LEAF Technical Training on Reference Level Development

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Forest Carbon Sampling Design and Plot Distribution

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Forest Carbon Sampling Design

• **To stratify national / sub-national forest** in a way to reflect the forest carbon stocks, potential for change and time efficiency in data collection

• **To create a robust design** of obtaining highly accurate and precise measurements of forest carbon stocks
How to Choose an Appropriate Forest Carbon Sampling Design?

When choosing an appropriate sampling design for forest carbon sampling, consider following:

• Common forest types at national/sub-national scale
• Existing forest inventory data related to carbon
• Historical and future drivers of deforestation
• Resources limitations (financial, time and human resources)
• Targeted precision for carbon stocks
Desirable Design Criteria

The sampling design should be:

- **Practical to implement** (simplicity)
- **Cost effective**
- **Spatially well distributed samples** (spatial balance)
- **Acceptable precision** (i.e. small standard errors). The ‘acceptable’ is defined based on the objectives
- **Unbiased estimation of variance**
- **Flexible and adaptable** to changes in the objectives, or changes in sample size arising from revisions of the objectives or budget that occur after the sample data has begun
Types of Sampling Designs

- **Systematic sampling** - involves creation of sampling grid at predetermined sampling intervals and random selection of the starting sampling unit.

- **Stratified sampling** - involves grouping the population of interest into strata to estimate characteristics of each stratum and to improving the precision (i.e., reducing standard error) of an estimate for the full population.

- **Cluster sampling** - involves a grouping of the spatial units or objects sampled.
Systematic sampling designs

Systematic sampling involves creation of sampling grid at predetermined sampling intervals and random selection of the starting sampling unit.

Advantages:
- Spatially well distributed
- Small standard errors
- Long history of use

Disadvantages:
- Bias in overestimating the actual standard error
- Less flexible to increase or decrease the sampling size
- Not applicable for fragmented strata
Stratified Sampling Designs

Stratified sampling involves grouping the population of interest into strata to estimate characteristics of each stratum and to improving the precision (i.e., reducing standard error) of an estimate for the full population.

Advantages
- Allows specifying the sample size within each stratum
- Allows for different sampling design for each stratum

Disadvantages
- Yields large standard error if the sampling size is not selected appropriate
- Not effective if all variables are equally important
Cluster Sampling Designs

• **Cluster sampling** - involves a grouping of the spatial units or objects sampled.

For increasing cost efficiency and reducing field crew travel, sample plots may be organized into clusters, thus leading to systematic cluster sampling and stratified systematic cluster sampling.

**Advantages**

- Allows specifying the sample size within each stratum
- Allows for different sampling design for each stratum

**Disadvantages**

- Yields large standard error if the sampling size is not selected appropriate
- Not effective if all variables are equally important
Probability Sampling Design

- **Probability sampling** is a rigorous design that includes the known probability of each sample unit and that this probability is greater than zero for all samples.

**Advantages**
- Allows specifying the sample size within each stratum
- Allows for different sampling design for each stratum

**Disadvantages**
- Yields large standard error if the sampling size is not selected appropriate
- Not effective if all variables are equally important
Sampling Design for RL

**Probability Stratified Sampling Design steps:**

1. Create sampling strata
2. Create PSUs 10 x 10 km grid
3. Create list of PSUs overlapping with stratum of interest
4. Select PSUs with probability proportional for size
5. Assign starting point for SSUs

**Abbreviations:**
- PSUs = Primary Sampling Units
- SSUs = Secondary Sampling Units
Step 1: Sampling Strata

Sampling strata should reflect the forest carbon stocks, potential for change and accessibility.

Potential for change + Accessibility = Sampling strata
Step 2: Primary Sampling Unit

Grid across the country or province = 10 x 10 km
Step 3: Create List of PSUs

• Combine 10 x 10 km grids with the stratum of interest to create unique PSUs

• Create a list of all PSUs overlapping with the stratum of interest
Step 4: Select PSUs

- Calculate cumulative area per PSUs
- Assign RANDOM numbers = numbers of sampling clusters

Selected PSU ➔ If the random number is < the cumulative area associated with the PSU and > the cumulative area from the previous PSU in the list
Step 5: Assign Starting Point for SSUs

Example SSU clusters

Randomly assigned starting points for SSUs
Initial Lat/Long GPS Point

Random compass direction 300 m
Summary

- **Stratification** is most commonly used approach
- **Stratified cluster sampling** is usually the most cost-effective approach
- **Systematic sampling** is the most simple, but it is biased of estimating variance and not flexible for changes
- **Random sampling** is flexible for change of sampling size
- Choosing a sampling design typically involves weighing the advantages and disadvantages of different design options
Forest Carbon Sampling Design

• Forest carbon design **stratify national / sub-national forest** in a way to reflect the forest carbon stocks, potential for change and time efficiency in data collection.

• The goal of the forest carbon sampling design is **to create a robust design** of obtaining highly accurate and precise measurements of forest carbon stocks.


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