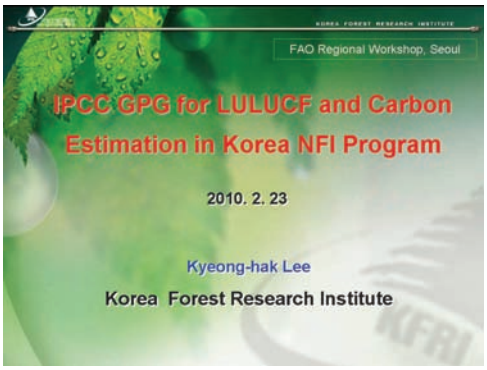
(Appendix 5.7.8)

IPCC Good Practice Guideline for LULUCF & Carbon estimations in Korea NFI program

Mr. Kyunghwak Lee
KFRI



Contents

- Introduction
- IPCC GPG 2003 (LULUCF)
- GHG Inventory System in Korea
- National Forest Inventory System
- Emission/Removal Factors
- Challenges

Introduction

GHG Inventory under UNFCCC

- **Kyoto Protocol - Inventory Report**
  - **All the required items of GHG Inventory**
  - **Difference between submitted and adjusted estimates < 9%**
  - ➢ No meet => No RMUs (sink credits)
- **Post-2012 Climate Regime**
  - **Annex I - Measurable, Reportable, Verifiable Commitment**
  - **Non Annex I - Measurable, Reportable, Verifiable Action**
  - ➢ MRV <=> Credits/Incentives
- **Guidance for Post-2012 GHG Inventory Reporting**
  - **Requirement of Strict Guidance for Credits/Incentives**
  - ➢ IPCC GPG or 2006 IPCC GL

IPCC GPG LULUCF

Definition of Good practice inventories

- Contain neither over- nor under- estimates so far as can be judged
- Have uncertainties reduced so far as is practicable.

GPG is delivered by advice on choice of estimation method, quality assurance and quality control in the application of methods, documentation, archiving and estimation of uncertainties.

Contents of IPCC GPG LULUCF

- **LULUCF Sector GPG**
  - **6 land use categories (matrix)**
    - **forest land, cropland, grassland, wetland, settlement, & other land**
  - **5 carbon pools**
    - **above and below ground biomass, dead wood, litter, & soil**
  - **3 tiers for activity data & emission factors**
    - **default => country specific => model / forest inventory based**

Land Use Categories

- **Forest land**
  - All woody vegetation above national threshold
  - Must be sub-divided into managed and unmanaged
  - Could be divided by ecosystem, province, etc.
- **Cropland**
  - Includes agroforestry if biomass below national forest threshold
- **Grassland**
  - Includes rangeland, pasture, wild lands, recreational areas
  - Sub-divided into managed and unmanaged
- **Wetlands**
  - Covered by water for part of year and
  - Not forest, crop, grass or settlement
  - Sub-divided into managed (reservoirs) and unmanaged (rivers, lakes)
- **Settlements**
  - Includes developed areas, transportation and human settlements (not in another category)
- **Other**
  - Bare soil, rock, ice and any unmanaged land not included elsewhere
  - Used to allow identified areas to match total national area, where data allows

Land-use and Land-use change

- ***Forest land***
  - Forest land remaining Forest land
  - Land converted to Forest Land
- *Cropland*
  - Cropland remaining cropland
  - Land converted to cropland
- *Grassland*
  - Grassland remaining grassland
  - Land converted to grassland

❖ Similarly for wetlands, settlements, and other land

Development of Categories

- Put each land area in only one category
- Use existing data where possible
- Harmonise definitions between agencies
- Use GPG categories as top level with appropriate sub-divisions

Approaches for estimating land-use area and area changes

Approach 1: Basic land-use data

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		Wetland =	0
S = 5		S = 8		Settlement =	+3
O = 2		O = 2		Other =	0
Sum = 140		*Sum = 140*		*Sum =*	*0*

F = Forest Land, G = Grassland, C = Cropland, W = Wetland, S = Settlement, O = Other. Numbers represent area units (Mha in this example.)

Approach 2: Survey of land-use and land-use change

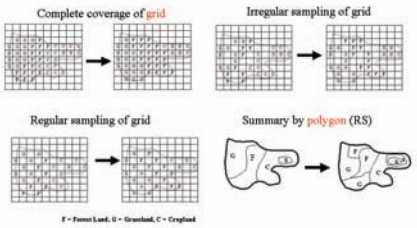
TABLE 3.3.4 ILLUSTRATIVE EXAMPLE OF APPROACH 2 DATA IN A LUC MATRIX WITH CATEGORY SUBDIVISIONS

Initial / Final	Forest (Unmanaged)	Forest (Managed)	Grassland (Rough grazing)	Grassland (Improved)	Cropland	Wetland	Settlement	Other	Final area
Forest (Unmanaged)	5								5
Forest (Managed)		10	1	2	1				14
Grassland (Rough grazing)		2	36						38
Grassland (Improved)			2	22					24
Cropland					29				29
Wetland						0			0
Settlement		1	1		1		5		8
Other								2	2
Initial area	5	13	40	24	31	0	5	2	160
NET change	0	+1	-2	0	-2	0	+3	0	0

F = Forest Land, G = Grassland, C = Cropland, W = Wetland, S = Settlement, O = Other. Numbers represent area units (Mha in this example.)

Approach 3: Geographically explicit land-use

Examples using grids for land-use



Tiers

- **Tier 1** employs basic method provided in the *IPCC Guidelines;* activity data and EF/RF are spatially coarse, default data provided
- **Tier 2** emission factors and activity data are defined by the country for the most important land uses/activities. Higher resolution activity data are typical
- **Tier 3**, higher order methods are driven by high-resolution activity data and disaggregated at sub-national to fine grid scales. A closer link between biomass and soil carbon dynamics established.

- Higher tiers for key categories
- Tiers are not fixed, they should be regarded as on a sliding scale
- Within a land-use category, tiers can differ per carbon pool

GPG arising from KP

- **LULUCF Activities under A 3.3 & 3.4**
  - **DF, AF, RF, FM, CM, GM, RV**
  - **Area Identification, Definition, Estimation and Reporting**
- **LULUCF projects under A6(JI) and A12(CDM)**
  - **Project boundary**
  - **Measuring, Monitoring and Estimating GHG Removals/Emissions**

Cross-Cutting Issues

- **Uncertainty, Sampling, Key Category, QA/QC, Time Series, Verification**

Sampling

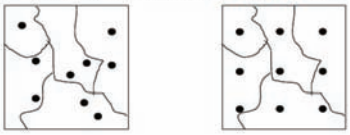
- **Data for the LULUCF sector**
  - **Sample surveys**
  - **Estimating changes in land use or in carbon stocks**
  - **National forest inventories**

  ⇒ Reporting of emissions/removals of GHG
- **Good practice guidance**
  - **Sampling principles, design, and methods**
  - **Uncertainty**

- **Scaling up the information from plots to population by sampling theory**
- **Increasing efficiency in the use of inventory resources by properly designed sampling**
- **Sampling theory**
  - **Random sampling : Standard**
  - **Subjective sampling : Limited resources**

Systematic sampling

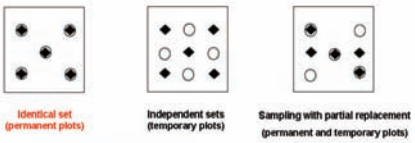
Simple random layout of plots (left) and systematic layout (right)



- Increasing the precision of the estimates
- Simplifying the field work

⇒ Superior to simple random sampling

Three sampling designs for change estimation



○ Sampling unit measured at occasion 1
◆ Sampling unit measured at occasion 2

- Permanent sample plots
  - More efficient than temporary plots : actual trend

GHG Inventory System in Korea

•Project funded by the Korea Forest Service ('07 - '11)

Forest and Forestry in Korea

- Forest land : 65% of total land area
- Location in warm temperate zone
- Heterogeneity in site, species and ownership
- Slow decrease of forest land : 0.1% annually
- Rapid increase of growing stock : 3% annually
- Immature stage
- Low economic efficiency in timber production
- Increasing demands of environmental services

Carbon Flux in Forests (2005) – based on 1996 IPCC Guideline

Categories of GHG emissions/removals	Emissions	Removals	Net emissions/ removals
	(Mg CO2)		
Total	9,625	(-)42,482	(-)32,856
A. Changes in Forest & other Woody Biomass Stocks	5,207	(-)43,472	(-)37,275
B. Forest & Grassland Conversion (biomass)	370	0	370
C. Abandonment of managed Lands	NE	NE	NE
D. Changes in Soil Carbon for Mineral Soil	4,052	0	4,052
E. others	NE	NE	NE

☞ LUCF in Korea - Net sinks

Objective

To establish the basis of

forest carbon inventory system

for reporting GHG inventory

under the UNFCCC and a potential Post-2012 agreement

☞ GPG LULUCF with tier 2 ~ tier 3

GHG Inventory System

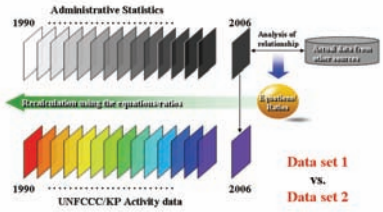
Statistical Sources for UNFCCC/KP Activity Data

Activity data / Statistical sources	AF/RF	DF	FM (narrow)	Forest fires	Harvest
Statistical yearbook	-	Forest conversion	Stand-level practices	Forest fire damage	Domestic timber supplies
Forest basic statistics	Reforesta-tion	Forest conversion	Stand-level practices	Forest fires	Various cuttings
Forest administrative statistics	-	Permit of forest conversion	Forest mgnt projects	Fire suppression	Permission of cutting
Forest products statistics	-	-	-	-	Harvest wood production

Complete time series,
but incomplete survey system

Activity Data Preparation

Recalculation of Administrative Statistics



National Forest Inventory System

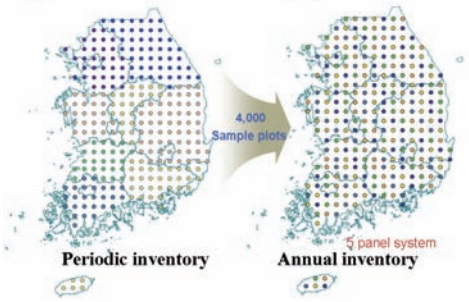
The 5th NFI (2006-2010)

➢ **Rationale for change from the 5th NFI**

To meet increasing demands for reliable forest statistics from domestic forest policies and international processes and conventions ;

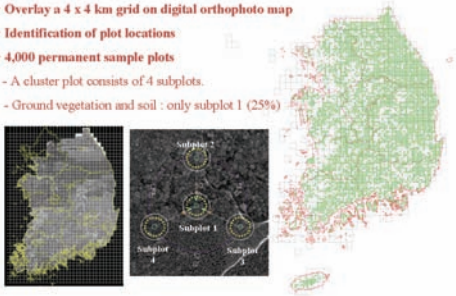
SFM, UNFCCC, CBD, FAO/FRA, OECD, etc.

Transition to Annual Inventory System



Sampling Design – systematic cluster sampling

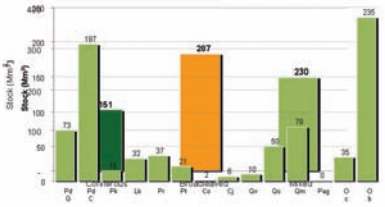
- Overlay a 4 x 4 km grid on digital orthophoto map
- Identification of plot locations
- 4,000 permanent sample plots
  - A cluster plot consists of 4 subplots.
  - Ground vegetation and soil : only subplot 1 (25%)



Carbon Stock Change Estimations in Living Biomass in the NFI

- ΔC_{LB} (I) = $C_{LB\ Gain} - C_{LB\ Loss}$
  - $C_{LB\ Gain}$ = GS x GR x WD x BEF x S/R x CF
    where GS : Growing stock
    GR : Growth rate
    (with only the 5th NFI)
- ΔC_{LB} (II) = $(GS_{t_2} - GS_{t_1})/(t_2 - t_1)$ x WD x BEF x S/R x CF
  (since the 6th NFI)

Growing stock 5th NFI ('06~'08)



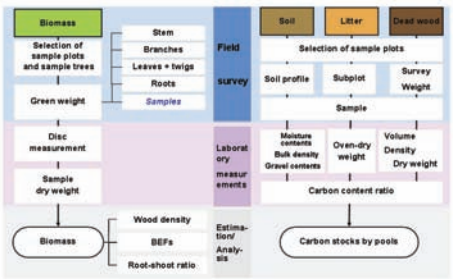
Emission/Removal Factors

Survey for Factors

- 12 major species
- 2007~2010
- Total 150 plots
  (allocation to species and provinces by growing stocks)
- Subjective sampling
- All 5 carbon pools

47 plots for *Pinus densiflora* (2007)

Process of Emission/Removal Factors Estimation

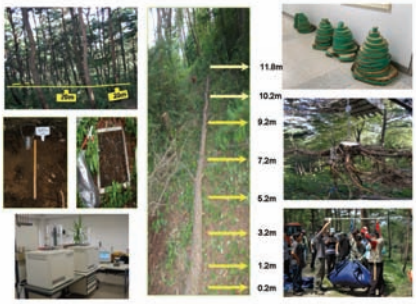


Field Survey Manual

- **Preparation of Standardized Manuals**
  - For 9 survey teams
  - **Survey Manual for Biomass and Soil Carbon**

Field Work

- **Training the Survey Teams**
  - Seminars, field demonstration, etc.
  - CD recording the process of standard field survey



Emission/Removal factors

Forest type / Tree species			WD	BEF	R
Results	Coni-ferous	Pd (G)	0.42	1.50	0.29
		Pd (C)	0.45	1.41	0.28
		Pk	0.39	1.89	0.28
		Lk	0.47	1.34	0.25
		Pr	0.46	1.41	0.59
		Cj	0.36	1.30	0.28
		Co	0.41	1.43	0.44
	Broad-leaved	Qv	0.73	1.34	0.34
		Qm	0.70	1.62	0.58

Carbon stock change estimation by tree species

(Gain-loss method, 2008, thousand tC)

Species	Net removals	Species	Net Removals
Pd (G)	1,189	Qa	270
Pd (C)	3,752	Qv	1,150
Pk	339	Qm	1,746
Lk	686	Pag	13
Pr	700	O c	798
Pt	463	O b	6,788
Co	47		
Cj	101	Total	18,041

Summary

- **IPCC Good Practice Guidance for MRV inventory in Post-2012 Climate Regime**
- **NFI with proper sampling design to address IPCC GPG LULUCF requirements**
- **Activity data in Korea**
  - **Current statistics with adjustments and/or supplementation**
  - **the 5th National Forest Inventory**
- **Emission/Removal factors in Korea**
  - **12 major tree species, 150 plots, & 5 carbon pools**
  - **Manuals & training**

Challenging Issues

- Land-Use Change : 6 x 6 matrix
- Time Series & Recalculation
- Tier 3 model : DOM C & Soil C
- Uncertainty : Approach I & Approach 2
- QA/QC : Institution, Data & Experts

Thank you !