A/R Methodological Tool

"Calculation of the number of sample plots for measurements within A/R CDM project activities"

(Version 02.1.0)

I. SCOPE, APPLICABILITY AND ASSUMPTIONS

Scope

1. This tool can be used for calculation of number of sample plots required for estimation of biomass stocks from sampling based measurements in the baseline and project scenarios of an A/R CDM project activity.

2. The tool calculates the number of required sample plots on the basis of the specified targeted precision for biomass stocks to be estimated.

3. For the purpose of this tool all parameters used in calculation of plot level biomass stock (e.g. biomass expansion factors, root-shoot ratios) are considered fixed constants. Similarly, all models used for calculation of plot level biomass stock (e.g. volume tables or equations, allometric equations) are considered to be exact.

Applicability

This tool has no internal applicability conditions.

Assumptions

4. This tool applies the following assumptions:

(a) Approximate value of the area of each stratum within the project boundary is known;

(b) Approximate value of the variance of biomass stocks in each stratum is known from a preliminary sample, existing data related to the project area, or existing data related to a similar area;

(c) The project area is stratified into one or more strata.

Parameters

5. This tool provides steps to estimate the following parameters:

Table 1: Parameters determined by the tool

Parameter	Unit	Description
n	dimensionless	Number of sample plots required for estimation of biomass stocks within the project boundary
n_i	dimensionless	Number of sample plots allocated to stratum i for estimation of biomass stocks within the project boundary

6. While applying this tool in a methodology, the following notation should be used:

In the baseline scenario:

n_{BSL} for n and $n_{BSL,i}$ for n_i .

In the project scenario:

n_{PROJ} for n and $n_{PROJ,i}$ for n_i .

II. CALCULATION OF NUMBER OF SAMPLE PLOTS REQUIRED FOR ESTIMATION OF C STOCK WITHIN THE PROJECT BOUNDARY

Estimation of total number of sample plots (n)

7. Number of sample plots required for estimation of biomass stocks in a carbon pool depends upon the targeted precision and the variability of the biomass stock being estimated.

8. Targeted precision is specified by the methodology applying this tool.

9. The project area is stratified on the basis of the variability of the biomass stock being estimated, and approximate area of each stratum is determined. If the biomass stock being estimated is sum of biomass stocks in two or more pools, then stratification is carried out on the basis of the variability of the biomass stock of the dominant pool (i.e. the pool containing the largest amount of biomass stock).

10. For the purpose of this tool, variability of biomass stock is expressed as the standard deviation of biomass stock in the stratum. Approximate value of the standard deviation of biomass stock in each stratum at the time of estimation is either known from existing data applicable to the project area or existing data related to a similar area, or is estimated on the basis of a preliminary sample or an expert judgement.

11. Number of sample plots required for estimation of biomass stocks within the project boundary is calculated iteratively. In the first iteration, the number of sample plots for the project area is calculated as:

$$n = \frac{N * t_{VAL}{}^2 * \left(\sum_i w_i * s_i \right)^2}{N * E^2 + t_{VAL}{}^2 * \sum_i w_i * s_i{}^2} \qquad (1)$$

where:

n	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
N	Total number of possible sample plots within the project boundary (i.e. the sampling space or the population); dimensionless
t_{VAL}	Two-sided Student's *t*-value, at infinite degrees of freedom, for the required confidence level; dimensionless
w_i	Relative weight of the area of stratum *i* (i.e. the area of the stratum *i* divided by the project area); dimensionless

s_i Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})

E Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stock within the project boundary; t d.m. (or t d.m. ha^{-1}), i.e. in the units used for s_i

i *1, 2, 3, …* biomass stock estimation strata within the project boundary

12. If the number of sample plots *n* calculated in the first iteration using equation 1 is 30 or more, then no further iteration is carried out and the value of *n* obtained in the first iteration is the final value of *n*.

13. If the number of sample plots *n* calculated in the first iteration using equation 1 is less than 30, then equation 1 is applied in the second iteration using the *t*-value for degrees of freedom equal to (*n*-1). The value of *n* obtained in the second iteration is the final value of *n*.

14. For a small sampling fraction (that is, when area sampled is less than 5% of the project area), the following simplified equation can be used for estimating the number of sample plots:

$$n = \left(\frac{t_{VAL}}{E}\right)^2 * \left(\sum_i w_i * s_i\right)^2 \quad \textbf{(2)}$$

where:

n Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

t_{VAL} Two-sided Student's *t*-value at infinite degrees of freedom for the required confidence level; dimensionless

E Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stock within the project boundary; t d.m. (or t d.m. ha^{-1}), i.e. in the units used for s_i

w_i Relative weight of the area of stratum *i* (i.e. the area of the stratum *i* divided by the project area); dimensionless

s_i Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})

i *1, 2, 3, …* biomass stock estimation strata within the project boundary

15. For a large sampling fraction (that is, when area sampled is more than 5% of the project area), the number of plots calculated using equation 1 is adjusted as:

$$n_a = n * \frac{1}{1 + n / N} \quad \textbf{(3)}$$

where:

n_a Adjusted number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

n Number of sample plots required for estimation of biomass stocks within the project boundary, as calculated from equation 1; dimensionless

N Total number of possible sample plots within the project boundary (i.e. the sampling space or the population); dimensionless

Allocation of number of sample plots among strata

16. The method of optimum allocation is used for allocating number of sample plots to different strata.

17. Number of sample plots allocated to a stratum is calculated as:

$$n_i = n * \frac{w_i * s_i}{\sum_i w_i * s_i} \quad (4)$$

where:

n_i	Number of sample plots allocated to stratum *i*; dimensionless
n	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
w_i	Relative weight of the area of stratum *i* (i.e. the area of the stratum *i* divided by the project area); dimensionless
s_i	Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})
i	*1, 2, 3, …* biomass stock estimation strata within the project boundary

III. DATA AND PARAMETERS USED IN THE TOOL

18. The following tables describe the data and parameters used in this tool. The guidelines contained in these tables regarding selection of data sources, and procedures to be followed in measurement, where applicable, should be treated as an integral part of this tool.

Data and parameters not measured

Data / Parameter:	t_{VAL}
Data unit:	dimensionless
Used in equations:	1, 2
Description:	Two-sided Student's *t*-value, at infinite degrees of freedom in the first iteration and at degrees of freedom equal to (*n*-1) in subsequent iterations, for the required confidence level; dimensionless
Source of data:	Student's t-distribution table. An extract of the table is included below for ready reference: (see table below) Df - degree of freedom
Comments:	Use the 90% confidence level for determination of biomass stock in A/R CDM project activities, unless a different confidence level is prescribed in a methodology

	Confidence level				
Df	**80%**	**90%**	**95%**	**98%**	**99%**
1	3.078	6.314	12.706	31.820	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.897	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.625	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.584	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
∞	1.282	1.645	1.960	2.326	2.576

Df - degree of freedom

Data / Parameter:	E
Data unit:	t d.m. (or t d.m. ha^{-1})
Used in equations:	1, 2
Description:	Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stock within the project boundary; in units used for s_i
Source of data:	A default value equal to 10% of the mean biomass stock within the project boundary may be used unless a different value is prescribed in a methodology

Data and parameters measured

Data / Parameter:	N
Data unit:	dimensionless
Used in equations:	1, 3
Description:	Total number of possible sample plots within the project boundary (the sampling space or the population); dimensionless
Measurement procedures:	*N* is equal to project area divided by the size of the sample plot
Comments:	With a project area of 1000 ha and a sample plot size of 0.10 ha, *N* is equal to 10,000

Data / Parameter:	w_i
Data unit:	dimensionless
Used in equations:	1, 2, 4
Description:	Relative weight of the area of stratum *i*; dimensionless
Measurement procedures:	The relative weight of the area of a stratum *i* is equal to the area of the stratum *i* divided by the project area

Data / Parameter:	s_i
Data unit:	t d.m. (or t d.m. ha^{-1})
Used in equations:	1, 2, 4
Description:	Estimated standard deviation of biomass stock in stratum *i*. Standard deviation of biomass stock per unit area (in t d.m. ha^{-1}) may also be used for this purpose
Measurement procedures:	Approximate value of the standard deviation of biomass stock in each stratum is either known from existing data related to the project area or existing data related to a similar area, or is estimated from a preliminary sample

IV. References

All references are quoted in footnotes.

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History of the document

Version	Date	Nature of revision
02.1.0	EB 58, Annex 15 26 November 2010	The revision: (i) Simplifies the method of calculation of sample plots; (ii) Introduces a simplified equation which applies in cases of small sampling fractions; (iii) Streamlines the general presentation of the tool with the recently approved tools. Due to overall modification of the document, no highlights of the changes are provided.
02	EB 46, Annex 19 25 March 2009	Further clarification of practical aspects on location of permanent sample plots for data collecting and improvement in clarity of formulae.
01	EB 31, Annex 15 04 May 2007	Initial adoption.
Decision Class: Regulatory **Document Type**: Tool **Business Function**: Methodology		