

The Curse of Rare Events

- Why results based payments might fail for REDD+ -

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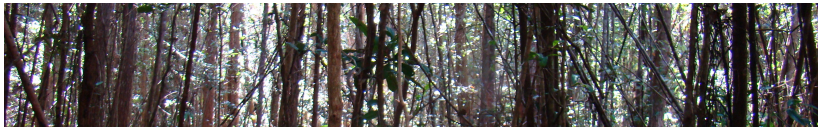
ForestEye Research GmbH, Göttingen, Germany





"Results based payments under REDD⁺"

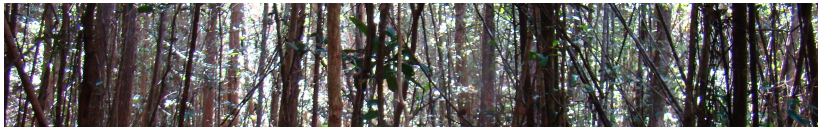
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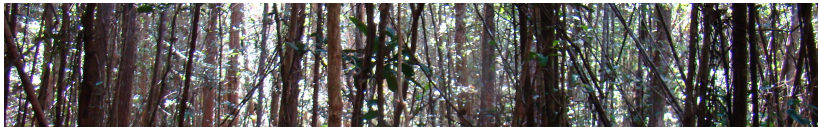
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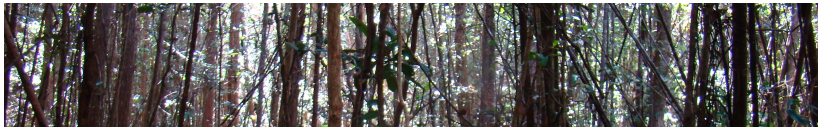
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- REDD⁺ should providing incentives via carbon finance
- REDD⁺ works with results based payments



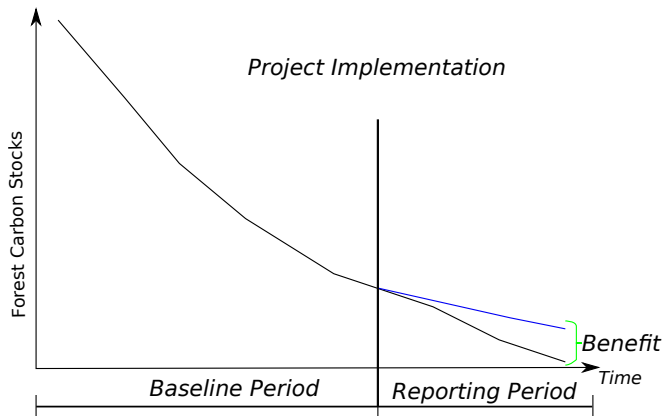


"Results based payments under REDD⁺"

- REDD⁺ aims at reducing greenhouse gas emissions by forest conservation and improved management
- REDD⁺ should providing incentives via carbon finance
- REDD⁺ works with results based payments
- REDD⁺ requires standardized and sound monitoring, verification and reporting



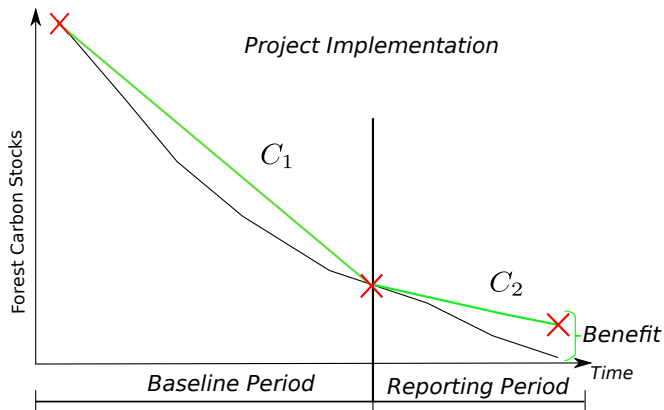
Monitoring options for REDD⁺



Monitoring options:

- Stock Change Method: Activity data \times Emission factors = GHG-Emissions
- Loss-Gain Method: Processed based, estimates net balance of carbon fluxes

Monitoring options for REDD⁺



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- Stock Change Method: Activity data \times Emission factors = GHG-Emissions

■



Region A8 of Colombian Amazon

- $406,000\text{km}^2 = 36\%$ of Colombia
- Large share of natural forests in Colombia
- Different forest types including dense tropical rain forest

Determine if there is a difference between the forest cover change rates in the Amazon Region ,A8 Colombia for the periods:

- Baseline: 2000-2012 (C_1)
- Reporting Period: 2012-2013 (C_2)

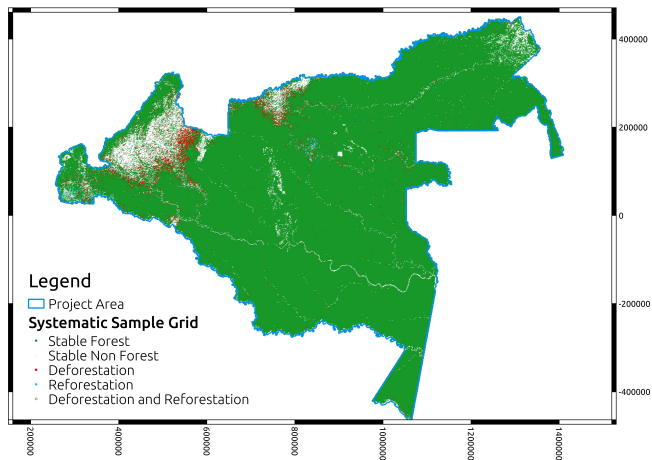
$$\Delta C = C_1 - C_2 \quad (1)$$

Challenges

- Very large and remote area
- No forest inventory data available
- Persistent cloud cover
- Limited time

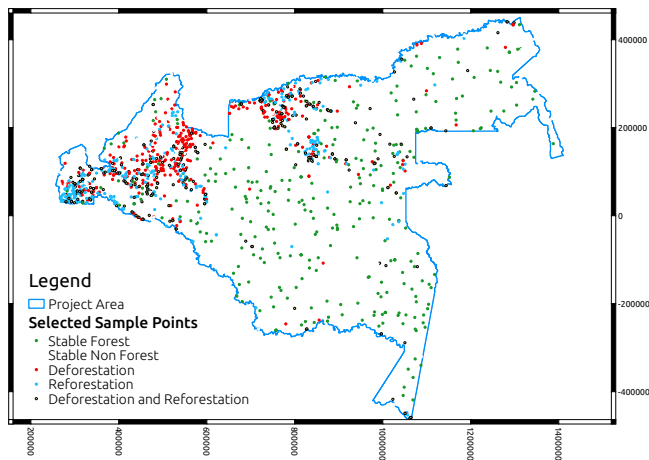
Approach:

- Stratified, sample based approach
- Landsat images
- Visual interpretation



Sampling Design

- Systematic sampling grid $2 \times 2\text{km}$ ($n = 328633$)
- Stratification by Global Forest Change Map (Hansen et al., 2013)



Stratification

- Random selection of $n = 300$ points in each of the $L = 4$ Strata

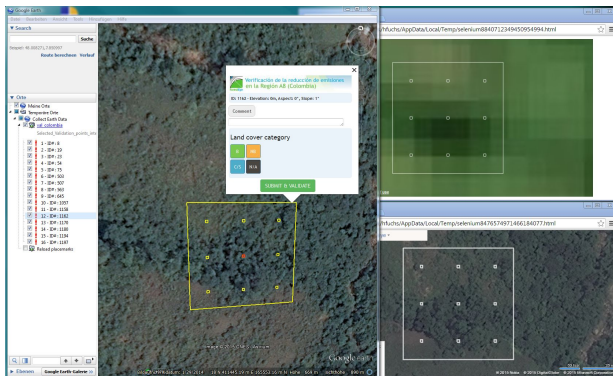


Image interpretation using Earth Collect software



In each stratum h and for each point i in time t the mean forest cover \hat{p} was estimated as:

$$\hat{p} = \frac{n_f}{n} \quad (2)$$

where n = total number of points and n_f = number of points classified as forest.

The corresponding variance $\hat{v}ar(\hat{p})$ is calculated following Cochran (1977) as:

$$\hat{v}ar(\hat{p}) = \frac{\hat{p} * (1 - \hat{p})}{n - 1} \quad (3)$$

Table : Strata sizes and strata weights that were derived from the GFC map using the base grid. Number of samples per stratum that were used for the image interpretation.

Stratum	N	Weight	Number of Samples
Stable-Forest	302310	0.920	300
Stable Non-Forest	19434	0.059	300
Deforestation	5605	0.017	300
Reforestation	948	0.003	300
Defor. and Refor.	336	0.001	300
Total	328633	1	1500

Table : Sample based estimates of the annual net forest cover change in the baseline and reporting period.

Period	Annual Deforestation Rate	Annual Deforestation Area
2000-2012	0.288%	121,094.8 ha
2012-2013	0.302%	122,348.7 ha

Table : Sample based estimates of the annual net forest cover change in the baseline and reporting period with 95% Confidence Interval (CI).

Period	Annual Deforestation Rate	Annual Deforestation Area	Confidence Intervall
2000-2012	0.288%	121,094.8 ha	± 23,276.66 ha
2012-2013	0.302%	122,348.7 ha	± 40,403.47 ha

Major Observations

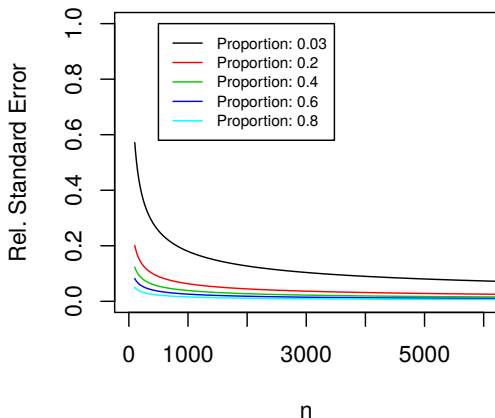
- Deforestation is a rare event in the Region A8 of Colombia
- Slight increase in the mean deforestation rate
- Confidence intervals overlap largely

$$\hat{v}ar(\hat{p}) = \frac{\hat{p} * (1 - \hat{p})}{n - 1} \quad (4)$$

Variance depends on n
and \hat{p} !

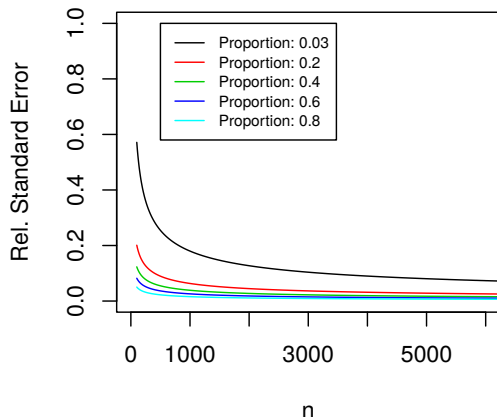
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"Simple random sampling, or any method of sampling that is adapted for general purposes, is an expensive method of sampling the total number of units of a scarce type" (Cochran, 1977)

UN-REDD partner countries in Africa

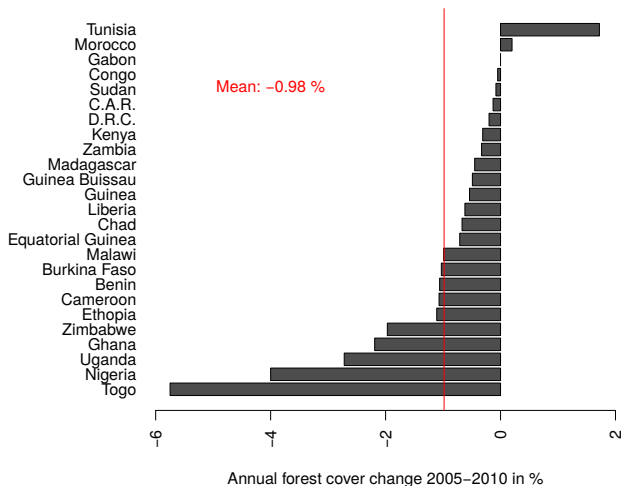


Figure : Source: FRA 2010, FAO

Often deforestation can be regarded a rare event:

- Detecting rare events with acceptable precision is challenging in sample based studies
- Including large parts of untouched forest is not helpful
- Monitoring should focus on areas where actions will take place

Further research needs

- Selection of the reference area
- Improved stratification and sample allocation
- Model-Assisted approaches

Thank you for your attention!

We thank the students from in Göttingen



Cochran, W. G. (1977). *Sampling Techniques*.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. a., Tyukavina, a., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, a., Egorov, a., Chini, L., Justice, C. O., and Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science (New York, N.Y.)*, 342(6160):850–3.