

Training Workshop on the National System for the GHG Inventory
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KEY CATEGORY ANALYSIS - EXAMPLE

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Coalition for Rainforest Nations



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UN-REDD
PROGRAMME



Approach 1 Level Assessment

- Input data

(Italian GHG Inventory 1990-2008)

CATEGORIES	Gas	base year (1990)	2008	base year (1990) <i>absolute values</i>	2008 <i>absolute values</i>	Level assessment 2008
		Gg CO ₂ eq.	Gg CO ₂ eq.	Gg CO ₂ eq.	Gg CO ₂ eq.	
CO2 stationary combustion liquid fuels	CO2	153,467	84,009	153,467	84,009	0.13
CO2 stationary combustion solid fuels	CO2	59,397	65,128	59,397	65,128	0.10
CO2 stationary combustion gaseous fuels	CO2	85,066	162,029	85,066	162,029	0.26
CO2 stationary combustion other fuels	CO2	1,779	4,943	1,779	4,943	0.01
CH4 stationary combustion	CH4	647	977	647	977	0.00
N2O stationary combustion	N2O	3,445	3,768	3,445	3,768	0.01
CO2 Mobile combustion: Road Vehicles	CO2	93,387	113,945	93,387	113,945	0.18
CO2 Cropland remaining Cropland	CO2	-20,765	-13,239	20,765	13,239	0.02
CO2 Land converted to Forest Land	CO2	-753	-1,667	753	1,667	0.00
CO2 Land converted to Cropland	CO2	656		656	0	0.00
CO2 Grassland remaining Grassland	CO2	-4,156	-7,032	4,156	7,032	0.01
CO2 Land converted to Grassland	CO2		-5,639	0	5,639	0.01
N2O Land converted to Cropland	N2O	80		80	0	0.00
CO2 Land converted to Settlements	CO2	2,151	3,253	2,151	3,253	0.01
TOTAL		452,292	454,187	587,902	635,392	

$$L_{x,t} = |E_{x,t}| / \sum_y |E_{y,t}|$$

Approach 1 Level Assessment

- Categories should be sorted in descending order of magnitude of the level assessment

CATEGORIES	2008 <i>absolute values</i> <i>Gg CO₂ eq</i>	Level assessment
CO2 stationary combustion gaseous fuels	162,029	0.255
CO2 Mobile combustion: Road Vehicles	113,945	0.179
CO2 stationary combustion liquid fuels	84,009	0.132
CO2 stationary combustion solid fuels	65,128	0.103
CO2 Forest land remaining Forest Land	63,026	0.099
CO2 Cement production	16,127	0.025
CO2 Cropland remaining Cropland	13,239	0.021
CH4 from Solid waste Disposal Sites	11,076	0.017
CH4 Enteric Fermentation in Domestic Livestock	10,921	0.017
Direct N2O Agricultural Soils	8,122	0.013

Approach 1 Level Assessment

The cumulative total of the level should then be computed

CATEGORIES	2008 <i>absolute values</i> <i>Gg CO₂ eq</i>	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	162,029	0.255	0.26
CO2 Mobile combustion: Road Vehicles	113,945	0.179	0.43
CO2 stationary combustion liquid fuels	84,009	0.132	0.57
CO2 stationary combustion solid fuels	65,128	0.103	0.67
CO2 Forest land remaining Forest Land	63,026	0.099	0.77
CO2 Cement production	16,127	0.025	0.79
CO2 Cropland remaining Cropland	13,239	0.021	0.81
CH4 from Solid waste Disposal Sites	11,076	0.017	0.83
CH4 Enteric Fermentation in Domestic Livestock	10,921	0.017	0.85
Direct N2O Agricultural Soils	8,122	0.013	0.86
HFC, PFC substitutes for ODS	7,371	0.012	0.87
Indirect N2O from Nitrogen used in agriculture	7,104	0.011	0.88
CO2 Grassland remaining Grassland	7,032	0.011	0.90
CO2 Land converted to Grassland	5,639	0.009	0.90
CO2 Mobile combustion: Waterborne Navigation	5,111	0.008	0.91
CH4 Fugitive emissions from Oil and Gas Operations	5,041	0.008	0.92
CO2 stationary combustion other fuels	4,943	0.008	0.93
N2O Manure Management	3,775	0.006	0.93
N2O stationary combustion	3,768	0.006	0.94
CO2 Land converted to Settlements	3,253	0.005	0.95
CH4 Manure Management	2,961	0.005	0.95



95%

The categories that cumulatively account for 95% of the total level assessment are considered *key categories*

Approach 1 Trend Assessment

- Trend assessment can be calculated if inventory agencies have data for more than 2 years

CATEGORIES	Gas	base year (1990)	2008	Trend assessment	% Contribution to trend
		Gg CO ₂ eq.	Gg CO ₂ eq.		
CO2 stationary combustion liquid fuels	CO2	153,467	84,009	0.12	0.28066
CO2 stationary combustion solid fuels	CO2	59,397	65,128	0.01	0.02195
CO2 stationary combustion gaseous fuels	CO2	85,066	162,029	0.13	0.30672
CO2 stationary combustion other fuels	CO2	1,779	4,943	0.01	0.01264
CH4 stationary combustion	CH4	647	977	0.00	0.00131
N2O stationary combustion	N2O	3,445	3,768	0.00	0.00123
CO2 Mobile combustion: Road Vehicles	CO2	93,387	113,945	0.03	0.08074
CH4 Mobile combustion: Road Vehicles	CH4	694	296	0.00	0.00160
N2O Mobile combustion: Road Vehicles	N2O	786	978	0.00	0.00075

$$\left| \frac{E_{x,0}}{\sum_y |E_{y,0}|} \cdot \left[\frac{(E_{x,t} - E_{x,0})}{|E_{x,0}|} \right] - \left[\frac{(E_t - E_0)}{\sum_y |E_{y,0}|} \right] \right|$$

- Contribution to trend should then be computed

Approach 1 Trend Assessment

- Categories should be sorted in descending order of contribution to trend and the cumulative percentage should be calculated

CATEGORIES	base year (1990)	2008	% Contribution to trend	Cumulative Percentage
	Gg CO ₂ eq	Gg CO ₂ eq		
CO2 stationary combustion gaseous fuels	85,066	162,029	0.307	0.31
CO2 stationary combustion liquid fuels	153,467	84,009	0.281	0.59
CO2 Forest land remaining Forest Land	-42,131	-63,026	0.084	0.67
CO2 Mobile combustion: Road Vehicles	93,387	113,945	0.081	0.75
CO2 Cropland remaining Cropland	-20,765	-13,239	0.030	0.78
HFC, PFC substitutes for ODS	134	7,371	0.029	0.81
CO2 Land converted to Grassland	0	-5,639	0.023	0.83
CO2 stationary combustion solid fuels	59,397	65,128	0.022	0.86
N2O Adipic Acid	4,579	707	0.016	0.87
CO2 stationary combustion other fuels	1,779	4,943	0.013	0.88
CO2 Grassland remaining Grassland	-4,156	-7,032	0.012	0.90
CH4 Fugitive emissions from Oil and Gas Operations	7,298	5,041	0.009	0.90
CH4 from Solid waste Disposal Sites	13,294	11,076	0.009	0.91
CO2 Ammonia production	2,765	882	0.008	0.92
N2O Nitric Acid	2,086	358	0.007	0.93
CO2 Iron and Steel production	3,124	1,424	0.007	0.94
PFC Aluminium production	1,673	111	0.006	0.94
Direct N2O Agricultural Soils	9,581	8,122	0.006	0.95
CH4 Enteric Fermentation in Domestic Livestock	12,179	10,921	0.005	0.95
CO2 Fugitive emissions from Oil and Gas Operations	3,341	2,258	0.004	0.96



95%

The categories that cumulatively account for 95% of the total trend are considered *key categories*

Aggregation level of Category-by-Category description

We'll focus on the category *Forest land*, and subcategories *Forest land remaining Forest land* and *Land converting to Forest land*.

The category *Forest land* is usually a key category; according to the suggestion of 2006 IPCC Guidelines we'll determine which pools (Living biomass, DOM, Soils) are significant. The resulting subcategories (or pools in our case) have to be treated as particularly significant.

Disaggregation per pools

Forest land remaining forest land

	Net C stock change in living biomass	Net C stock change in DOM	Net C stock change in soils
	%	%	%
1990	41.3	8.8	49.9
2008	49.3	8.4	42.3

Forest land

	Net C stock change in living biomass	Net C stock change in DOM	Net C stock change in soils
	%	%	%
1990	41.0	8.7	50.3
2008	48.4	8.3	43.3

Land converting to Forest land

	Net C stock change in living biomass	Net C stock change in DOM	Net C stock change in soils
	%	%	%
1990	22.7	5.0	72.2
2008	16.2	2.8	81.0

The contribute of different pools (Living biomass, DOM, Soils) have been computed for the above-mentioned subcategories, for the base year under UNFCCC and for the last inventory year.

Disaggregation per subcategories

Forest land remaining forest land

Net C stock change in living biomass

	stands	coppices	rupicolous and riparian forests
	%	%	%
1990	22.7	70.9	6.4
2008	34.0	58.7	7.3

Forest land

Net C stock change in living biomass

	stands	coppices	rupicolous and riparian forests
	%	%	%
1990	22.7	70.9	6.4
2008	34.0	58.7	7.3

Land converting to Forest land

Net C stock change in living biomass

	stands	coppices	rupicolous and riparian forests
	%	%	%
1990	23.4	69.9	6.7
2008	34.4	58.0	7.6

Each subcategory has been reported disaggregated into 3 classes (*stands*, *coppices*, *rupicolous* and *riparian forests*). The contributes of the different classes have been computed, for the base year under UNFCCC and for the last inventory year.

Uncertainties:

Approach 1 (error propagation method)

Where uncertain quantities are to be combined by multiplication, as when deriving the overall uncertainty in national estimates, IPCC 2006 Guidelines suggest to use the following equation:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2}$$

where:

U_{total} = percentage uncertainty in the product of the quantities

U_i = percentage uncertainty associated with source/sink i

Where uncertain quantities are to be combined by multiplication, as when deriving the overall uncertainty in national estimates, IPCC 2006 Guidelines suggest to use the following equation:

$$U_E = \frac{\sqrt{(U_1 \cdot E_1)^2 + (U_2 \cdot E_2)^2 + \dots + (U_n \cdot E_n)^2}}{|E_1 + E_2 + \dots + E_n|}$$

where:

U_E = percentage uncertainty of the sum

U_i = percentage uncertainty associated with source/sink i

E_i = emission/removal estimate for source/sink i

Disaggregation and uncertainties

A notable difference among the pools (*Living Biomass, Dead Organic Matter and Soils*) emerges from uncertainties analysis.

Uncertainties for C pools		
Net C stock change in living biomass	Net C stock change in DOM	Net C stock change in soils
%	%	%
78%	96%	152%

The uncertainty assessment carried out for the 3 classes (*stands, coppices, rupicolous and riparian forests*) results in very similar values.

Disaggregation and uncertainties

The category by category description is functional to the key category analysis. In this context, high uncertainties can affect the outcomes of Approach 2 key category analysis, where categories uncertainties are incorporated by weighting the Approach 1 Level and Trend assessment results by categories' relative uncertainty.

This is the rationale that has led to the exercise of the key category analysis: in the analysis, following the outcomes of the category by category description two cases will be studied, taking into account the disaggregation per pools of the category forest land remaining forest land. The chosen example will emphasize the role of uncertainty in the key category analysis, and the consequent attention to be given to category (subcategory or pool) in estimation process.

Approach 2 Level assessment

- The uncertainty analysis should be carried out

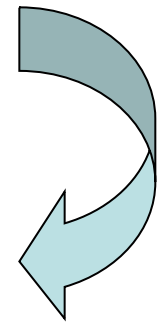
IPCC category	Gas	Base year emissions 1990	Year t emissions 2008	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance in year t
CO2 stationary combustion liquid fuels	CO2	153,467	84,009	3%	3%	0.042	0.000
CO2 stationary combustion solid fuels	CO2	59,397	65,128	3%	3%	0.042	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	162,029	3%	3%	0.042	0.000
CO2 stationary combustion other fuels	CO2	1,779	4,943	3%	3%	0.042	0.000
CH4 stationary combustion	CH4	647	977	3%	50%	0.501	0.000
N2O stationary combustion	N2O	3,445	3,768	3%	50%	0.501	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	113,945	3%	3%	0.042	0.000
CH4 Mobile combustion: Road Vehicles	CH4	694	296	3%	40%	0.401	0.000
N2O Mobile combustion: Road Vehicles	N2O	786	978	3%	50%	0.501	0.000
CO2 FL remaining FL - Living biomass	CO2	-17,391	-31,072	30%	72%	0.780	0.003
CO2 FL remaining FL - Dead Organic matter	CO2	-3,709	-5,310	30%	91%	0.958	0.000
CO2 FL remaining FL - Soils	CO2	-21,031	-26,644	41%	146%	1.516	0.008
CH4 Forest land remaining Forest Land	CH4	146	46	30%	54%	0.613	0.000
N2O Forest land remaining Forest Land	N2O	15	5	30%	54%	0.613	0.000
CO2 Cropland remaining Cropland	CO2	-20,765	-13,239	75%	75%	1.061	0.001
CO2 Land converted to Forest Land	CO2	-753	-1,667	75%	75%	1.061	0.000
CO2 Land converted to Cropland	CO2	656	0	75%	75%	1.061	0.000
CO2 Grassland remaining Grassland	CO2	-4,156	-7,032	75%	75%	1.061	0.000
CO2 Land converted to Grassland	CO2	0	-5,639	75%	75%	1.061	0.000
N2O Land converted to Cropland	N2O	80	0	75%	75%	1.061	0.000
CO2 Land converted to Settlements	CO2	2,151	3,253	75%	75%	1.061	0.000
TOTAL		452,292	454,187				0.014
						Percentage uncertainty in total inventory	12%

Approach 2 Level Assessment

- The level assessment with uncertainty should be computed for each category ($LU_{x,t}$)
- The category uncertainties are incorporated by weighting the Approach 1 level assessment results to the relative uncertainty
- Results should be sorted according to decreasing order of magnitude, similarly as Approach 1
- The key categories are those that add up to 90% of the sum of all $LU_{x,t}$

Approach 2 Level assessment

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative percentage
CO2 FL remaining FL - Soils	0.0636	0.2426	0.24
CO2 FL remaining FL - Living biomass	0.0381	0.1455	0.39
CO2 Cropland remaining Cropland	0.0221	0.0843	0.47
Direct N2O Agricultural Soils	0.0130	0.0497	0.52
CO2 Grassland remaining Grassland	0.0117	0.0448	0.57
Indirect N2O from Nitrogen used in agriculture	0.0114	0.0435	0.61
CO2 stationary combustion gaseous fuels	0.0108	0.0413	0.65
CO2 Land converted to Grassland	0.0094	0.0359	0.69
CO2 FL remaining FL - Dead Organic matter	0.0080	0.0305	0.72
CO2 Mobile combustion: Road Vehicles	0.0076	0.0290	0.75
HFC, PFC substitutes for ODS	0.0068	0.0258	0.77
CH4 from Solid waste Disposal Sites	0.0063	0.0240	0.80
N2O Manure Management	0.0061	0.0231	0.82
CO2 stationary combustion liquid fuels	0.0056	0.0214	0.84
CH4 Enteric Fermentation in Domestic Livestock	0.0049	0.0185	0.86
CH4 Manure Management	0.0048	0.0181	0.88
CH4 Emissions from Wastewater Handling	0.0047	0.0178	0.90
CO2 stationary combustion solid fuels	0.0043	0.0166	0.91
N2O stationary combustion	0.0030	0.0113	0.92
CO2 Land converted to Forest Land	0.0028	0.0106	0.93



90%

$$L_{x,t} \cdot U_{x,t}$$

$$(L_{x,t} \cdot U_{x,t}) / \sum_y [(L_{y,t} \cdot U_{y,t})]$$