IPCC Good Practice Guidance criteria for estimation of activity data, emissions factors, and total emissions:

- neither over- nor underestimates
- uncertainties are reduced as far as practicable

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

Corollary: **MAPS ARE NOT TRUTH!**

The Gain-Loss method:

$$E_{Total} = \sum_{i=1}^{n} AD_i \cdot EF_i$$

where

i denotes activities,

n is the total number of activities

AD_i=activity data=estimate of area change for activity *i*

EF_i – emissions factor estimate per unit area for activity *i*

REDD Stratification:

- A stratification for REDD purposes is typically not a stand-alone product

- A stratification can serve multiple purposes
  - supports separate estimates
  - accommodates different sampling intensities
  - increases precision of estimates

Three kinds of data:

- Training data
  - Can be acquired from any source
  - Can be acquired using any sampling design

- Map data
  - Subject to classification/prediction error
  - Estimates do not satisfy IPCC GPG
  - Support and enhance reference estimates

- Reference data

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
  - Systematic sample
  - Stratified sample

Reference data:

- Reference data are sufficient to produce estimates that satisfy the IPCC GPG
- Reference data are necessary to compensate for classification errors in map data

Estimate activity data for forest to non-forest conversion:

- Construct a forest/non-forest change map

- Use map classes to define three strata
  - F-NF
  - F-F
  - NF-NF

- Collect reference data in the form of change observations
  - Stratified random sampling
  - Simple random sampling within strata
  - Greater sampling intensity for F-NF stratum

Map class	Class size	Class weight	Reference class F-NF	F-F	NF-NF	Total
F-NF	1000	0.10				100
F-F	6000	0.60				50
NF-NF	3000	0.30				50

Map class	Class size	Class weight	Reference class			Total
			F-NF	F-F	NF-NF	
F-NF	1000	0.10	80	15	5	100
F-F	6000	0.60	2	45	3	50
NF-NF	3000	0.30	5	5	40	50

Map class	Class size	Class weight	F-NF	Total
F-NF	1000	0.10	80	100
F-F	6000	0.60	2	50
NF-NF	3000	0.30	5	50

Map Class	Class size	Class weight	F-NF	Total	Mean
F-NF	1000	0.10	80	100	0.80
F-F	6000	0.60	2	50	0.04
NF-NF	3000	0.30	5	50	0.10

Map class	Class size	Class weight	F-NF	Total	Mean	Mn*Wt
F-NF	1000	0.10	80	100	0.80	0.08
F-F	6000	0.60	2	50	0.04	0.02
NF-NF	3000	0.30	5	50	0.10	0.03
Estimate		0.10	0.43			0.13

Map class	Class size	Class weight	F-NF	Total	Mean	Mn*Wt	Var
F-NF	1000	0.10	80	100	0.80	0.08	0.0016
F-F	6000	0.60	2	50	0.04	0.02	0.0008
NF-NF	3000	0.30	5	50	0.10	0.03	0.0018
Estimate						0.13	

Map class	Class size	Class weight	F-NF	Total	Mean	Mn*Wt	Var	Var*Wt^2
F-NF	1000	0.10	80	100	0.80	0.08	0.0016	0.000016
F-F	6000	0.60	2	50	0.04	0.02	0.0008	0.000288
NF-NF	3000	0.30	5	50	0.10	0.03	0.0018	0.000162
Estimate						0.35		0.000466

Map class	Class size	Class weight	F-NF	Total	Mean	Mn*Wt	Var	Var*Wt^2
F-NF	1000	0.10	80	100	0.80	0.08	0.0016	0.000016
F-F	6000	0.60	2	50	0.04	0.02	0.0008	0.000288
NF-NF	3000	0.30	5	50	0.10	0.03	0.0018	0.000162
Estimate						0.35		0.000466

$$\text{Confidence interval}: \quad \hat{\mu} \pm 2 \cdot \sqrt{\hat{\text{Var}}(\hat{\mu})} = 0.13 \pm 0.04 = [0.09, 0.17]$$

Estimate emission factor for dry tropical forest remaining forest in Peru:

- Construct a forest type map

- Use forest types as strata
  - dry tropical forest
  - Andean forest

- Collect reference data in the form of carbon change observations
  - Use NFI plot data
  - Equal sampling intensity everywhere

Map class	Class size	Class weight	Reference class DT	Reference class AF	Total	Mean*Wt	Var*Wt^2
Dry tropical	2100	0.60	30	6	36	0.6*40	0.36*20
Andean forest	1400	0.40	2	20	22	0.3*35	0.16*15
Estimate						34.50	9.60

$$\text{Confidence interval}: \quad \hat{\mu} \pm 2 \cdot \sqrt{\hat{\text{Var}}(\hat{\mu})} = 34.50 \pm 6.20 = [28.30, 34.70]$$

The 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:

Penman et al. (2016). Methods and Guidance Document, ed 2.0. Chapters 4 & 5.

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