Consistent Representation of Land

(Capacity Building Program for Indian Experts on National Greenhouse Gas Inventory Preparation as per Enhanced Transparency Framework Guidelines, 25 April 2024 – 1 May 2024, Indian Institute of Technology Gandhinagar, Gujarat, India)

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Steps in Calculating Emissions/Removals in AFOLU sector

Step 1:
- **Land use representation by climate, ecological zone, soil type, land use, and management system**
- Livestock population characterization by climate, category, and sub-category

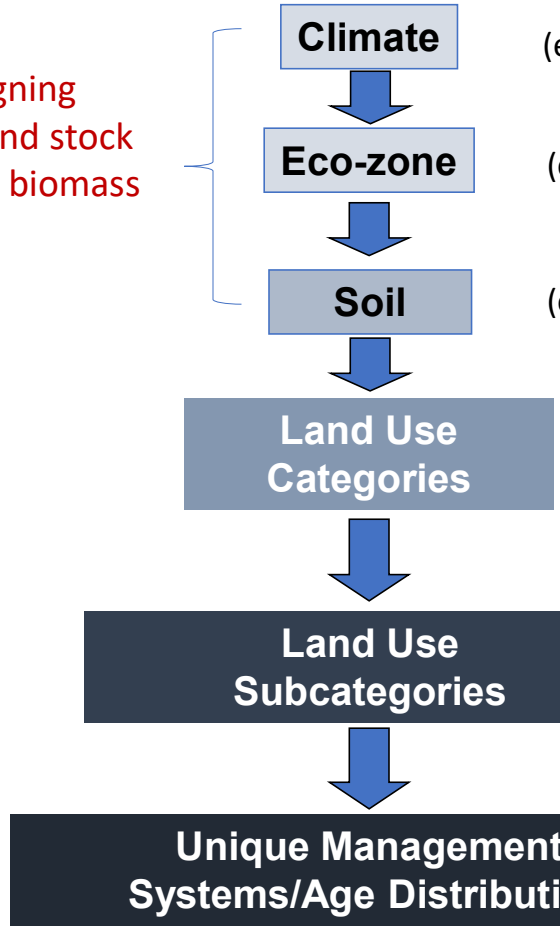
Step 2:
Compile activity data and emission/stock change corresponding to Step 1 classifications and based on the choice of method, AD, and EF

Step 3:
Estimate CO_2 emissions and removals and non-CO_2 emissions at the appropriate tier level

Step 4:
Sum up CO_2 emissions and removals and non-CO_2 emissions over the inventory period for each category by land use and stratum; then report

Step 1: Land use Representation

Important in assigning emission factors and stock change factors for biomass and soils



(e.g. Tropical Dry, Tropical Moist, Tropical Wet, etc.)

(e.g. Tropical Rain Forest, Tropical Shrubland, Temperate Continental Forest, etc.)

(e.g. High Activity Clay, Low Activity Clay, Sandy, etc.)

For Approach 1: 6 IPCC categories: Forest Land, Cropland, Grassland, Wetlands, Settlement, and Other Land

For Approaches 2 and 3: there are 36 IPCC categories; e.g. Forest Land Remaining Forest Land, Cropland Converted to Forest Land, etc.

(e.g. Open Forest, Closed Forest, Plantation, Mangrove, etc.)

(e.g. IPCC age ranges of <= 20 yrs; and > 20 yrs in Forest Land)

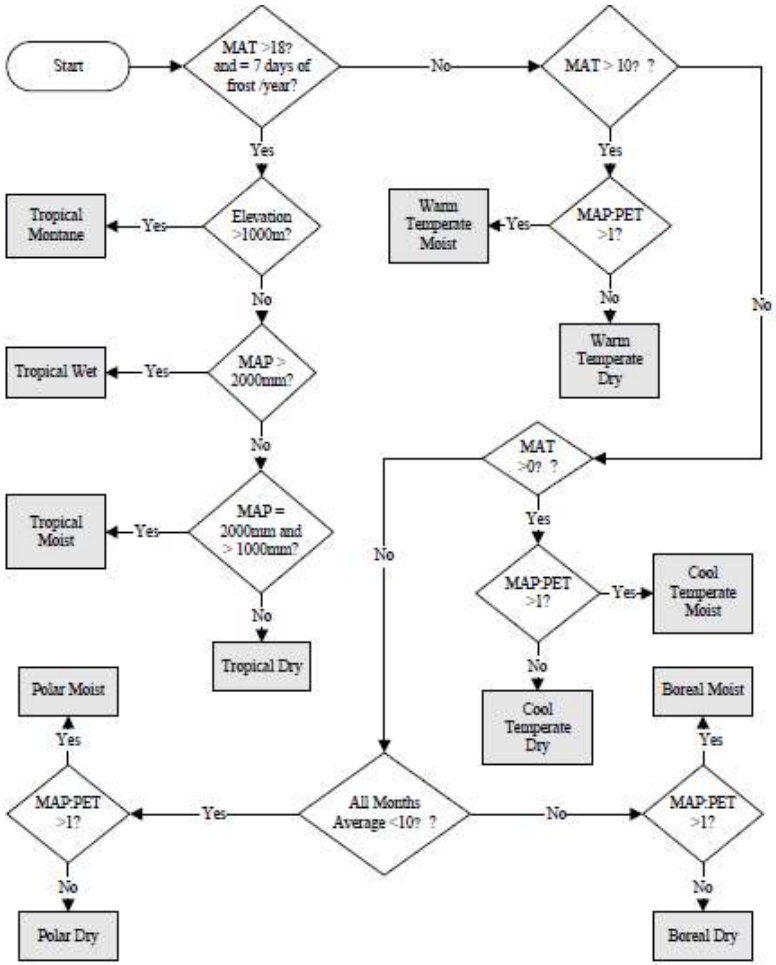
Decision tree for climate type

Input data required:

- ✓ mean annual temperature (MAT)
- ✓ Elevation
- ✓ mean annual precipitation (MAP)
- ✓ mean annual precipitation to potential evapotransporation ratio (MAP:PET), and
- ✓ frost occurrence

IPCC Climate Classification:

- ✓ Tropical Moist, Long Dry Season
- ✓ Tropical Moist, Short Dry Season
- ✓ Tropical Montane Dry
- ✓ Tropical Montane Moist
- ✓ Tropical Wet
- ✓ Etc…



Decision tree for soil type

Data required:

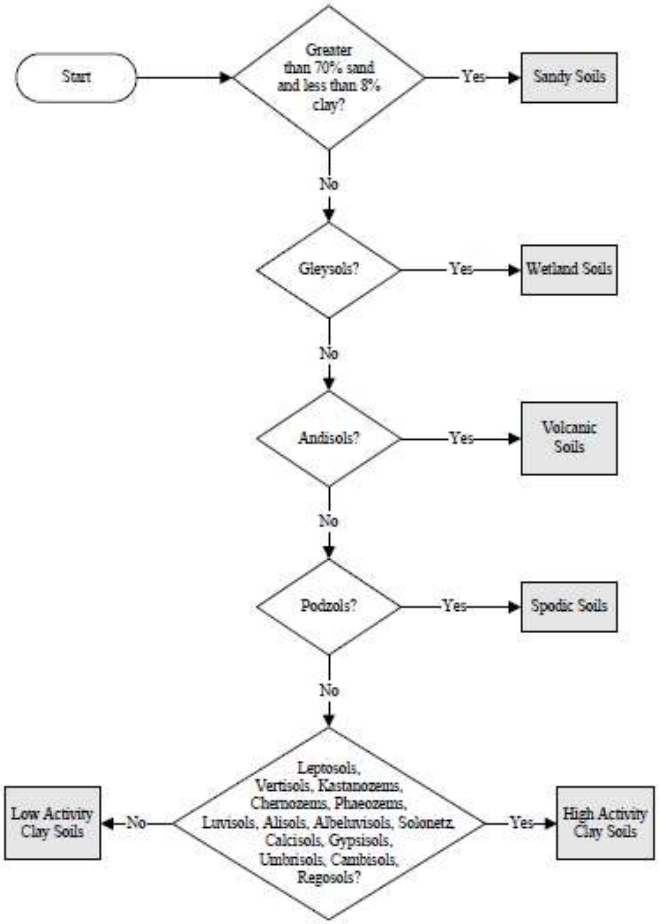
Soils classified according to based on World Reference Base for Soil Resources (WRB) classification or USDA soil taxonomy:

For Example (for WRB):

- ✓ Leptosols
- ✓ Vertisols
- ✓ Cambisols, etc.

IPCC Soil Classification:

- ✓ High Activity Clay Mineral
- ✓ Low Activity Clay Mineral
- ✓ Organic Sandy Mineral
- ✓ Spodic Mineral
- ✓ Volcanic Mineral
- ✓ Wetland Mineral



IPCC Land Use Categories and Sub-categories


Forest land


Cropland


Grassland


Wetlands


Settlements


Other Lands

Source: GHGMI, 2016

Land use *During a given time interval*	**Land-use change** *With the specific land categories prior to conversion being identified as appropriate (e.g. Grassland converted to Forest Land)*
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

3 Approaches to Land Use Representation

APPROACH 1: TOTAL LAND-USE AREA, NO DATA ON CONVERSION BETWEEN LAND USES

TABLE 3.2
EXAMPLE OF APPROACH 1: AVAILABLE LAND USE DATA WITH COMPLETE NATIONAL COVERAGE

Time 1			Time 2			Net land-use conversion between Time 1 and Time 2		
F	=	18	F	=	19	Forest Land	=	+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: TOTAL LAND-USE AREA, INCLUDING CHANGES BETWEEN CATEGORIES

TABLE 3.6
SIMPLIFIED LAND-USE CONVERSION MATRIX FOR APPROACH 2 EXAMPLE

Net land-use conversion matrix

Final \ Initial	F	G	C	W	S	O	*Final sum*
F	15	3	1				*19*
G	2	80					*82*
C			29				*29*
W				0			*0*
S	1	1	1		5		*8*
O						2	*2*
Initial sum	*18*	*84*	*31*	*0*	*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).

APPROACH 3: SPATIALLY-EXPLICIT LAND-USE CONVERSION DATA

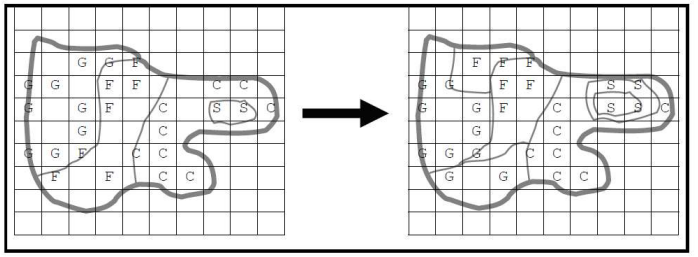
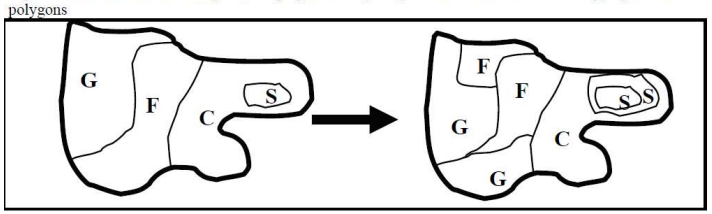


Figure 3A.4.1D Generalised maps can be prepared using the grid cells, which can also be aggregated into polygons



India Land Use 2005 - 2019

Year	Forestland	Cropland	Grassland	Settlement	Other Land	Total area
2005	69.16	160.65	20.35	8.61	69.96	328.73
2006	69.24	160.94	20.42	8.72	69.41	328.73
2007	69.25	161.23	20.48	8.84	68.93	328.73
2008	69.27	161.53	20.55	8.96	68.42	328.73
2009	69.44	161.82	20.62	9.08	67.77	328.73
2010	69.50	162.12	20.69	9.20	67.22	328.73
2011	69.79	162.41	20.75	9.31	66.47	328.73
2012	69.98	162.71	20.82	9.43	65.79	328.73
2013	70.15	163.00	20.89	9.55	65.14	328.73
2014	70.49	163.29	20.89	9.55	64.51	328.73
2015	70.83	163.85	21.65	9.56	62.84	328.73
2016	71.03	164.40	22.42	9.57	61.31	328.73
2017	71.22	164.81	22.66	9.61	60.43	328.73
2018	71.30	165.22	22.91	9.64	59.66	328.73
2019	71.38	166.05	23.40	9.71	58.20	328.73
	2.22	5.396	3.051969485	1.0954202	-11.76	

Source: TNC

Table 4.1 LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1)

Year
Submission
Country

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TO: / FROM: (2005)	Forest land (managed)	Forest land (unmanaged)	Cropland	Grassland (managed)	Grassland (unmanaged)	Wetlands (managed)	Wetlands (unmanaged)	Settlements	Other land	Total unmanaged land	**Initial area**
	(kha)										
Forest land (managed) (2)	69,160,000										69,160,000
Forest land (unmanaged) (2)											
Cropland (2)			160,650,000								160,650,000
Grassland (managed) (2)				20,350,000							20,350,000
Grassland (unmanaged) (2)											
Wetlands (managed) (2)											
Wetlands (unmanaged) (2)											
Settlements (2)								8,610,000			8,610,000
Other land (2)	2,220,000		5,396,000	3,051,969				1,095,420	58,200,000		69,963,389
Total unmanaged land (3)											
Final area (2019)	71,380,000		166,046,000	23,401,969				9,705,420	58,200,000		328,733,389
Net change (4)	2,220,000		5,396,000	3,051,969				1,095,420	-11,763,389		

Table 2.7 Forest Cover change matrix for India between 2019 and 2021 assessments. (in sq km)

Class	2021 Assessment						%
	VDF	MDF	OF	Scrub	NF	Total ISFR 2019	
Very Dense Forest	97,770	982	348	28	150	99,278	0.31
Moderately Dense Forest	1,696	3,02,216	2,736	331	1,493	3,08,472	9.76
Open Forest	245	2,939	2,94,200	1,491	5,624	3,04,499	9.64
Scrub	31	241	3,048	40,977	2,000	46,297	0.15
Non Forest	37	512	6,788	3,712	25,17,874	25,28,923	80.14
Total ISFR 2021	**99,779**	**3,06,890**	**3,07,120**	**46,539**	**25,27,141**	**32,87,469**	100.00
Net Change	501	-1,582	2,621	242	-1,782		

● Gain ● Loss

Rice Ecosystem 2019

Ecosystem	Area %
Upland	12.72%
Multiple Aeration	21.99%
Single Aeration	20.66%
Continuous Floodir	17.48%
Drought Prone	12.52%
Flood Prone	11.56%
Deep Water	3.06%
	100.00%

Hands-on exercise …

Using available country-specific data on land use, let us use the ALU Software to:

1. Demonstrate how GIS Land Use data can be imported or integrated into the ALU Software
2. Categorize land use of India, using manual method, taking into account TNC land use and management data for 2019.