GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

esa

European Space Agency
Agence spatiale européenne

GOFC-GOLD Activities & Recommended Practices for Land Cover/Forest Cover Change Assessment

Brice Mora

SCERIN-4 Capacity Building Workshop
Zvolen, Slovakia, July 19-22, 2016

What is GOFC-GOLD?

- Developed in 1997, originally under the Committee on Earth Observation Satellites (CEOS):

  - To improve use of Earth Observation data to address major problems of global concern

  - To improve coordination of national programs

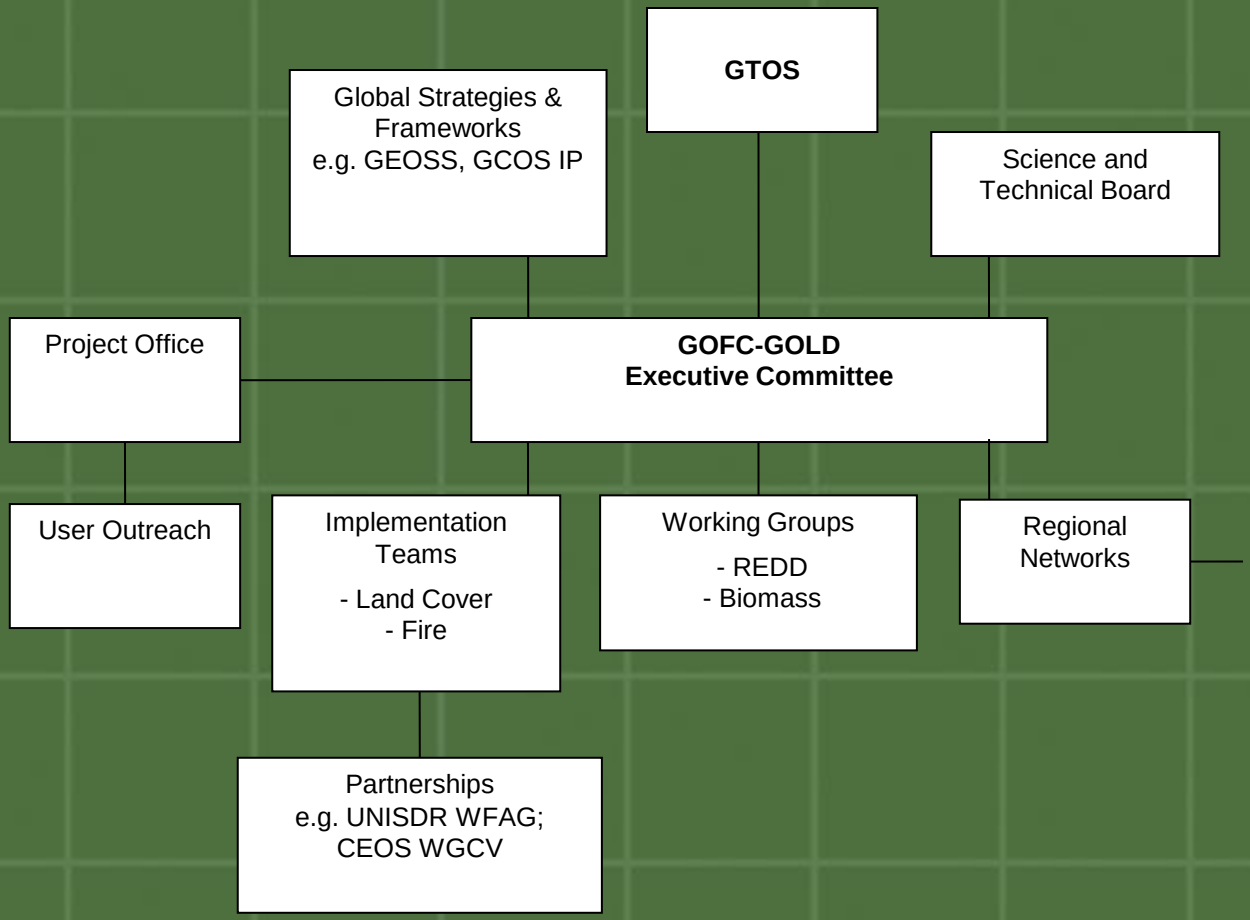
  - To improve co-operation between providers and users of Earth Observation data for regional and global applications

- Has become one of the Panels of the Global Terrestrial Observing System GTOS (FAO GTOS Secretariat)

  - Helping to address the Carbon Theme of the IGOS Partners

- Sponsors: FAO, WMO, UNEP, UNESCO, ICSU, EC-JRC, ESA, NASA, USGS, CSA, CFS

Background to GOFC-GOLD



1. RedLatiF – Latin America
2. SAFNET – Southern. Africa
3. Miombo – Southern Africa
4. OSFAC – Central Africa
5. WARN – West Africa
6. SEARRIN – S.E. Asia
7. NERIN – Northern Eurasia
8. CARIN – Central Asia
9. SCERIN – S.Central Europe.
10. *SARIN – South Asia*
11. *BARIN – Baltic-Arctic*

GOFC-GOLD

GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

esa

European Space Agency
Agence spatiale européenne

Development of in situ Reference Network for Land Cover

Available Land Cover Reference Datasets on GOFC-GOLD Portal

- GLC 2000
- GlobCover 2005
- STEP
- VIIRS
- GLCNMO 2008
- Urban Dataset

Spatial distribution of the reference datasets available on the portal

www.gofcgold.wur.nl/sites/gofcgold_refdataportal.php

GOFC-GOLD

GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

esa

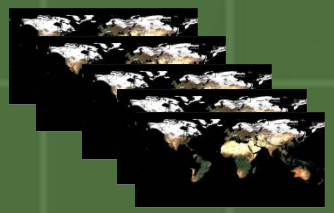
European Space Agency
Agence spatiale européenne

Land cover Products at Moderate Resolutions

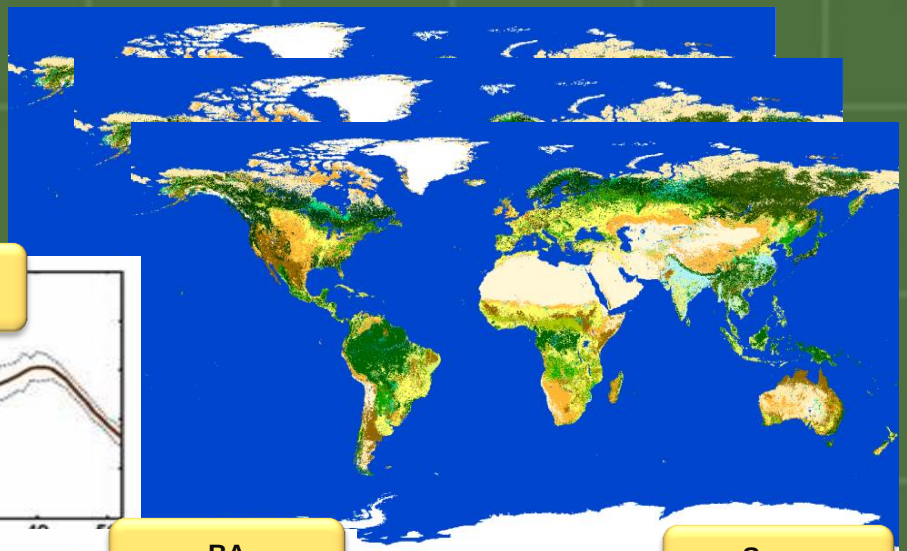
Land Cover Products at Moderate Resolutions

- Users requirements
- New LC concept
- Efficient prototype system
- 4 major products

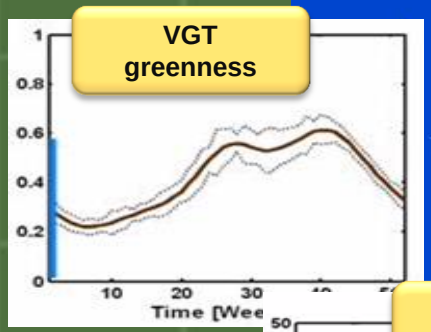
MERIS FR & RR 7-day composites
SR time series from 2003 to 2012



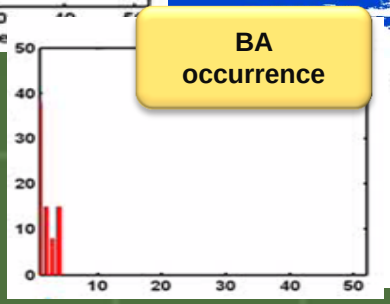
3 LC state products
for the 2000, 2005 and 2010 epochs

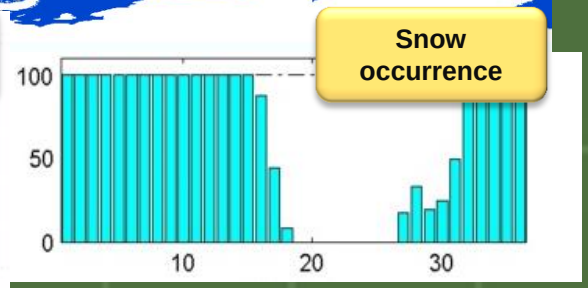


Global open permanent WB map



3 LC condition products





Data access:
http://maps.elie.ucl.ac.be/CCI/viewer/index.html

Copernicus Global Land Service - Land Cover

- Provides a series of bio-geophysical products at global scale at mid and low spatial resolution since 2013
- Land cover is included as one of the variables in the Copernicus Global Land Operations (C-GLOPS) project (2016-2019).

C-GLOPS- Land Cover

- Annual Global land cover map from 2015 onwards -initially Africa
- 100 m resolution Proba-V data
- Build upon knowledge and data available
- Engaging users and addressing their needs

vito vision on technology

IIASA

WAGENINGEN UNIVERSITY WAGENINGEN UR

GOFC-GOLD

GOFC-GOLD

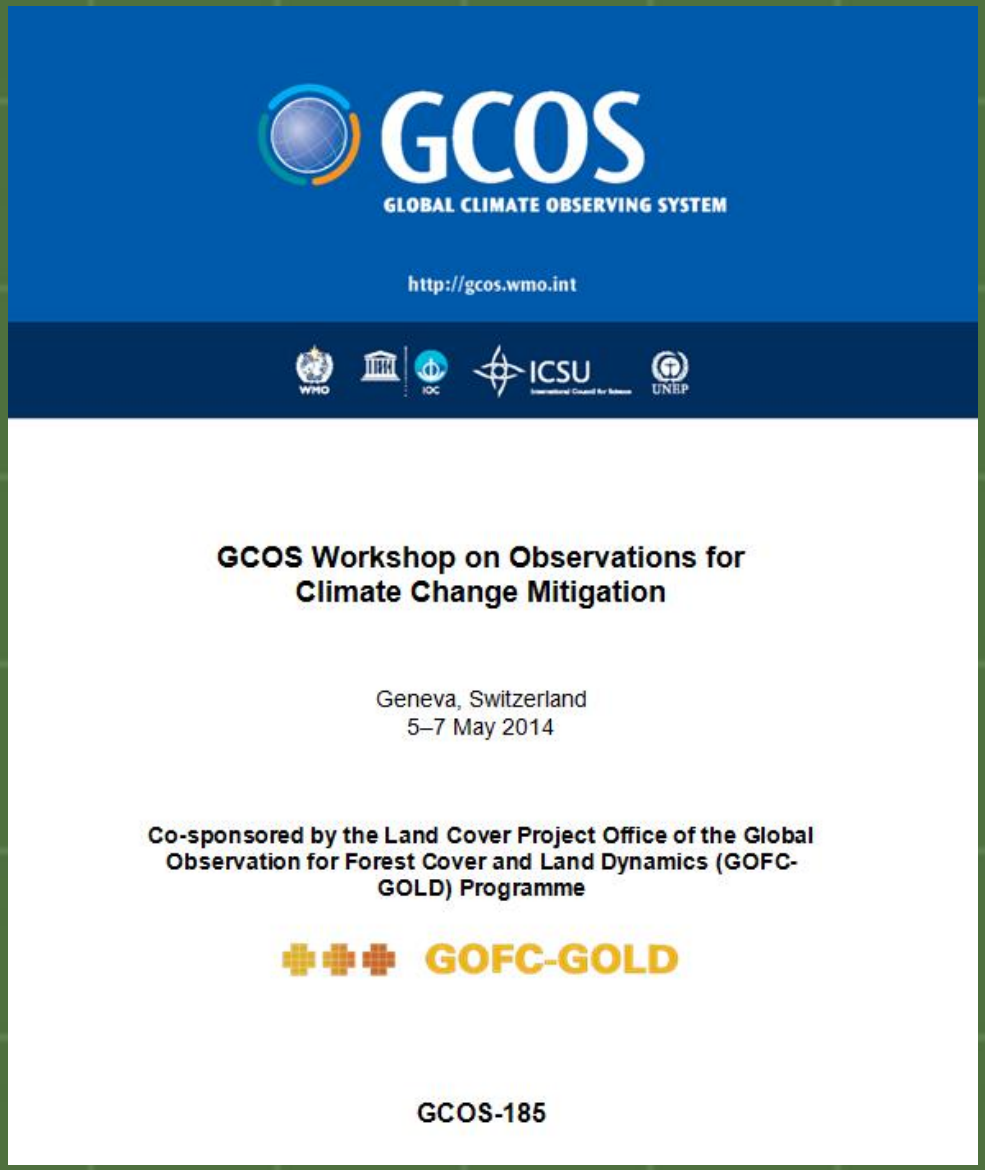
Global Observation of Forest and Land Cover Dynamics

esa

European Space Agency
Agence spatiale européenne

Land Cover and Land Use Information for CC Modelling & Mitigation

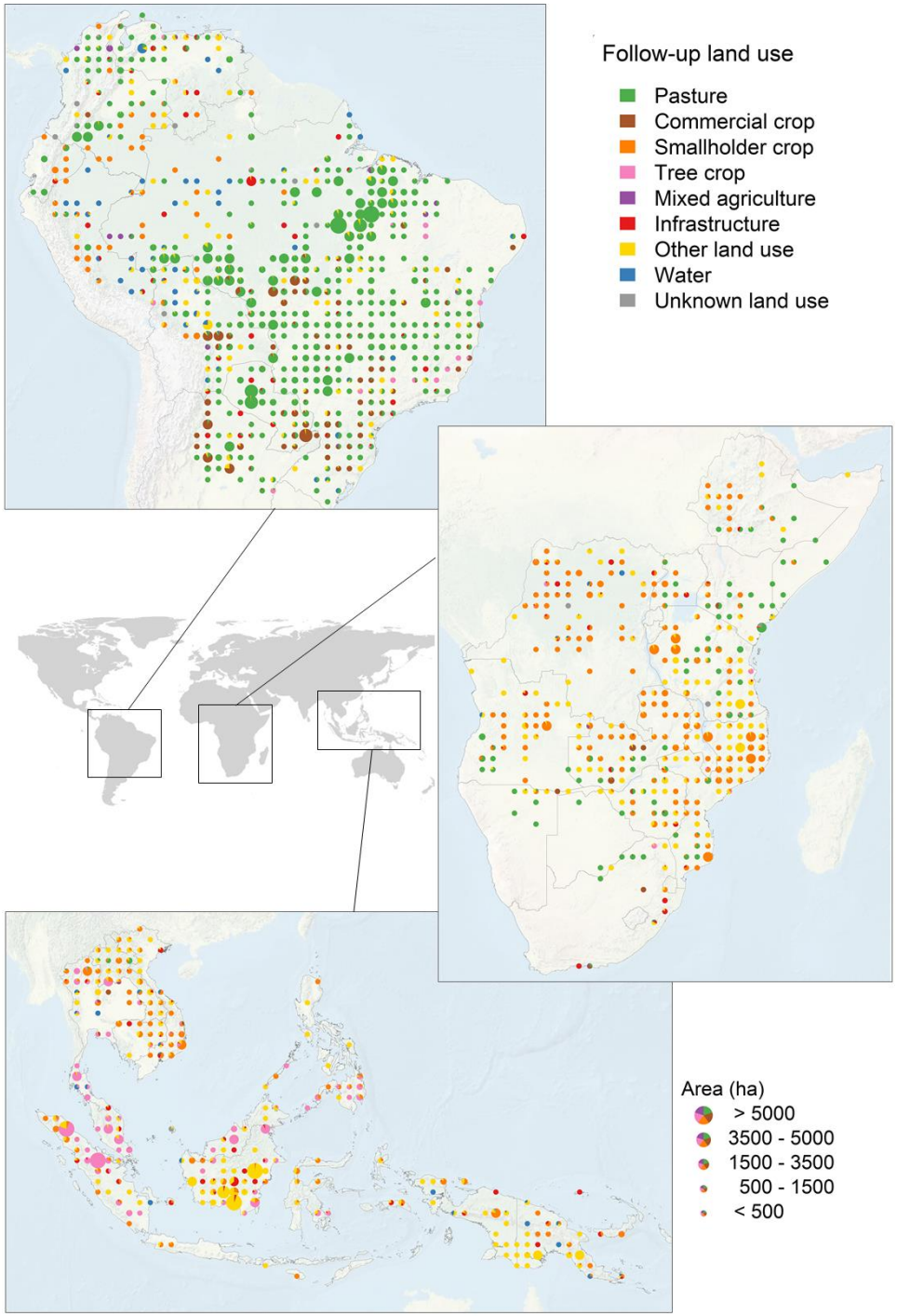
Starting the dialog between observation and mitigation community



- ***Representatives from UNFCCC, FAO, IPCC, ICRAF, ESA, etc.***
- ***Focus on Land-based mitigation (land use and land management)***
- ***ECVs in the context of mitigation***
- ***Users and data requirements***
- ***Recommendations and actions***

Workshop website:

http://www.wmo.int/pages/prog/gcos/index.php?name=ObservationsforMitigation



Land Use Change after Deforestation

Using JRC TREES III and FAO remote sensing survey data

Land use following deforestation 1990-2005	Area (1000 ha)	%
Smallholder crop	12123	18.8
Commercial crop	4326	6.7
Tree crop	5584	8.7
Pasture	27305	42.3
Mixed agriculture	404	0.6
Total Agricult.	**49781**	**77.1**
Infrastructure	2210	3.4
Other land use	11230	17.4
Water	1073	1.7
Unknown	200	0.3
Total other	**14748**	**22.9**
Total	64529	100.0

(preliminary)

De Sy et al., 2015, ERL (LA)

GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

esa

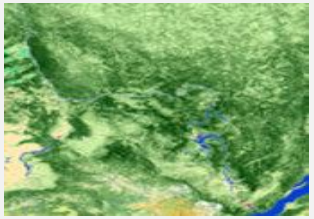
European Space Agency
Agence spatiale européenne

Biodiversity Monitoring in Tropical Forests

SOURCEBOOK

UNCBD COP 13




A SOURCEBOOK OF METHODS AND PROCEDURES FOR MONITORING ESSENTIAL BIODIVERSITY VARIABLES IN TROPICAL FORESTS WITH REMOTE SENSING

GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

GEOBON

GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

esa

European Space Agency
Agence spatiale européenne

Recommended Practices for Land Cover/Forest Cover Change Assessment

Credits:
Pontus Olofsson, Boston U.,
Ronald McRoberts, US Forest Service

IPCC Good Practice Guidance Criteria for Estimation of Activity Data (change)

1. Neither over- nor underestimates
2. Uncertainties are reduced as far as practicable

In: Penman et al. (2003) Good Practice Guidance for Land Use, Land-Use Change and Forestry.

Corollary: "MAPS ARE NOT TRUTH!"
Ronald McRoberts, US Forest Service

Estimation of Activity Data (change)

- To find change, compare images, not maps
- Frequently magnitude of change less than cumulative error of individual map products.
- Use time-series whenever possible: allows capture of forest growth cycles
- Reference data necessary to compensate for classification errors in map data
- Stratified random sampling useful for rare classes

Reference Data

- Greater accuracy than map data
  - Ground data (e.g., NFI plot data)
  - Finer resolution remotely sensed data
  - More careful classification of remotely sensed data
  - Use of additional data sources

- Acquired using a probability sampling design
  - Simple random sample
  - Stratified random sample
  - Systematic sample

Estimation of Activity Data for Forest to Non-Forest Conversion

- Construct a forest/non-forest change map

- Use map classes to define four strata
  - Deforestation
  - Forest gain
  - Stable forest
  - Stable non-forest

- Collect reference data in the form of change observations
  - Stratified random sampling
  - Greater sampling intensity for Deforestation stratum

Estimation of Activity Data for Forest to Non-Forest Conversion

Pixel counts

Map	Reference: Defore-station	Forest gain	Stable forest	Stable non-forest	in map: Total	$A_{m,i}$ [pixels]	W_i
Deforestation	66	0	5	4	75	200,000	0.020
Forest gain	0	55	8	12	75	150,000	0.015
Stable forest	1	0	117	7	125	3,200,000	0.320
Stable non-forest	2	1	9	213	225	6,450,000	0.645
Total	69	56	139	236	500	10,000,000	1.000

Source: Penman et al. (2016)

Estimation of Activity Data for Forest to Non-Forest Conversion

Area proportions

Map \ Reference	Defore-station	Forest gain	Stable forest	Stable non-forest	Total (W_i)	$A_{m,i}$ [pixels]
Deforestation	0.0176	0.0000	0.0013	0.0011	0.020	200,000
Forest gain	0.0000	0.0110	0.0016	0.0024	0.015	150,000
Stable forest	0.0026	0.0000	0.2995	0.0179	0.320	3,200,000
Stable non-forest	0.0057	0.0029	0.0258	0.6106	0.645	6,450,000
Total	0.0259	0.0139	0.3283	0.6320	1.000	10,000,000

$$\hat{p}_{ij} = W_i \frac{n_{ij}}{n_{i\cdot}}$$

$$\hat{p}_{\cdot j} = \sum_i W_i \frac{n_{ij}}{n_{i\cdot}}$$

Cochran, 1977: Eq. 5.52

GOFC-GOLD

Estimation of Activity Data for Forest to Non-Forest Conversion

Area estimate:

$\hat{A}_1 = \hat{p}_{\cdot 1} \times A_{tot}$ = 0.0259 * 10,000 000 pixels = 258,933 = 23,304 ha

Estimate from map: 200,000 pixels, i.e., 18,000 ha
=> underestimation of 58,933 pixels, i.e., 5,303 ha

Confidence intervals (95%):

$$SE(\hat{p}_{\cdot j}) = \sqrt{\sum_i \frac{w_i \hat{p}_{ij} - \hat{p}_{ij}^2}{n_{i\cdot} - 1}}$$

Cochran, 1977: Eq. 5.57

Estimation of Activity Data for Forest to Non-Forest Conversion

Confidence interval calculation (Cochran's Eq. 5.57):

First calculation of variance:

$$\hat{\mathrm{Var}}(\bar{y}_{str}) = \sum_{j=1}^{4} \frac{w_j \cdot p_j - p_j^2}{n_j - 1}$$

$$= \frac{0.020 \cdot 0.0176 - 0.0176^2}{75-1}$$

$$+ \frac{0.015 \cdot 0.0000 - 0.0000^2}{75-1}$$

$$+ \frac{0.320 \cdot 0.0026 - 0.0026^2}{125-1}$$

$$+ \frac{0.645 \cdot 0.0057 - 0.0057^2}{225-1}$$

$$= 0.00000057 + 0.00000000 + 0.00000655 + 0.00001636$$

$$= 0.00002348,$$

Then calculation of Standard Error (SE):

$$SE(\bar{y}_{str}) = \sqrt{0.00002349} = 0.0048$$

$SE(\hat{p}_{\cdot 1}) \times A_{tot}$ = 0.0048 * 10,000 000 = 48,000

48,000 * 1,96 = 94,08 pixels = 8,467 ha

GOFC-GOLD

Estimation of Activity Data for Forest to Non-Forest Conversion

Class	Proportion area		Area (ha)	
	$\hat{p}_{.j}$	$SE(\hat{p}_{.j})$	Confidence interval	
Deforestation	0.0259	0.0048	14,755	31,853
Forest gain	0.0139	0.0030	7,243	17,717
Stable forest	0.3283	0.0110	275,991	314,865
Stable non-forest	0.6320	0.0118	548,058	589,518

Deforestation class: Estimated area: 23,304 ha.

"I am 95% confident that the true area estimate for the deforestation class is comprised between 14,755 ha and 31,853 ha."

Take-home Messages

- IPCC Good Practice Guidance criteria
  - neither over- nor underestimates
  - uncertainties are reduced as far as practicable

- Because map data are subject to error, estimates based on map data alone do not satisfy IPCC GPG criteria

- Reference data necessary to adjust map-based estimates for classification error
  - of greater quality than map data
  - acquired using probability sampling design

References

- Cochran W.G. (1977) Sampling techniques, 3rd Edition.
- New York: Wiley. 428 p.
- McRoberts & Walters. (2014). Remote Sensing of Environment 124: 394-401.
- Sannier et al. (2014). Remote Sensing of Environment 151: 138-148.
- Næsset et al. (2016). Remote Sensing of Environment 175: 282-300.
- Olofsson et al. (2014). Remote Sensing of Environment 148: 42–57.
- Penman et al. (2016). Methods and Guidance Document, ed 2.0. Chapters 4 & 5.
- Sannier et al. (2016). Remote Sensing of Environment 173: 326-338.

References

- McRoberts et al. (2016). Canadian Journal of Forest Research 46: 924-932.

Online

http://beeoda.org/

developed by Pontus Olofsson *et al.*, Boston U.

GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover Project Office

esa
European Space Agency
Agence spatiale européenne

brice.mora@wur.nl

Follow us:

Twitter: @gofcgold_lc
Facebook: www.facebook.com/gofcgold.lc.po
Newsletter: www.gofcgold.wur.nl