UN-REDD PROGRAMME

UN-REDD approach to GHG inventory component of an NFMS

FAO UN-REDD

African Regional Workshop on REDD+
National Forest Monitoring Systems and
Greenhouse Gas (GHG) National Inventory Systems
Livingstone, Zambia

25-28 February 2014

UN-REDD PROGRAMME

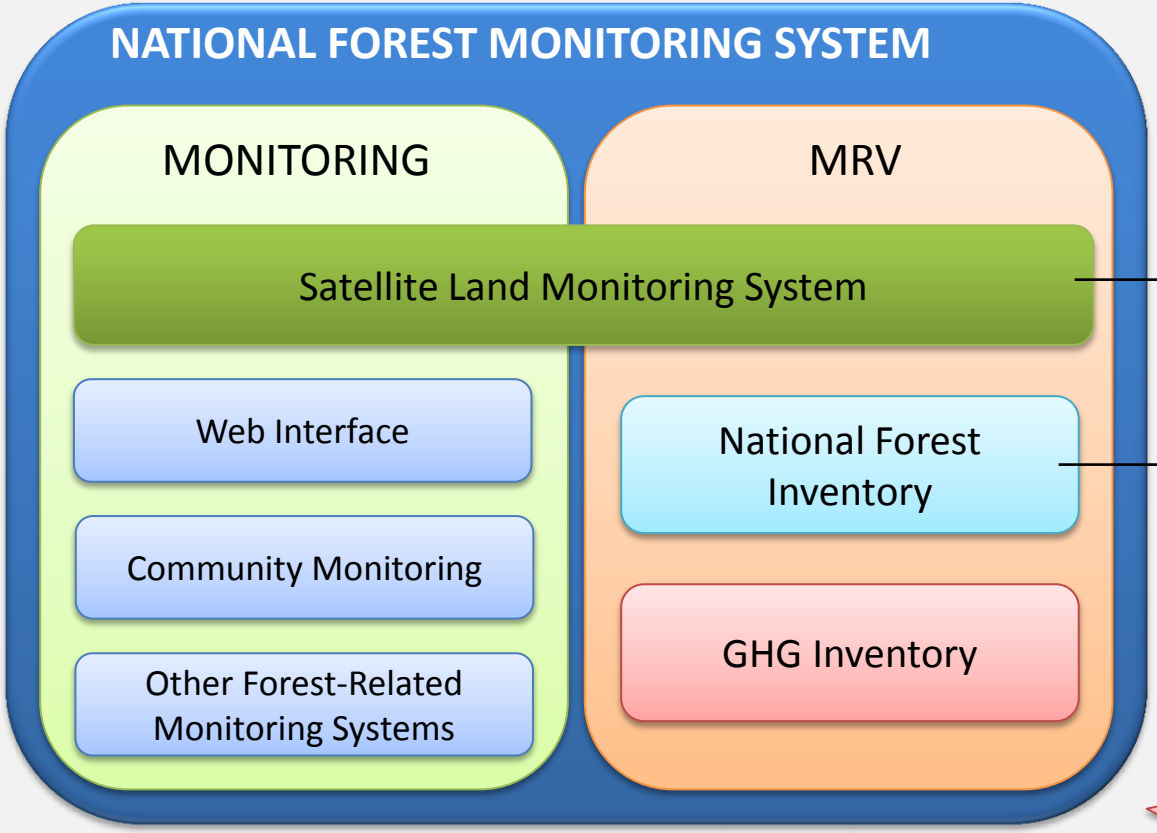
MRV components

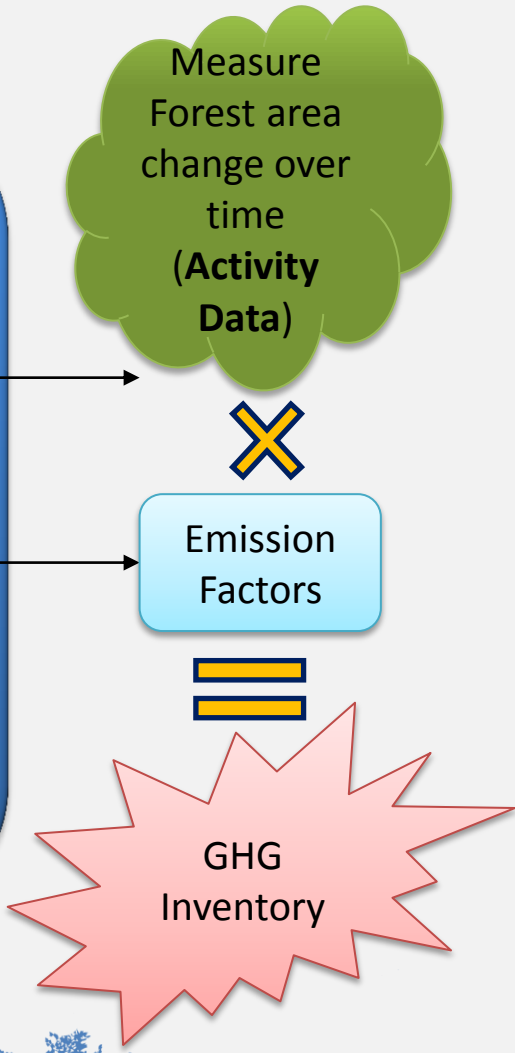
The MRV function consists of three main components or 'pillars':

1. **The satellite land monitoring system (SLMS)**
   - To collect Activity Data (AD) on forest area change
2. **The national forest inventory (NFI)**
   - To gather information to obtain Emission Factors (EFs)
3. **The national GHG inventory (GHG-I)**
   - To provide emissions & removals estimates for national GHG inventory report

UN-REDD PROGRAMME

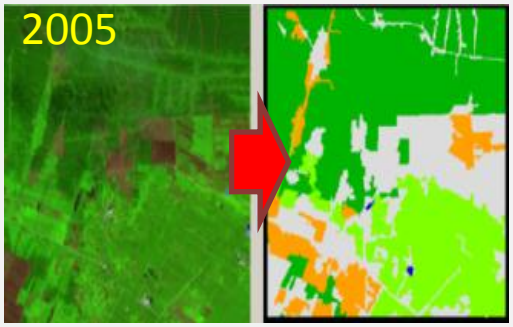
National Forest Monitoring Systems for REDD+





UN-REDD PROGRAMME

Measuring & Reporting forest carbon emissions and removals



CO_2

	FL Wet evergreen	FL Moist evergreen	FL Moist semi-deciduous	FL South-east subtype	FL North-west subtype	FL North-west subtype	FL Dry semi-deciduous	Agricultural land	Savanna	Shrub Ticket	Settlements	Wetlands	Other land	Unclassified	Final Area
FL Wet evergreen	51														51
FL Moist evergreen		42													42
FL Moist semi-deciduous			60												60
FL South-east subtype				52											52
FL North-west subtype					12										12
FL North-west subtype						2									2
FL Dry semi-deciduous							25		2						27
Agricultural land	5	2				2	3	1							13
Savanna			1			3	1		20						25
Shrub Ticket					1					12					13
Settlements						1		10			25				36
Wetland									0			2			2
Other land								5					25		30
Unclassified								9						10	19
Initial Area	56	44	61	52	13	8	29	25	22	12	25	17	25	10	
Net change (Δ = T0-T1)	-5	-2	-1	0	-1	-6	-2	-12	3	1	11	-15	5	9	0

Area change data from satellite remote sensing

Forest carbon stock change data from a national forest inventory

Inventory of greenhouse gas **emissions** from the forest sector

ACTIVITY DATA × **EMISSION FACTOR** = **EMISSIONS ESTIMATE**

UN-REDD PROGRAMME

Report on Changes in the Five Forest Carbon Pools

1. Above-ground biomass
2. Below-ground biomass

} biomass

3. Deadwood
4. Litter

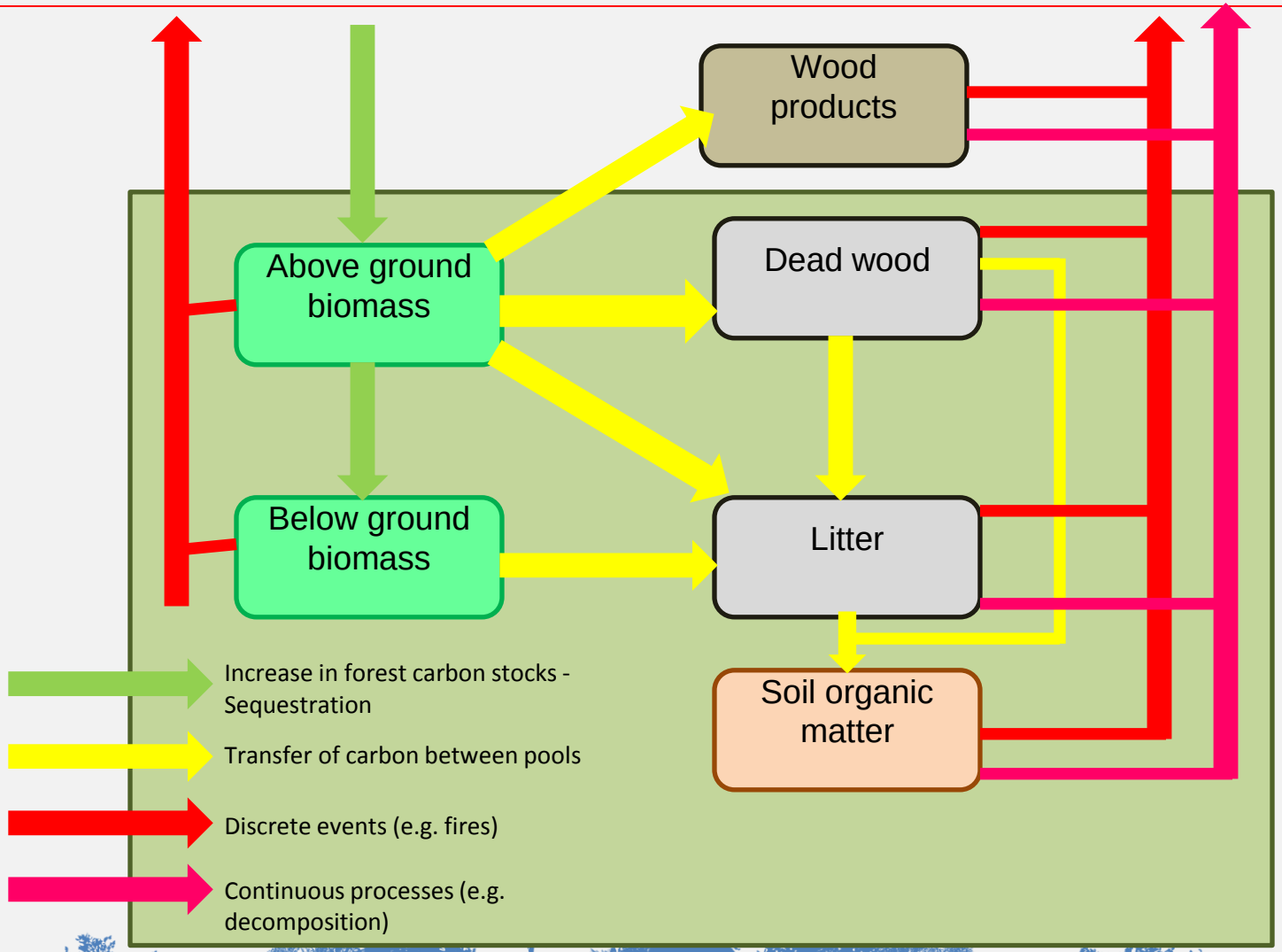
} dead organic matter

5. Soil

{ - mineral
- organic

$$\Delta Carbon = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SO}$$

Changes in Forest Carbon Pools



UN-REDD PROGRAMME

Activity Data in a GHG Inventory report

TABLE 5(KP-I)A.2. SUPPLEMENTARY BACKGROUND DATA ON CARBON STOCK CHANGES AND NET CO_2 EMISSIONS AND REMOVALS FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO

AUSTRALIA
Inventory 2011
Submission 2013 v1.1

Article 3.3 activities: Deforestation [1]

GEOGRAPHICAL LOCATION [2]	ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FA							N STOCK [5]				
Identification code	Subdivision [3]	Area subject to the activity	Area of organic soils [4]	Carbon stock change in above-ground biomass per			Carbon stock change in below-ground biomass per			Net carbon stock change in litter per	Net carbon stock change in litter [5]	Net carbon stock change in dead wood [5]	Net carbon stock change in soils [5]		Net CO_2 emissions/ removals [5]
				Gains	Losses	Net change	Gains	Losses	Net change				Mineral soils	Organic soils [5]	
		(kha)	(kha)	(Mg C/ha)											(Gg CO_2)
Total for activity A.2.		6,501.52	NO	0.00	-0.39	-0.39	0.00	-0.17	-0.17	-0.15	-958.47	-2,185.90	-3,044.52	NO	36,244.92
NSW		1,020.73	NO	0.00	-0.80	-0.80	0.00	-0.34	-0.34	-0.33	-331.81	-416.51	-556.98	NO	9,049.08
	Acacia Forest and Woodland	61.17	NO	IE	-0.18	-0.18	IE	-0.08	-0.08	-0.14	-8.59	-10.92	0.69	NO	127.18
	Acacia Open Woodland	0.44	NO	IE	-0.52	-0.52	IE	-0.50	-0.50	-0.22	-0.10	-0.15	0.02	NO	2.49
	Acacia Shrubland	93.21	NO	IE	-0.12	-0.12	IE	-0.12	-0.12	-0.15	-14.21	-5.86	-1.38	NO	159.82
	Callitris Forest and Woodland	48.32	NO	IE	-0.46	-0.46	IE	-0.21	-0.21	-0.29	-14.15	-7.29	-9.17	NO	229.99
	Casuarina Forest and	51.32	NO	IE	-0.39	-0.39	IE	-0.18	-0.18	-0.23	-11.68	-23.06	-2.53	NO	243.29
	Eucalyptus Low Open	1.38	NO	0.19	IE	0.19	0.09	IE	0.09	-0.20	-0.28	-0.69	-0.32	NO	3.31
	Eucalyptus Open Forest	243.31	NO	IE	-1.39	-1.39	IE	-0.63	-0.63	-0.58	-140.17	-265.00	-299.61	NO	4,386.28
	Eucalyptus Open	82.39	NO	IE	-1.58	-1.58	IE	-0.66	-0.66	-0.30	-24.56	7.77	-43.77	NO	896.73
	Eucalyptus Tall Open Forest	20.71	NO	IE	-2.37	-2.37	IE	-0.31	-0.31	-0.76	-15.80	-42.64	-28.29	NO	522.03
	Eucalyptus Woodland	338.73	NO	IE	-0.62	-0.62	IE	-0.26	-0.26	-0.26	-89.27	-50.82	-134.55	NO	2,103.99
	Heath	1.62	NO	IE	-1.38	-1.38	IE	-1.35	-1.35	-0.59	-0.96	-0.81	-2.57	NO	32.09
	Low Closed Forest and	1.98	NO	IE	-0.29	-0.29	IE	-0.28	-0.28	-0.14	-0.27	-0.08	-0.61	NO	7.70
	Mallee Woodland and	69.97	NO	IE	-0.08	-0.08	IE	-0.08	-0.08	-0.11	-7.74	-5.47	-25.31	NO	181.40
	Melaleuca	0.79	NO	IE	-2.35	-2.35	IE	-1.08	-1.08	-0.19	-0.15	0.26	-0.98	NO	13.15

NSW		1,020.73
	Acacia Forest and Woodland	61.17
	Acacia Open Woodland	0.44
	Acacia Shrubland	93.21
	Callitris Forest and Woodland	48.32
	Casuarina Forest and	51.32
	Eucalyptus Low Open	1.38
	Eucalyptus Open Forest	243.31
	Eucalyptus Open	82.39
	Eucalyptus Tall Open Forest	20.71
	Eucalyptus Woodland	338.73
	Heath	1.62
	Low Closed Forest and	1.98
	Mallee Woodland and	69.97
	Melaleuca	0.79

UN-REDD PROGRAMME

Emission Factors in the GHG Inventory report

TABLE 5(KP-I)A.2. SUPPLEMENTARY BACKGROUND DATA ON CARBON STOCK CHANGES AND NET CO_2 EMISSIONS AND REMOVALS FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

AUSTRALIA
Inventory 2011
Submission 2013 v1.1

Article 3.3 activities: Deforestation [1]

GEOGRAPHICAL LOCATION [2]	ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [5]										Implied emission / removal factor per area [5]	CHANGE IN CARBON STOCK [5]										Net CO_2 emissions/ removals [5]
				Carbon stock change in above-ground biomass per			Carbon stock change in below-ground biomass per			Net carbon stock change in litter per	Net carbon stock change in dead wood	Net carbon stock change in soils per			Carbon stock change in above-ground biomass [4], [5]			Carbon stock change in below-ground biomass [4], [5]			Net carbon stock change in litter [4]	Net carbon stock change in dead wood [4]	Net carbon stock change in soils [4]		
Identification code	Subdivision [3]	Area subject to the activity	Area of organic soils [7]	Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils		Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils [5]	
		(kha)	(kha)	(Mg C/ha)										Mg CO_2/ha	(Gg C)										(Gg CO_2)
Total for activity A.2.		6,501.52	NO	0.00	-0.39	-0.39	0.00	-0.17	-0.17	-0.15	-0.34	-0.47	NO	5.57	0.50	-2,561.09	-2,560.59	0.23	-1,135.73	-1,135.50	-958.47	-2,185.90	-3,044.52	NO	36,244.92
NSW		1,220.73	NO	0.00	-0.80	-0.80	0.00	-0.34	-0.34	-0.33	-0.41	-0.55	NO	8.87	0.27	-812.57	-812.30	0.12	-350.44	-350.32	-331.81	-416.51	-556.98	NO	9,049.08
	Acacia Forest and Woodland	61.17	NO	IE	-0.18	-0.18	IE	-0.08	-0.08	-0.14	-0.18	0.01	NO	2.08	IE	-10.92	-10.92	IE	-4.95	-4.95	-8.59	-10.92	0.69	NO	127.18
	Acacia Open Woodland	0.44	NO	IE	-0.52	-0.52	IE	-0.50	-0.50	-0.22	-0.33	0.04	NO	5.61	IE	-0.23	-0.23	IE	-0.22	-0.22	-0.10	-0.15	0.02	NO	2.49
	Acacia Shrubland	93.21	NO	IE	-0.12	-0.12	IE	-0.12	-0.12	-0.15	-0.06	-0.01	NO	1.71	IE	-11.28	-11.28	IE	-10.86	-10.86	-14.21	-5.86	-1.38	NO	159.82
	Callitris Forest and Woodland	48.32	NO	IE	-0.46	-0.46	IE	-0.21	-0.21	-0.29	-0.15	-0.19	NO	4.76	IE	-22.01	-22.01	IE	-10.10	-10.10	-14.15	-7.29	-9.17	NO	229.99
	Casuarina Forest and	51.32	NO	IE	-0.39	-0.39	IE	-0.18	-0.18	-0.23	-0.45	-0.05	NO	4.74	IE	-20.05	-20.05	IE	-9.03	-9.03	-11.68	-23.06	-2.53	NO	243.29
	Eucalyptus Low Open	1.38	NO	0.19	IE	0.19	0.09	IE	0.09	-0.20	-0.50	-0.23	NO	2.40	0.27	IE	0.27	0.12	IE	0.12	-0.28	-0.69	-0.92	NO	3.31
	Eucalyptus Open																								4,386.28
	Eucalyptus Open																								896.73
	Eucalyptus Open																								522.03
	Eucalyptus Woodland																								2,103.99
	Heath																								32.09
	Low Forest																								7.70
	Mallee Woodland																								181.40
	Melaleuca																								13.15

IMPLIED CARBON STOCK CHANGE FACTORS [5]

Carbon stock change in above-ground biomass per			Carbon stock change in below-ground biomass per			Net carbon stock change in litter per	Net carbon stock change in dead wood	Net carbon stock change in soils per		Implied emission / removal factor per area [5]
Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils	
(Mg C/ha)										Mg CO_2/ha

UN-REDD PROGRAMME

Carbon stock change for the 5 pools in GHG report

TABLE 5(KP-I)A.2. SUPPLEMENTARY BACKGROUND DATA ON CARBON STOCK CHANGES AND NET CO_2 EMISSIONS AND REMOVALS FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

AUSTRALIA
Inventory 2011
Submission 2013 v1.1

Article 3.3 activities: Deforestation [1]

GEOGRAPHICAL LOCATION [2]	ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [5]										Implied emission / removal factor per area [4]	CHANGE IN CARBON STOCK [5]									Net CO_2 emissions/ removals [4]
				Carbon stock change in above-ground biomass per			Carbon stock change in below-ground biomass per			Net carbon stock change in litter per	Net carbon stock change in dead wood per	Net carbon stock change in soils per			Carbon stock change in above-ground biomass [4], [5]			Carbon stock change in below-ground biomass [4], [5]			Net carbon stock change in litter [4]	Net carbon stock change in dead wood [4]	Net carbon stock change in soils [4]		
Identification code	Subdivision [1]	Area subject to the activity	Area of organic soils [1], [7]	Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils		Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils [3]	
		(kha)	(kha)	(Mg C/ha)										Mg CO_2/ha	(Gg C)									(Gg CO_2)
Total for activity A.2.		6,501.52	NO	0.00	-0.39	-0.39	0.00	-0.17	-0.17	-0.15	-0.34	-0.47	NO	5.57	0.50	-2,561.09	-2,560.59	0.23	-1,135.73	-1,135.50	-958.47	-2,185.90	-3,044.52	NO	36,244.92
NSW		1,020.73	NO	0.00	-0.80	-0.80	0.00	-0.34	-0.34	-0.33	-0.41	-0.55	NO	8.87	0.27	-812.57	-812.30	0.12	-350.44	-350.32	-331.81	-416.51	-556.98	NO	9,049.08
	Acacia Forest and Woodland	61.17	NO	IE	-0.18	-0.18	IE	-0.08	-0.08	-0.14	-0.18	0.01	NO	2.08	IE	-10.92	-10.92	IE	-4.95	-4.95	-8.59	-10.92	0.69	NO	127.18
	Acacia Open Woodland	0.44	NO	IE	-0.52	-0.52	IE	-0.50	-0.50	-0.22	-0.33	0.04	NO	5.61	IE	-0.23	-0.23	IE	-0.22	-0.22	-0.10	-0.15	0.02	NO	2.49
	Acacia Shrubland	93.21	NO	IE	-0.12	-0.12	IE	-0.12	-0.12	-0.15	-0.06	-0.01	NO	1.71	IE	-11.28	-11.28	IE	-10.86	-10.86	-14.21	-5.86	-1.38	NO	159.82
	Callitris Forest and Woodland	48.32	NO	IE	-0.46	-0.46	IE	-0.21	-0.21	-0.29	-0.15	-0.19	NO	4.76	IE	-22.01	-22.01	IE	-10.10	-10.10	-14.15	-7.29	-9.17	NO	229.99
	Casuarina Forest and	51.32	NO	IE	-0.39	-0.39	IE	-0.18	-0.18	-0.23	-0.45	-0.05	NO	4.74	IE	-20.05	-20.05	IE	-9.03	-9.03	-11.68	-23.06	-2.53	NO	243.29
	Eucalyptus Low Open	1.3	NO	0.19	IE	0.19	0.09	IE	0.09	-0.20	-0.50	-0.23	NO	2.40	0.27	IE	0.27	0.12	IE	0.12	-0.28	-0.69	-0.32	NO	3.31
	Eucalyptus Open Forest	243.31	NO	IE	-1.39	-1.39	IE	-0.63	-0.63	-0.58	-1.09	-1.23	NO	18.03	IE	-337.78	-337.78	IE	-153.70	-153.70	-140.17	-265.00	-299.61	NO	4,386.28
	Eucalyptus Open																				14	-24.56	7.77	-43.77	NO	896.73
	Eucalyptus Open Fore																				2	-15.80	-42.64	-28.29	NO	522.03
	Eucalyptus Woodland																				79	-89.27	-50.82	-134.55	NO	2,103.99
	Heath																				9	-0.96	-0.81	-2.57	NO	32.09
	Low Close Forest and																				6	-0.27	-0.08	-0.61	NO	7.70
	Mallee Woodland																				0	-7.74	-5.47	-25.31	NO	181.40
	Melaleuca																				6	-0.15	0.26	-0.98	NO	13.15

CHANGE IN CARBON STOCK [5]

Carbon stock change in above-ground biomass [4], [5]			Carbon stock change in below-ground biomass [4], [5]			Net carbon stock change in litter [4]	Net carbon stock change in dead wood [4]	Net carbon stock change in soils [4]	
Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils [3]
(Gg C)									
0.50	-2,561.09	-2,560.59	0.23	-1,135.73	-1,135.50	-958.47	-2,185.90	-3,044.52	NO
0.27	-812.57	-812.30	0.12	-350.44	-350.32	-331.81	-416.51	-556.98	NO

UN-REDD PROGRAMME

Net CO2 emissions &/or removals in GHG report

TABLE 5(KP-I)A.2. SUPPLEMENTARY BACKGROUND DATA ON CARBON STOCK CHANGES AND NET CO_2 EMISSIONS AND REMOVALS FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

AUSTRALIA
Inventory 2011
Submission 2013 v1.1

Article 3.3 activities: Deforestation [1]

GEOGRAPHICAL LOCATION [2]	ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [5]										Implied emission / removal factor per area [10]	CHANGE IN CARBON STOCK [5]										Net CO_2 emissions/ removals [10]
Identification code	Subdivision [1]	Area subject to the activity	Area of organic soils [7]	Carbon stock change in above-ground biomass per			Carbon stock change in below-ground biomass per			Net carbon stock change in litter per	Net carbon stock change in dead wood	Net carbon stock change in soils per			Carbon stock change in above-ground biomass [4], [5]			Carbon stock change in below-ground biomass [4], [5]			Net carbon stock change in litter [4]	Net carbon stock change in dead wood [4]	Net carbon stock change in soils [4]		
				Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils		Gains	Losses	Net change	Gains	Losses	Net change			Mineral soils	Organic soils [9]	
		(kha)	(kha)	(Mg C/ha)										Mg CO_2/ha	(Gg C)										(Gg CO_2)
Total for activity A.2.		6,501.52	NO	0.00	-0.39	-0.39	0.00	-0.17	-0.17	-0.15	-0.34	-0.47	NO	5.57	0.50	-2,561.09	-2,560.59	0.23	-1,135.73	-1,135.50	-958.47	-2,185.90	-3,044.52	NO	36,244.92
NSW		1,020.73	NO	0.00	-0.80	-0.80	0.00	-0.34	-0.34	-0.33	-0.41	-0.55	NO	8.87	0.27	-812.57	-812.30	0.12	-350.44	-350.32	-338.59	-416.51	-556.98	NO	9,049.08
	Acacia Forest and Woodland	61.17	NO	IE	-0.18	-0.18	IE	-0.08	-0.08	-0.14	-0.18	0.01	NO	2.08	IE	-10.92	-10.92	IE	-4.95	-4.95		-10.92	0.69	NO	127.18
	Acacia Open Woodland	0.44	NO	IE	-0.52	-0.52	IE	-0.50	-0.50	-0.22	-0.33	0.04	NO	5.61	IE	-0.23	-0.23	IE	-0.22	-0.22					2.49
	Acacia Shrubland	93.21	NO	IE	-0.12	-0.12	IE	-0.12	-0.12	-0.15	-0.06	-0.01	NO	1.71	IE	-11.28	-11.28	IE	-10.86	-10.86					159.82
	Callitris Forest and Woodland	48.32	NO	IE	-0.46	-0.46	IE	-0.21	-0.21	-0.29	-0.15	-0.19	NO	4.76	IE	-22.01	-22.01	IE	-10.10	-10.10					229.99
	Casuarina Forest and	51.32	NO	IE	-0.39	-0.39	IE	-0.18	-0.18	-0.23	-0.45	-0.05	NO	4.74	IE	-20.05	-20.05	IE	-9.03	-9.03					243.29
	Eucalyptus Low Open	1.38	NO	0.19	IE	0.19	0.09	IE	0.09	-0.20	-0.50	-0.23	NO	2.40	0.27	IE	0.27	0.12	IE	0.12					3.31
	Eucalyptus Open Forest	243.31	NO	IE	-1.39	-1.39	IE	-0.63	-0.63	-0.58	-1.09	-1.23	NO	18.03	IE	-337.78	-337.78	IE	-153.70	-153.70					4,386.28
	Eucalyptus Open	82.39	NO	IE	-1.58	-1.58	IE	-0.66	-0.66	-0.30	0.09	-0.53	NO	10.88	IE	-129.86	-129.86	IE	-54.14	-54.14					896.73
	Eucalyptus Tall Open Forest	20.71	NO	IE	-2.37	-2.37	IE	-0.31	-0.31	-0.76	-2.06	-1.37	NO	25.21	IE	-49.12	-49.12	IE	-6.52	-6.52					522.03
	Eucalyptus Woodland	338.73	NO	IE	-0.62	-0.62	IE	-0.26	-0.26	-0.26	-0.15	-0.40	NO	6.21	IE	-210.38	-210.38	IE	-88.79	-88.79					2,103.99
	Heath	1.62	NO	IE	-1.38	-1.38	IE	-1.35	-1.35	-0.59	-0.50	-1.58	NO	19.81	IE	-2.23	-2.23	IE	-2.19	-2.19					32.09
	Low Closed Forest and	1.98	NO	IE	-0.29	-0.29	IE	-0.28	-0.28	-0.14	-0.04	-0.31	NO	3.89	IE	-0.57	-0.57	IE	-0.56	-0.56					7.70
	Mallee Woodland and	69.97	NO	IE	-0.08	-0.08	IE	-0.08	-0.08	-0.11	-0.08	-0.36	NO	2.59	IE	-5.57	-5.57	IE	-5.40	-5.40					181.40
	Melaleuca	0.79	NO	IE	-2.35	-2.35	IE	-1.08	-1.08	-0.19	0.32	-1.23	NO	16.55	IE	-1.86	-1.86	IE	-0.86	-0.86					13.15

Net CO_2 emissions/ removals [10]

(Gg CO_2)

36,244.92

9,049.08

127.18

GHG Inventory Reporting Principles: "TACC"

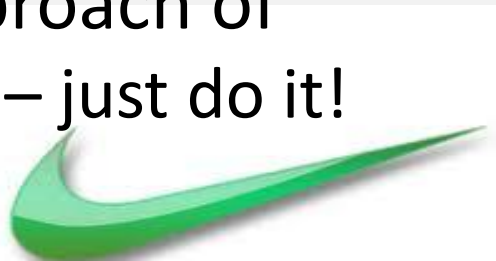
- **T**ransparency
  - Assumptions/methods are clear; inventory can be replicated
- **A**ccuracy
  - Reflect actual emissions and removals
- **C**onsistency
  - Consistent methods so results reflect real emission differences
- **C**ompleteness
  - All relevant sources, sinks and geographic areas
- **C**omparability
  - Methodologies and reporting approach allows comparisons

Recommendations for developing GHG inventory

- Country determine if the GHG inventory as proposed by UN-REDD is a 'component' that it would like to use and develop;
- Establish needs: technology and capacities, incl. institutional arrangements to manage GHG inventory process;
- Establish a clear, realistic roadmap setting out the steps to follow to develop a full GHG inventory for the forest sector;
- Build up technology and capacities required for implementation of an GHG inventory, including: institutional arrangements, collection of information, archiving system;
- Implement GHG inventory and produce clear, measurable results (TACC)
- Source Box 11: page 21 FAO NFMS approach document.

UN-REDD PROGRAMME Concluding comments

- GHG emissions in LULUCF or AFOLU are often some of the largest contributing sectors in developing countries – important to get right!
- GHG emissions = Activity Data X Emission factors
- Report changes in all five forest carbon pools
- Best to understand the principles (TACC) and Components of a GHG Inventory to plan system and BEFORE data collection, calculations or software entry
- REDD+ will take time for countries to learn and implement, = phased / stepwise approach of continual improvement recognised – just do it!



UN-REDD PROGRAMME

Thank you for your attention.

For more information go to our websites:

www.un-redd.org

http://www.unredd.net/