Carbon Monitoring in Moist Tropical Forest

Experiences from early action projects

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Introduction

INFAPRO, Sabah, Malaysia:

Intervention: rehabilitation of logged-over dipterocarp forest and avoidance of relogging

Methodology: VCS VM0005 IFM conversion from Low to High Productive forest

Monitoring: tree carbon stock changes in rehabilitated areas & parts of the untreated area (representing the baseline)

→ The impact of the avoidance of relogging is only quantified once, during the validation and the first verification

Kibale National Park, Uganda:

Intervention: rehabilitation of tropical natural high forest through indigenous tree planting and promoting of natural regeneration

Methodology: CDM AR-ACM0001 Afforestation and reforestion of degraded land

Monitoring: tree carbon stock changes in planted and naturally regenerated areas

INFAPRO baseline and project scenario

Emission reductions in INFAPRO due to:

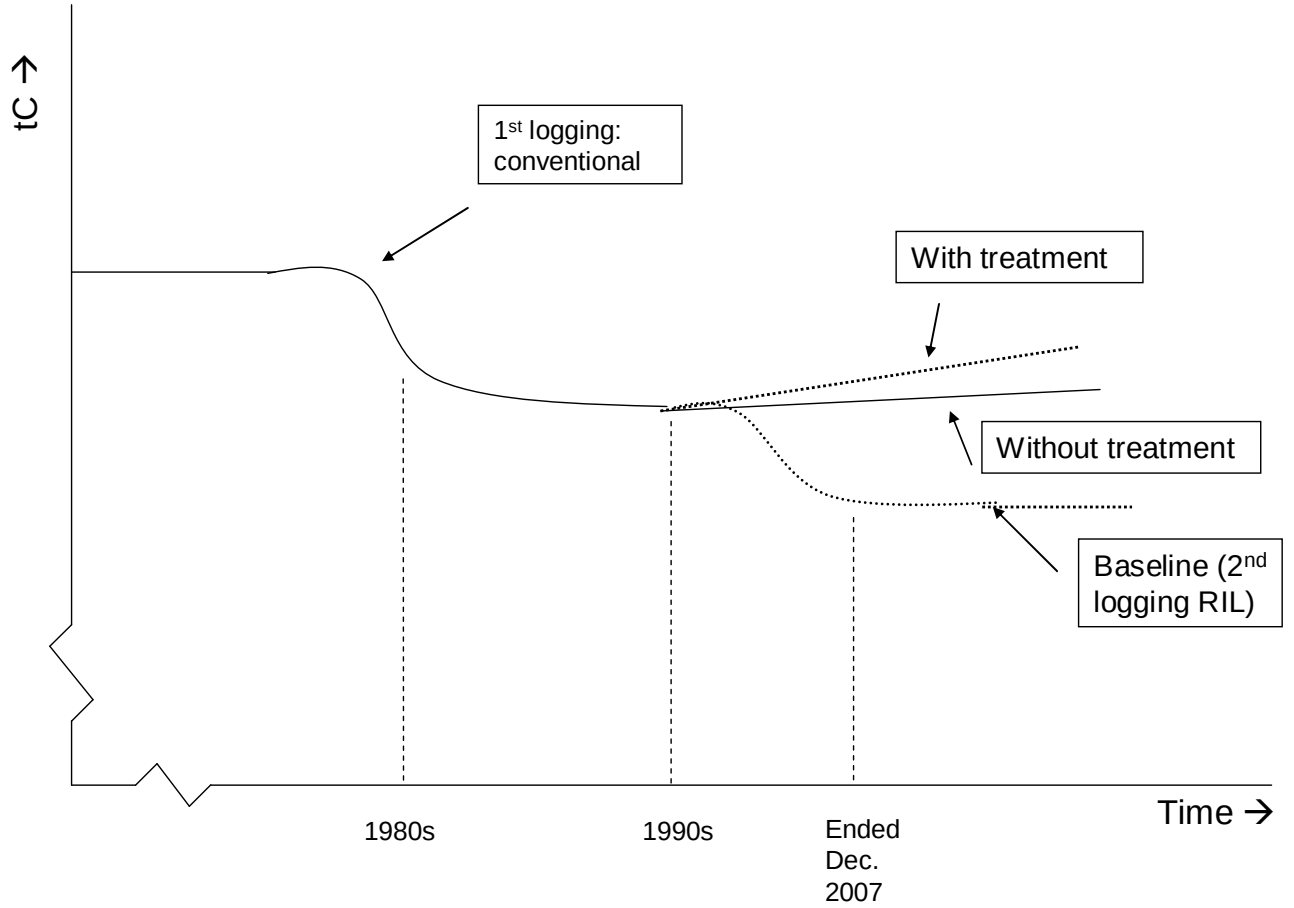
Avoidance of relogging

Treatment / rehabilitation of degraded forest

Project carbon benefits calculated:

Difference between Project scenario and Baseline scenario

AND deductions due to leakage, uncertainty and risk

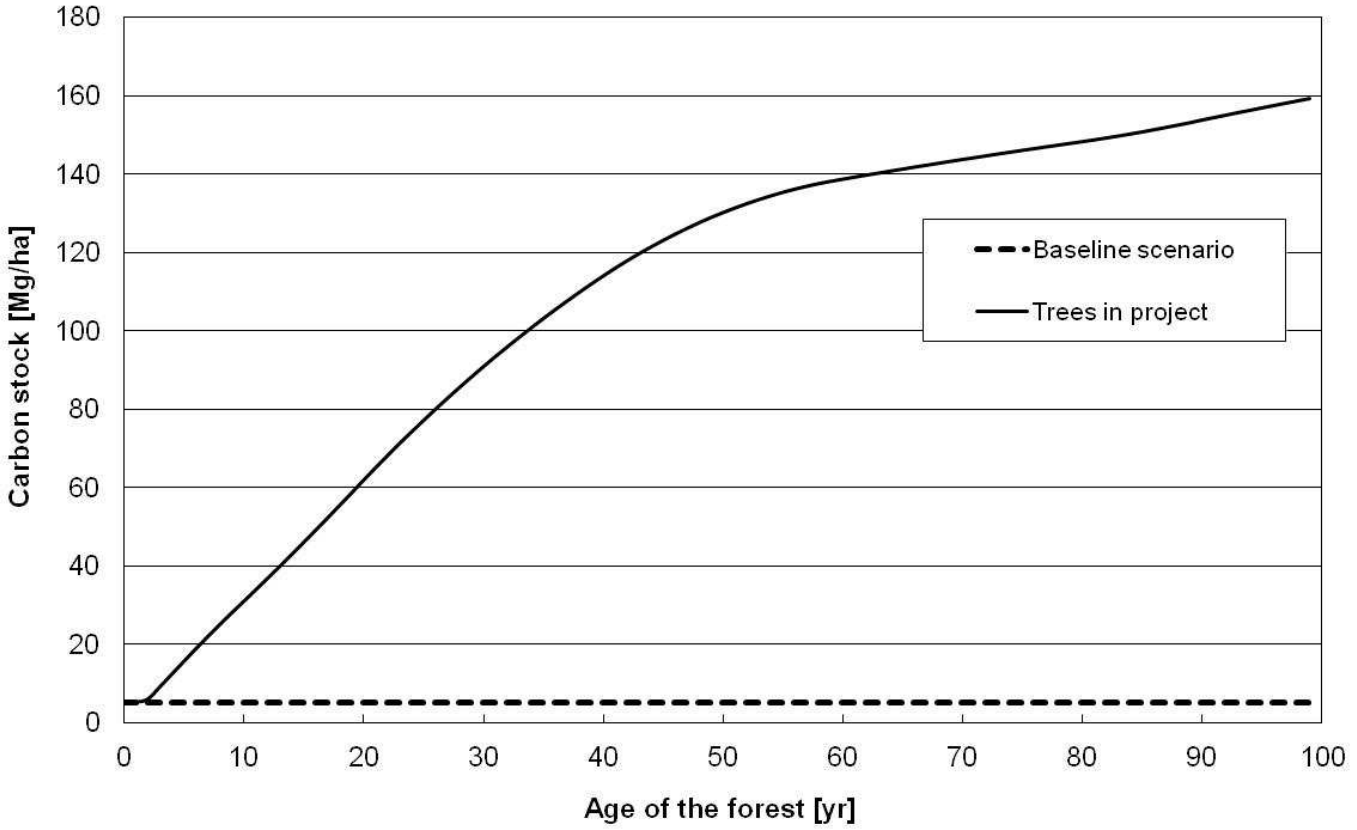


Kibale baseline and project scenario

Emission reductions in Kibale due to:

Tree growth in the project scenario

A steady state of the baseline



Parameters to monitor

INFAPRO:

Calculation of tree volume for 15 different species groups:

→ Recording of input parameters: DBH, Tree Species

Volume is converted to carbon based on tree species specific wood densities

Kibale:

Calculation of tree fresh weight for 3 DBH classes:

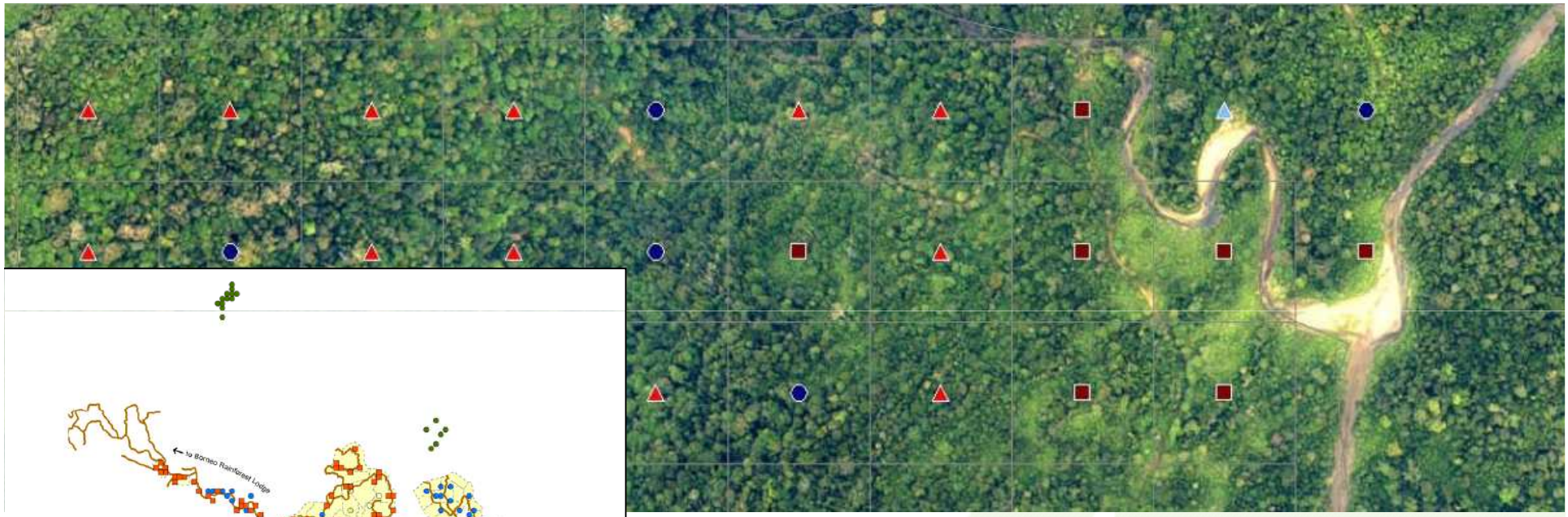
→Recording of input parameters: DBH, Height, Crown Width

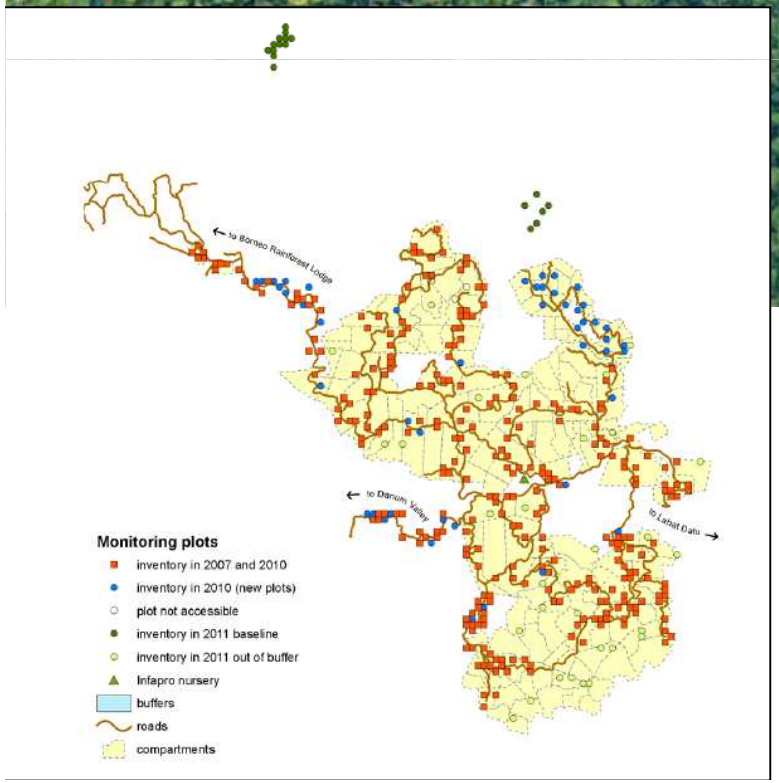
Calculation of dry weight, conversion with species specific factor:

→ Recording of input parameter: Tree Species

Monitoring design: stratified sampling

Stratification: virtual plots on aerial image to determine forest type





Plots located in both treated and untreated area

Monitoring campaigns took place in 2007 and in 2010/2011

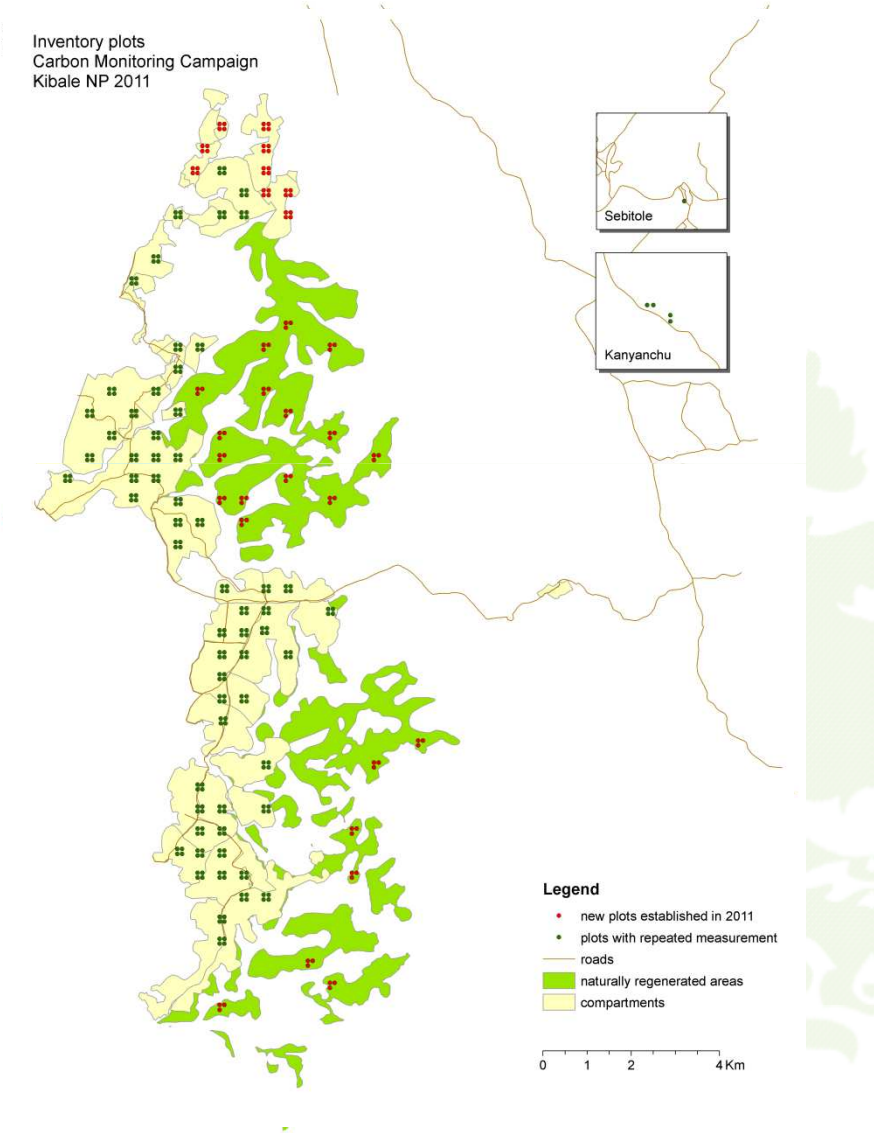
Monitoring design: stratified sampling

Kibale:

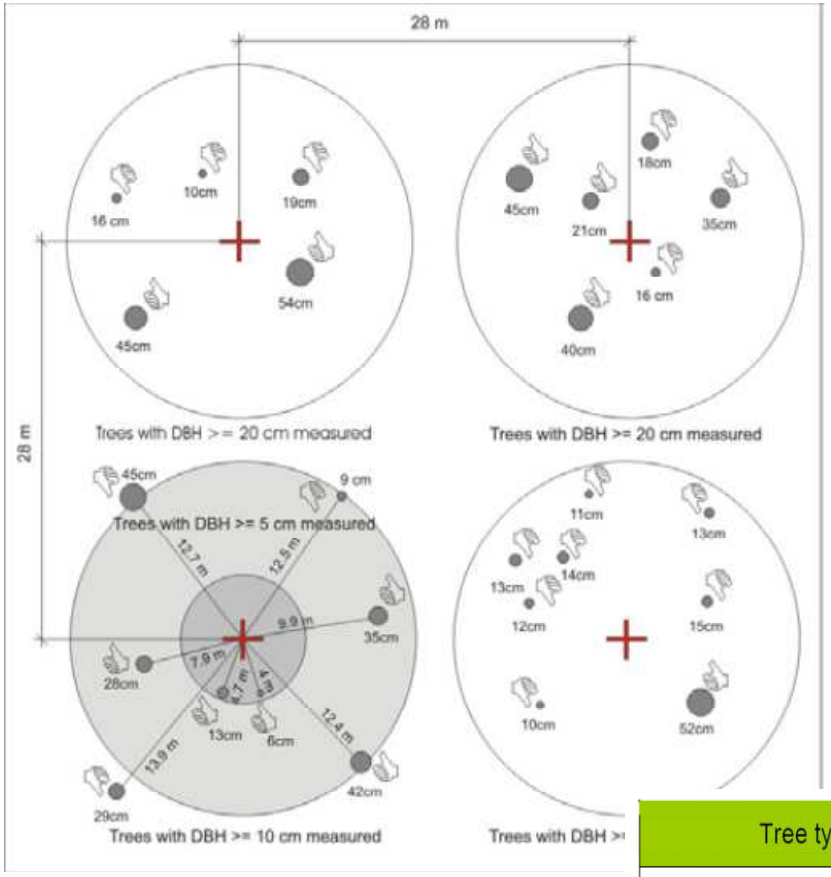
- Stratification based on planting years and type of treatment: planting and protection for natural regeneration
- Sampling based on a grid of clusters, each consisting of 3 or 4 monitoring plots

Western part: Planted area

Eastern part: Natural regenerating area



Monitoring design: plots



Plot design:

- Plot size is 2.000 m2

- 4 circles of 500 m2 each: 1 key circle and 3 satellite circles

- Nested approach, with a subcircle in the keycircle

Tree type	Tree dimensions	Sample area	Circle radius
regeneration	(>0,2 m of height; 50 mm of DBH)	12,56 m^2	2 m, key circle
small trees	(50 mm of DBH; 100 mm of DBH)	78,5 m^2	5 m, key circle
medium trees	(100 mm of DBH; 200 mm of DBH)	500 m^2	12,62 m, key circle
large trees (DBH>70cm)	(200 mm of DBH and more)	2000 m^2	whole inventory plot

Monitoring technology

Field-Map monitoring technology, developed by IFER (Czech Republic): advanced computer aided field data collection technology

Hardware: computer, laser rangefinder, compass and GPS mounted on a monopod

Software: Field-Map data collector → direct input of measurements in database

Quality Control and Assurance

Quality Assurance:

- Continuous training of local staff
- Supervision by external expert at the start of the campaign and senior supervision during whole campaign
- Standard Operational Procedures (SOP) for field staff
- Field-Map build-in checking routines
- Database backup at several locations

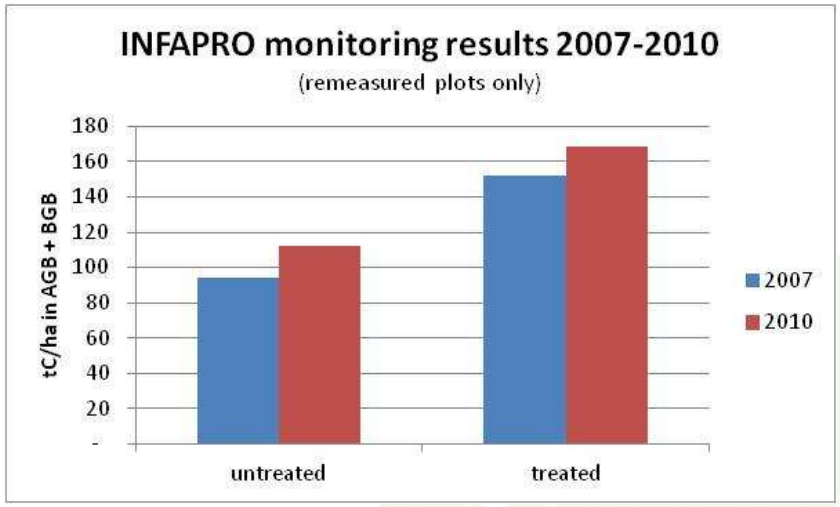
Quality Control:

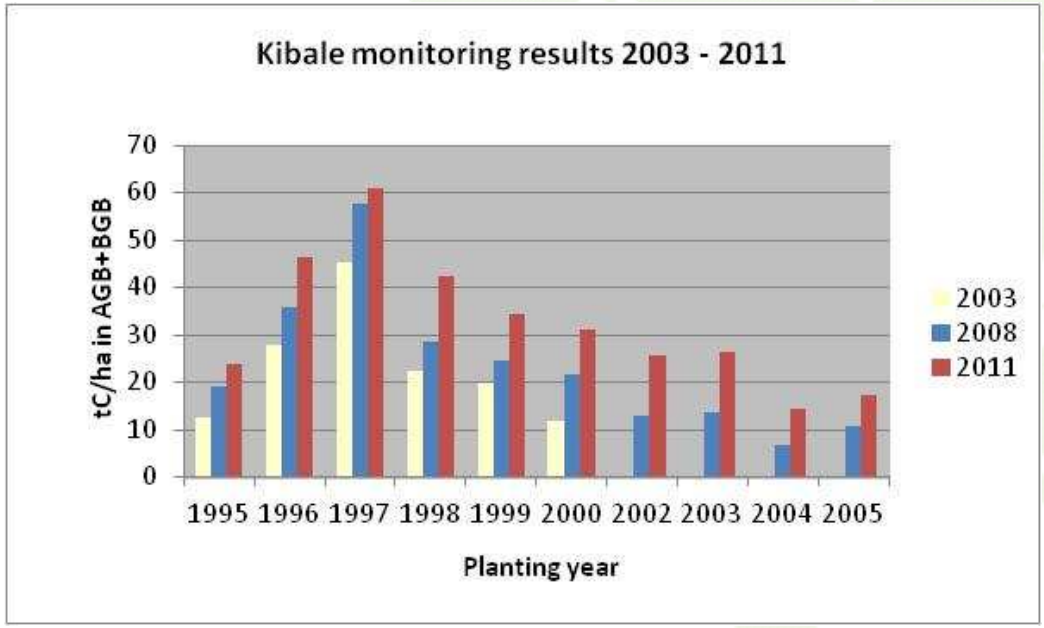
- Data checks by data analyst
- Re-measurement of 10% of plots to estimate measurement error

Experiences: 1.Carbon Data

- Lack of scientific data→ uncertainty around growth in project scenario and baseline
- INFAPRO: how does logged-over forest recover?
- Learning by doing: in Kibale the reliability of modeling improves after field reality check

Challenge for research community: fill the forest carbon knowledge gap





Experiences: 2.Costs

		Kibale	INFAPRO
Costs per plot	2007 / 2008	€ 235	€ 265
	2010 / 2011	€ 120	€ 260
Total costs	2007 / 2008	€ 55.000	€ 75.000
	2010 / 2011	€ 55.000	€ 100.000

Running monitoring costs, excluding initial purchase of equipment, aerial photo acquisition and internal coordination activities

Variation in costs explained by :

- Economies of scale
- Verification non-conformities: additional sampling required
- Phasing of monitoring and allocation of costs: development of SOP for INFAPRO reduces costs for Kibale
- The role of start-up costs: 2007 is the first monitoring event for INFAPRO, requiring extra consultancy and development costs

Consolidation of monitoring approach and economies of scale important factors for costs

Experiences: 3.Effort

INFAPRO, monitoring campaign 2010/2011:

- Ca. 17.500 trees measured
- 382 plots = 76,4 ha
- 1.050 mandays fieldwork
- Productivity: 2,5 plots/day for 1 team
- Length of campaign: around 3 months

Kibale, monitoring campaign 2011:

- Ca. 12.000 trees measured
- 461 plots = 92,2 ha
- 900 mandays fieldwork
- Productivity: 3,5 plots/day for 1 team
- Length of campaign: around 2,5 months

Experiences: 4.Capacity

Tree species identification crucial in tropical forests:

- INFAPRO: 226 different species identified in 2010
- Kibale: 130 different species identified in 2011

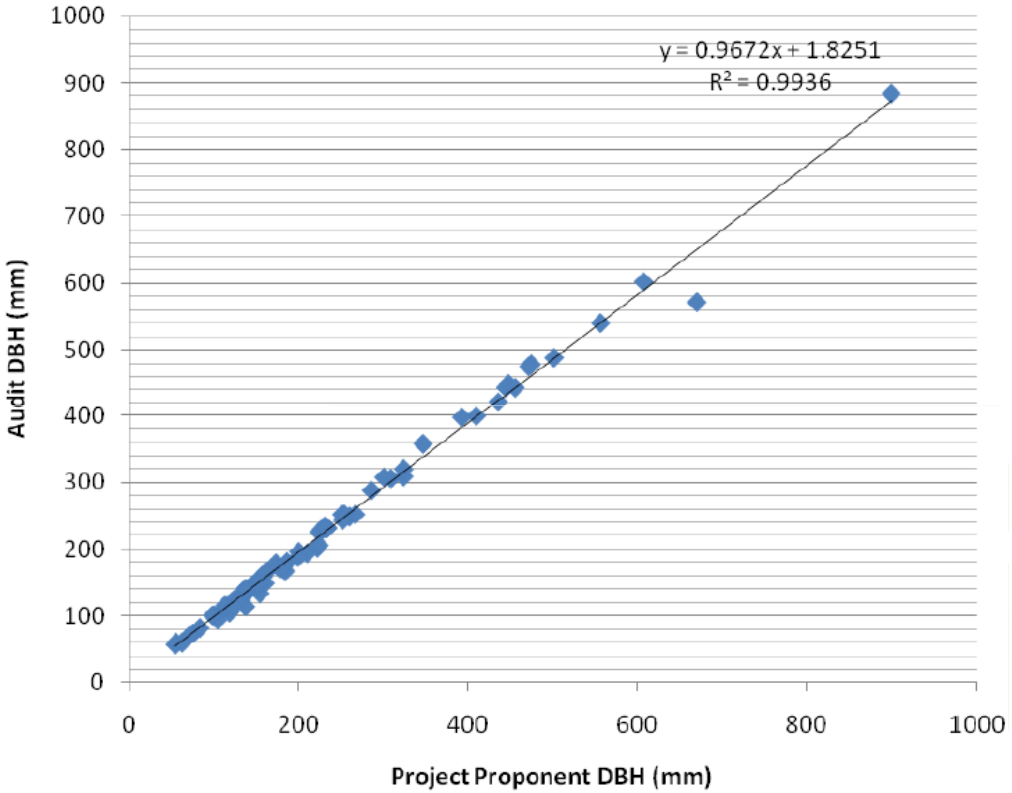
Maintain measurement skills of monitoring staff

Fieldwork by local project staff, trained and supported by senior staff and external consultants

Experiences: 5.Technology

Field-Map equipment:

- High quality data collection
- Quality assurance provisions:
  - Conditional lookup lists
  - Warnings for extreme input values
  - Warning for trees outside the plot boundary
  - Optional measurement wizard
  - Software check on missing variables after completing a plot
- High level plot information: position of trees in database in local coordinates

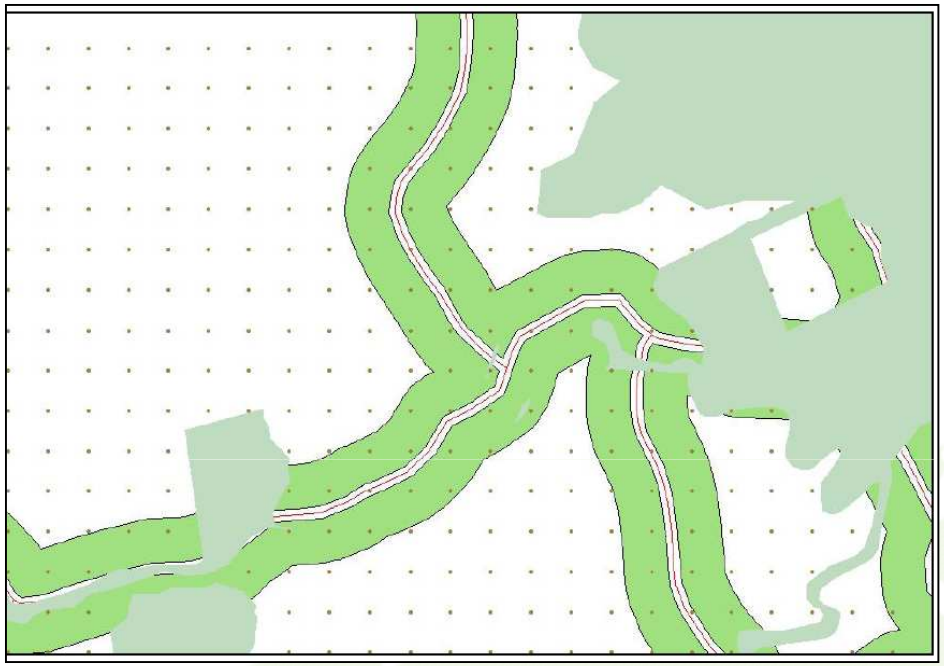


- Requires considerable training and retraining → need to maintain skills
- Relatively high costs for equipment maintenance and shipping: 15 – 20% of total costs

Decision for technology depends on quality requirements versus costs

Experiences: 6.Sampling

- INFAPRO inaccessible areas: buffer approach not a solution
  - (+) Buffer area covers 42 % of total treated area
  - (+) Proximity to roads not an indicator for intensity of previous logging damage: skid trails cover 15-30 % of the area
  - (-) There could be an effect of 'treatment intensity'
  - (-) Not statistical valid sampling scheme



Additional sampling shows similarity between core area and buffer area: an absolute difference of 0,5 t Carbon/ha, and 1,8% relative difference

Experiences: 7.Early action

The implications of a head start

- **INFAPRO**: data collection pre-2007 does not meet current certification standards
- **Kibale**: big effort in retrieving, re-analysing and reprocessing old baseline data

Flexibility towards pioneering projects will encourage visionary early action projects

Experiences: 8.We're not alone

As we monitor the forest…. The forest monitors us…