

The importance of uncertainties in forest monitoring

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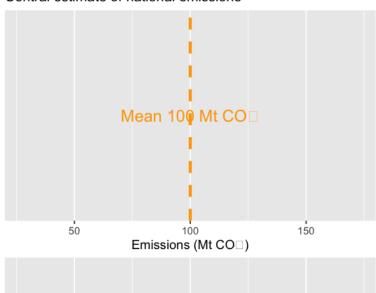


Uncertainty isn't noise — it's information needed for credible emission reductions.



Uncertainty is INFORMATION

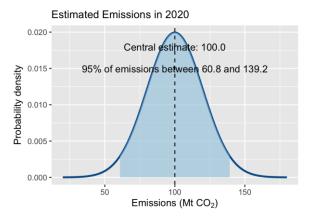
Central estimate of national emissions

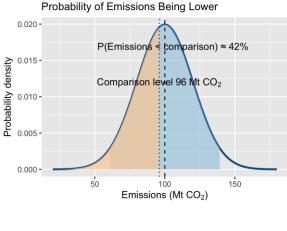


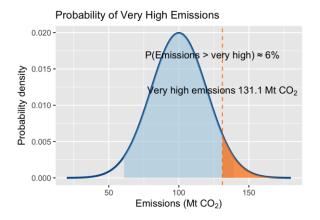
95% interval: [60.8, 139.2]

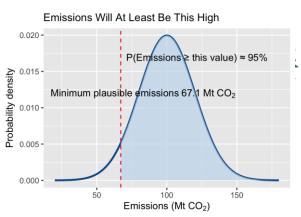
Emissions (Mt CO₂)

150









How uncertainty propagates through forest monitoring

error

 Uncertainty compounds at every level, from tree measurement to national totals

 Different error types accumulate: measurement, model, sampling,...

 Understanding propagation is essential before interpreting emissions or reductions measure

allometric model

sum over trees

average over plots

Chave, et al. (2004). Philos. Trans. R. Soc.
London B 359(1443), 409-420.

quality of the data

diameter of one tree

quality of the model

AGB of one tree

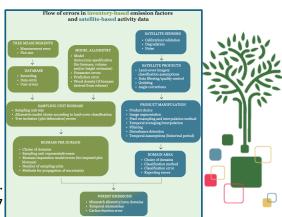
size of the sampled area

AGB of one plot

representativity of

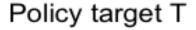
the plots

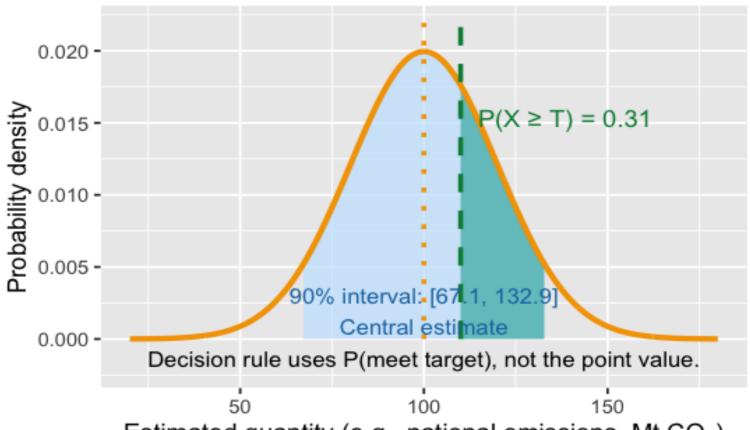
This is why emissions are distributions, not single numbers



AGB of the forest

From intervals to decision-relevant probabilities



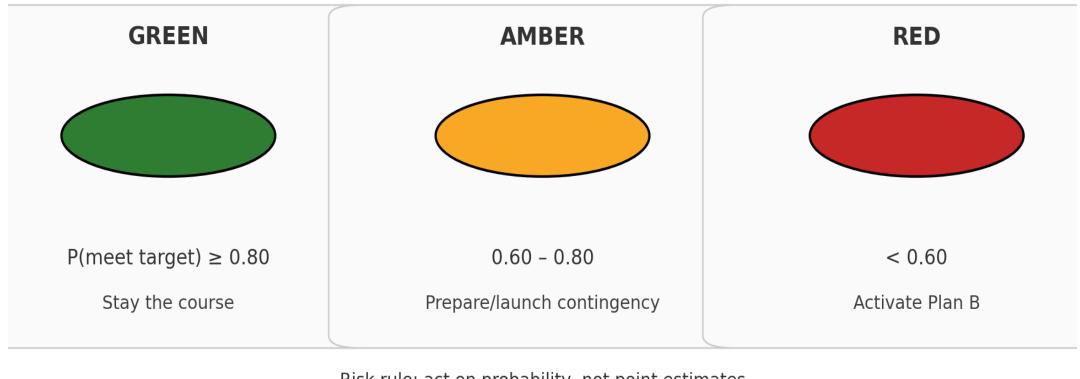


Estimated quantity (e.g., national emissions, Mt CO₂)



Decision rules for decision makers

Simple "traffic-light" rule, editable for countries



Risk rule: act on probability, not point estimates



International status of uncertainty reporting

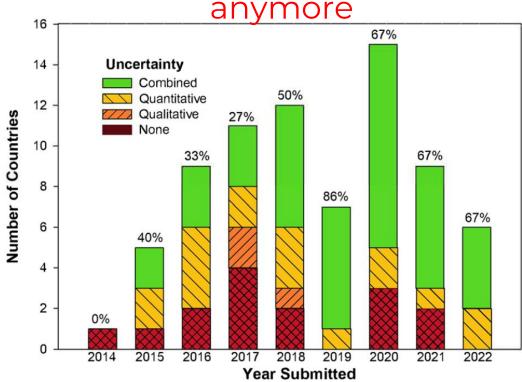
Uncertainty in REDD+ carbon accounting: a survey of experts involved in REDD+ reporting

Brett J. Butler¹, Emma M. Sass², Javier G. P. Gamarra³, John L. Campbell⁴, Craig Wayson⁵, Marcela Olguín⁶, Oswaldo Carrillo⁶ and Ruth D. Yanai^{7*}

Source: Butler et al (2024) Carbon Balance Manag. 19: 22.



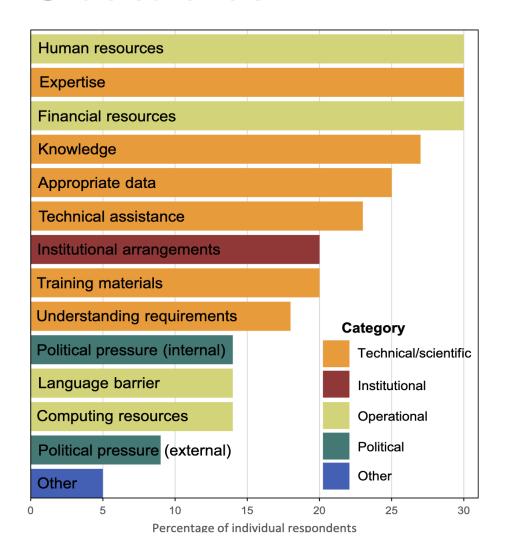
Not reporting uncertainties seems not an option anymore



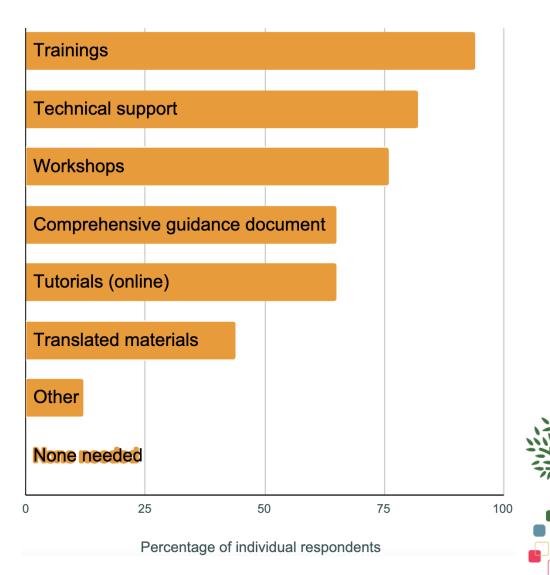
Global Forest Observations Initiative

Uncertainty Quantification & Reporting

Obstacles



Needs



Looking at uncertainties as probabilities we link 'actions' to reducing decision risk, based on uncertainty information

Thank you



Additional detail on error sources

Flow of errors in inventory-based emission factors and satellite-based activity data

TREE MEASUREMENTS

- Measurement error
- Plot size

DATABASE

- Recording
- Data entry User errors

• Sampling unit size

MODEL ALLOMETRY

- Model choice/mis-specification (for biomass, volume and/or height estimates)
- Parameter errors
- Prediction error
- Wood density (if biomass derived from volume)

SATELLITE SENSORS

- Calibration/validation
- Degradation
- Noise

SATELLITE PRODUCTS

- · Land-cover imagery classification assumptions
- Data filtering/quality control
- Gridding
- Angle corrections



- Product choice
- Image segmentation
- Pixel resampling and interpolation method

PRODUCT MANIPULATION

- Temporal averaging/interpolation
- Filtering
- · Disturbance detection
- Temporal assumptions (historical period)

SAMPLING UNIT BIOMASS

• Allometric model choice according to land-cover classification

BIOMASS PER DOMAIN

- Choice of domains
- Sampling unit representativeness

• Tree inclusion (plot delineation) errors

- Biomass imputation model errors (for imputed plot
- Number of sampling units
- Methods for propagation of uncertainty



DOMAIN AREA

- · Choice of domains
- · Classification method
- Classification error
- Reporting errors



- Mismatch allometry/area domains
- Temporal mismatches
- Carbon fraction error





FAO (2018). Working Paper 17.