of different CSCF according to different types of conversion. If the land use has not changed in the last 20 years, the land is reported under the category “Land remaining under the same land use.” If the land use has changed in the last 20 years, the land is reported under the category “Land converted to the new land use” and in the relevant subcategory

Differentiation c
history of use is
appropriate methodology for estimating GHG emissions/removals

Different C stock levels & dynamics in C stock changes occur between those two subcategories

| | nd converted to a new category in the last 20 ars 20 years |
|---|---|
| Forest Land Remaining Forest Land | Land Converted to Forest Land |
| Grassland Remaining Grassland | Land Converted to Grassland |
| Cropland Remaining Cropland | Land Converted to Cropland |
| Wetlands Remaining Wetlands | Land Converted to Wetlands |
| Settlements Remaining Settlements | Land Converted to Settlements |
| Other Land Remaining Other Land | Land Converted to Other Land |

# Land representation | stratification | land use

land under conversion in the new land use category
(conversion within the last 20 years)

Source: FAO e-learning course: The national GHG inventory for land use

Differentiation of land conversion subcategories according to the previous land-use

In total 30 land-use change sub-categories

| | |
|---|---|
| Forest land | Cropland converted to Forest land |
| | Grassland converted to Forest land |
| | Wetland converted to Forest land |
| | Settlements converted to Forest land |
| | Other land converted to Forest land |
| Cropland | Forest land converted to Cropland |
| | Grassland converted to Cropland |
| | Wetland converted to Cropland |
| | Settlements converted to Cropland |
| | Other land converted to Cropland |
| Grassland | Forest land converted to Grassland |
| | Cropland converted to Grassland |
| | Wetland converted to Grassland |
| | Settlements converted to Grassland |
| | Other land converted to Grassland |

.....

.....

# Land representation | stratification | management

Management systems & practices & disturbances directly affect certain C pools

Stratification by management system/practices on land is a good proxy for the expected level & dynamic of C stocks

It can be used as a further level of land stratification

Stratification by management system is required especially for the SOM pool

| Management system of practices | C pools for which C stocks changes and associated emissions need to be estimated at Tier 1 |
|---|---|
| Management of Natural Forest | Biomass (LB), Harvested Wood Products (HWP) |
| Managed Forest Plantation | Biomass (LB), Harvested Wood Products (HWP) |
| Improved Grassland | Soil Organic Matter (SOM) |
| Annual Crop Management | Soil Organic Matter (SOM) |
| Perennial Crop Management | Biomass (LB), Soil Organic Matter (SOM) |
| Drainage/Rewetting | Soil Organic Matter (SOM) |
| Tillage | Soil Organic Matter (SOM) |
| Peat Extraction | Soil Organic Matter (SOM) |
| Prescribed Burning | Biomass (LB), Dead Organic Matter (DOM) |
| Organic Fertilizaton | Soil Organic Matter (SOM) |

# Land representation | stratification | disturbances


Source: FAO e-learning course: The national GHG inventory for land use

C stocks are affected by disturbances, so it is important to stratify by disturbances

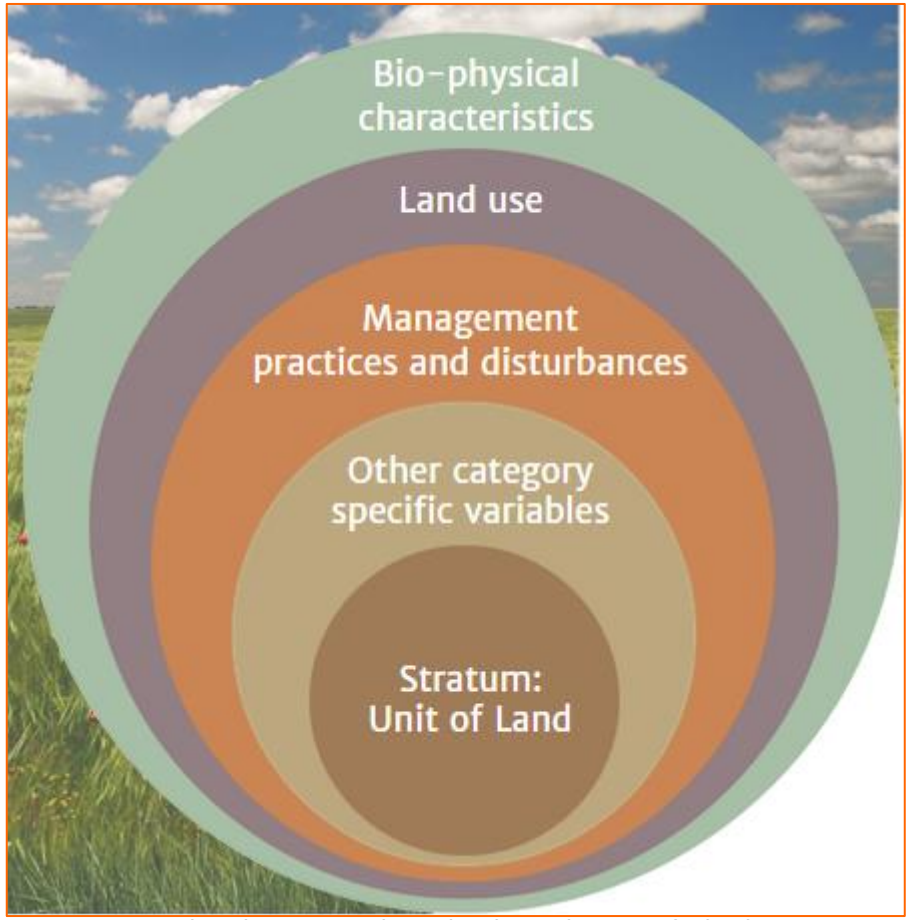
Fires is the most relevant & frequent disturbance, however, there are other common disturbances

Both wildfires & prescribed burning has to be taken into account in the GHG inventory when occurring

# Land representation | stratification | other variables

Other variables can be used for further stratification, e.g. crop/tree species

Additional level of stratification can be added according to data availability for C stock & stock change factors associated with the strata



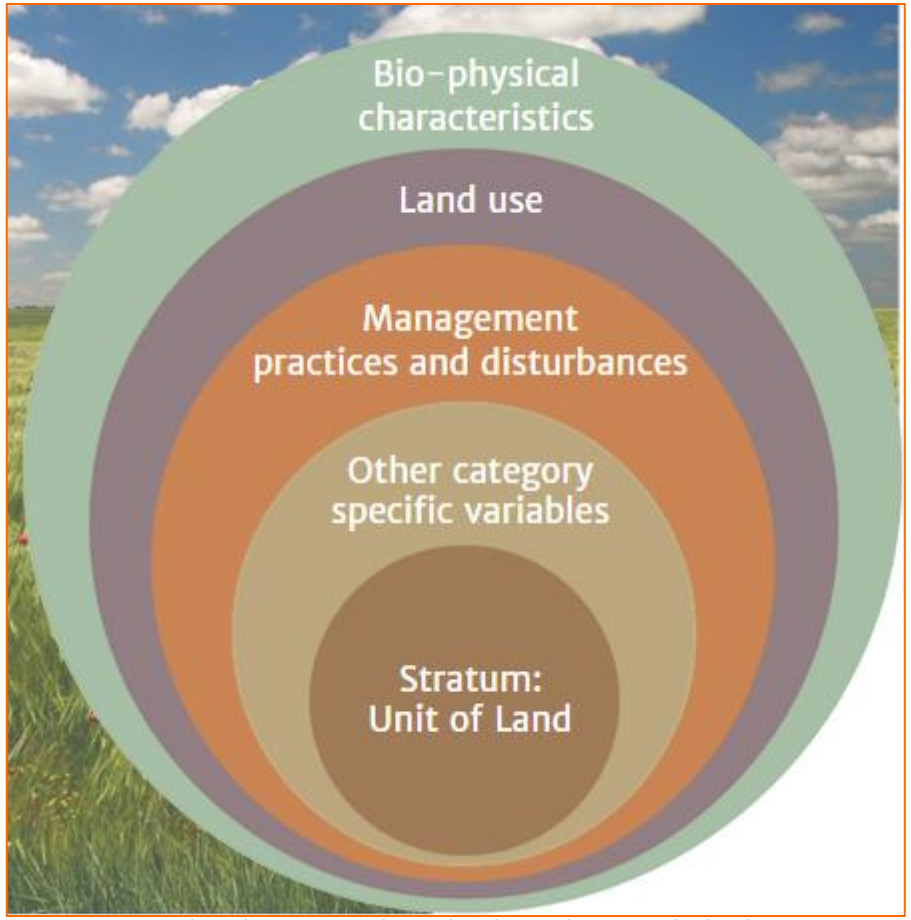

Source: FAO e-learning course: The national GHG inventory for land use

# Land representation | stratification | other variables

Once the stratification scheme has been determined

Must be applied across the entire national territory in a way that

- ✓ **The same stratification scheme applies to each carbon pool in the unit of land**
- ✓ **The same stratification scheme applies across the entire time series**




Source: FAO e-learning course: The national GHG inventory for land use

# Land representation | methodological approach

IPCC provides **three** methodological approaches for land representation

**Approach 1**

- land use/management categories are identified & areas quantified
- land use/management changes between categories are neither identified nor quantified (spatially-explicit data are not available)
- Net area change of each land use/management category over time are quantified

**Approach 2**

- land use/management categories are identified and areas quantified
- land use/management changes are identified and their areas quantified
- areas of changes are not spatially-explicit tracked over time

**Approach 3**

- land use/management categories are identified and areas quantified
- land use/management changes are identified and their areas quantified
- areas of changes are spatially-explicit tracked over time

# Land representation | methodological approach

- The choice of the approach depends on the availability of data over time and space
- Approach 1: when data do not allow land use/management conversions identification
- Approaches 2/3: when data allow land use/management conversions identification between two consecutive inventory years
- Approaches are applied to classify the territory according to the stratification scheme applied & to quantify the area of each unit of land
- A combination of approaches can be used to better adapt to data availability over time and space. Although, to ensure consistency of land representation, each unit of land identified must be reported with the same approach across the entire time series
- The most efficient tactic to build a consistent land representation is to apportion the land in macro-units of land homogeneous for climate, ecological zone and soil and to build a land representation for each of the macro-units

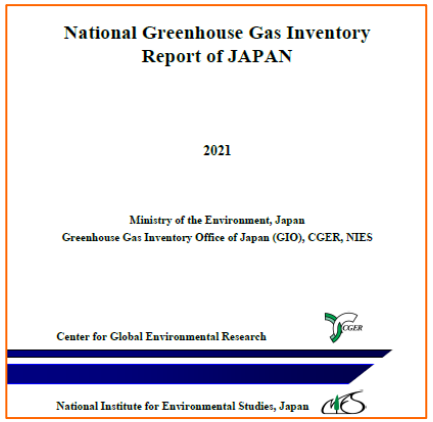
# Land representation | methodological approach

- The level of aggregation at which the land representation should be reported in the NGHGI is that of land use categories (6 land remaining categories & associated 30 land-use change categories)
- This means that units of land with homogeneous history of use are aggregated under the same land use category (although the units of land within a land use category may differ for other variables, according to the stratification scheme applied)

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Forest land
(Sheet 1 of 1)

Back to Index

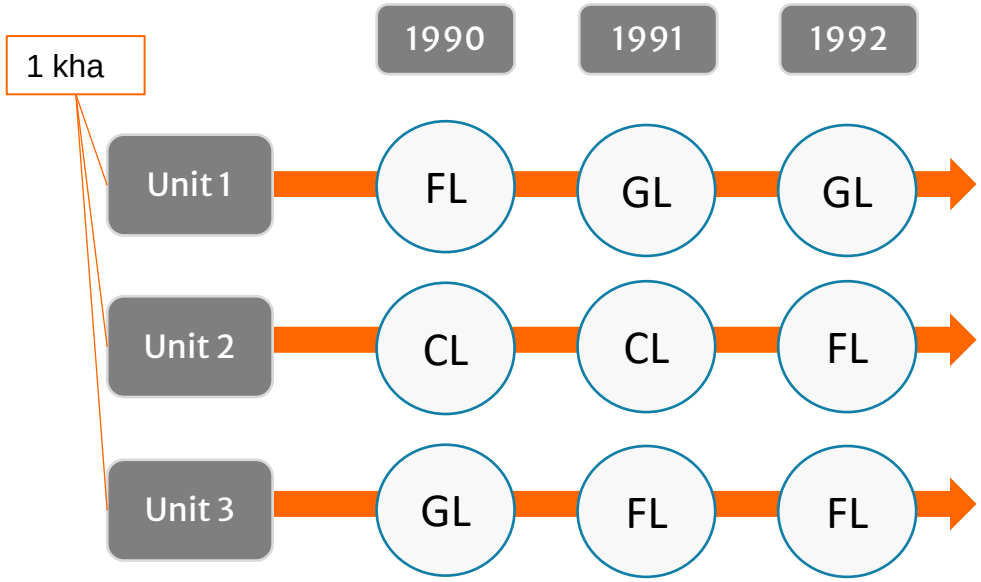
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | ACTIVITY DATA | | | IMPLIED CARBON STOCK CHANGE FACTORS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Land-use category | Subdivision [2] | Total area [3] | Area of mineral soil | Area of organic soil | Carbon stock change in living biomass per area [4,5] | | | Net carbon stock change in dead wood per area | Net carbon stock change in litter per area | Net ch |
| | | | | | Gains | Losses | Net change | | | Min so |
| | | (kha) | | | (t C/ha) | | | | | |
| 4.A. Total forest land | | | | | | | | | | |
| 4.A.1. Forest land remaining forest land | | | | | | | | | | |
| 4.A.2. Land converted to forest land [18] | | | | | | | | | | |
| 4.A.2.a. Cropland converted to forest land | | | | | | | | | | |
| 4.A.2.b. Grassland converted to forest land | | | | | | | | | | |
| 4.A.2.c. Wetlands converted to forest land | | | | | | | | | | |
| 4.A.2.d. Settlements converted to forest land | | | | | | | | | | |
| 4.A.2.e. Other land converted to forest land | | | | | | | | | | |




- Detailed information on land representation should be included in the NID (main body or annexes)
- The reader should be able to replicate the land representation results used for estimating GHG emissions/removals

# Land representation | methodological approach

- The GHG inventory is composed of a number of annual estimates (time series), thus the land representation is expected to provide area information (AD) for the entire time series



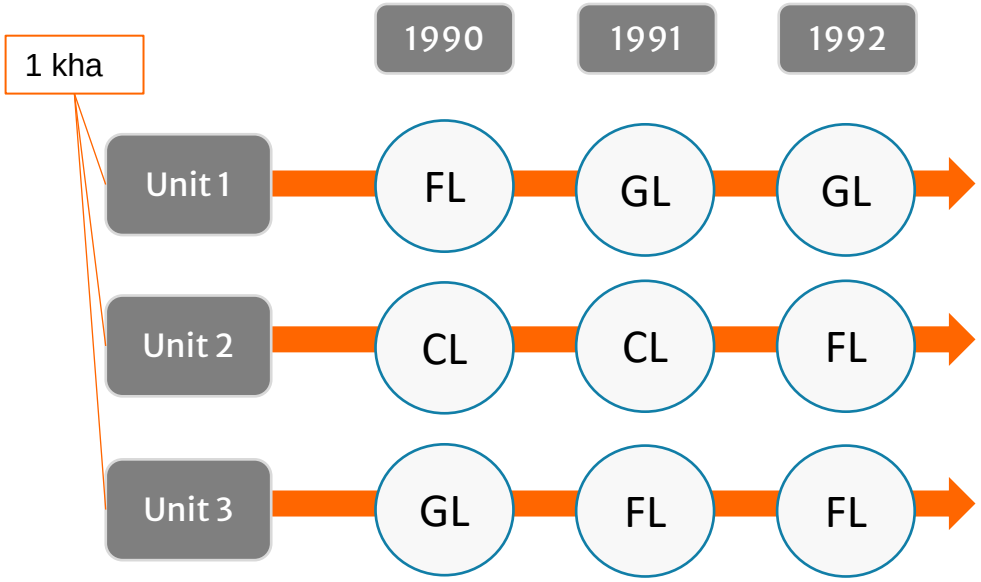

**Approach 1**

| | Total area (kha) | | |
|---|---|---|---|
| Category | 1990 | 1991 | 1992 |
| Forest land | 1 | 1 | 2 |
| Cropland | 1 | 1 | 0 |
| Grassland | 1 | 1 | 1 |
| **Total** | **3** | **3** | **3** |

| | Net area changes (kha) | | |
|---|---|---|---|
| Category | 1990 | 1991 | 1992 |
| Forest land | 0 | 0 | +1 |
| Cropland | 0 | 0 | -1 |
| Grassland | 0 | 0 | 0 |
| **Total** | **0** | **0** | **0** |

- The area of land use categories are quantified over time (just ‘land remaining in same land use category’)
- The land use changes are not identified (only net area changes are quantified), e.g. between 1990 and 1991 approach 1 does not report any conversion

# Land representation | methodological approach




**Approach 2**

| | Total area (kha) | | |
|---|---|---|---|
| Category | 1990 | 1991 | 1992 |
| Forest land remaining forest land | 1 | 0 | 0 |
| Cropland remaining cropland | 1 | 1 | 0 |
| Grassland remaining grassland | 1 | 0 | 0 |
| Cropland converted to forest land | 0 | 0 | 1 |
| Grassland converted to forest land | 0 | 1 | 1 |
| Forest land converted to grassland | 0 | 1 | 1 |
| **Total** | **3** | **3** | **3** |

- Provides gross land use conversions (i.e. losses & gains) between 2 points in time only
- Emission/removal factors can be applied to reflect different rates of change in C stocks according to the land use categories (previous and current) of the unit of land under conversion
- Area information can be organized in land use change matrix

# Land representation | methodological approach

**Approach 2**

| 1990 | | | | |
|---|---|---|---|---|
| | FL | CL | GL | **Area at the beginning of year** |
| FL | 1 | 0 | 0 | 1 |
| CL | 0 | 1 | 0 | 1 |
| GL | 0 | 0 | 1 | 1 |
| **Area at the end of year** | **1** | **1** | **1** | **3** |

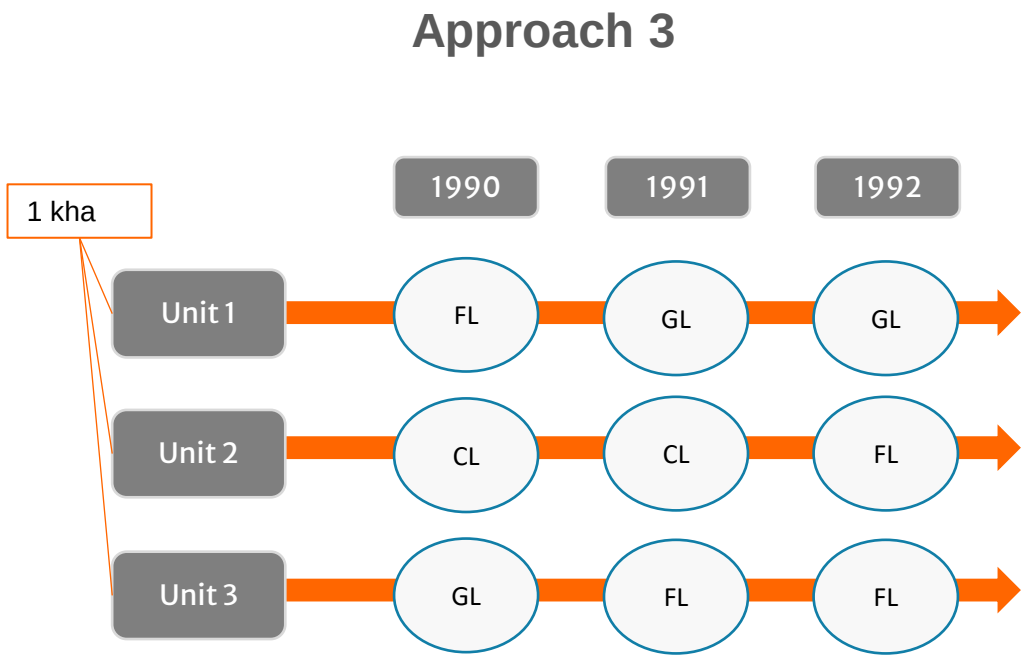
| 1991 | | | | |
|---|---|---|---|---|
| | FL | CL | GL | **Area at the beginning of year** |
| FL | 0 | 0 | 1 | 1 |
| CL | 0 | 1 | 0 | 1 |
| GL | 1 | 0 | 0 | 1 |
| **Area at the end of year** | **1** | **1** | **1** | **3** |

| 1992 | | | | |
|---|---|---|---|---|
| | FL | CL | GL | **Area at the beginning of year** |
| FL | 0 | 0 | 1 | 1 |
| CL | 1 | 0 | 0 | 1 |
| GL | 1 | 0 | 0 | 1 |
| **Area at the end of year** | **2** | **0** | **1** | **3** |

- Provides gross land use conversions (i.e. losses & gains) between 2 points in time only
- Emission/removal factors can be applied to reflect different rates of change in C stocks according to the land use categories (previous and current) of the unit of land under conversion
- Area information can be organized in land use change matrix

# Land representation | methodological approach

- Data provide fully spatially-explicit information on the use/management of each unit of land over the entire time series. So, it is capable to track over time each land converted
- Similar to approach 2, data may be obtained through sampling or wall-to-wall mapping techniques or a combination of the two methods
- Emission/removal factors can be chosen to reflect different rates of change in carbon stocks according to the history of each tracked unit of land
- Although Approach 3 may be illustrated by means of land use and land use change matrices, Geographic Information Systems are likely needed to track across time each single unit of land



# Land representation | methodological approach

- A time series is composed by a number of tables corresponding to the number of years for which the land representation is built plus 19 (when the IPCC default 20 years transition period is applied)
- For example, the time series for the GHG inventory period 1990-2020 will be composed by 50 annual matrices (i.e. from matrix 1970-1971 till matrix 2019-2020)
- Remember that when a change occurs, it must be reported cumulated for 20 years in the respective land conversion category (e.g. FL→CL). Therefore, to accurately report the starting year areas for converted land, areas converted in that year plus the areas converted in the previous 19 years are needed (e.g. in the year 2005, the area reported in the conversion category “Forest land converted to Cropland” is the area of forest land converted to cropland over the entire time period 1986-2005)
- To construct a consistent time series for the years before the starting year of the inventory, alternative data sources may be utilized (e.g., dataset on authorization of deforestation, dataset on afforestation) & proxies (e.g., use of the same conversion type(s) observed in the inventory period for the years before the starting year)
- Use of average rates of changes from the inventory period for years before starting year should be the last resort

# Land representation | conclusions

The data collection & analysis system (including land classification) should respect the **guiding principles** of MPGs to ensure quality of data outputs (i.e. the land representation) & sustainability of operations

- **Transparent**: Related documentation is sufficient, data sources, definitions, methodologies & assumptions are clearly described, such that individuals other than the inventory compilers can understand how the land representation was developed & are confident it meets good practice
- **Accurate**: The GHG estimates are neither over- nor under-estimated so far as can be judged, and are free of bias
- **Complete:** All land area within the country is represented
- **Consistent**: Capable of representing categories/subcategories/ subdivisions consistently across time
- **Comparable**: Categories are suitable to be aggregated according to the IPCC default categories

The data collection & analysis system should also be **adequate** in that is capable of representing all land use categories & associated subcategories/subdivisions

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etf@fao.org

*Thank you !*