ZERO2NATURE™ NEGATIVE EMISSIONS REDUCTION PROJECT DEVELOPMENT METHODOLOGY THROUGH AFFORESTATION, REFORESTATION, LAND USE CHANGE AND/OR MONITORED PRESERVATION OF FORESTS – ZERO2NATURE - PREFOR

Version 1.0

ZERO2NATURE™ METHODOLOGY APPROVED UNDER ZNP0001 REGISTRATION

SECTORAL SCOPE 17

"Developed from the UNFCCC methodological concept."

September 2012

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INTRODUCTION

This methodology shall be used in the ZERO2NATURE™ project conception platform context. This methodology function is to guide ZERO2NATURE™ project activities, which aims to reduce and/or remove negative emissions through afforestation, reforestation, land use change and/or monitored forest integrity preservation (hereafter ZERO2NATURE™-PREFOR).

2 SCOPE, APPLICABILITY AND ENTRY INTO FORCE

2.1 Scope

This methodology applies to ZERO2NATURE™-PREFOR project activities.

2.2 Applicability

By applying this methodology, the baseline scenario can include both the programmed and unforeseen forest depletion related to the ZERO2NATURE™-PREFOR project activity.

The ZERO2NATURE™-PREFOR project activity cannot introduce environmental changes that alter the project activity baseline scenario of the area in more than 10% (ten per cent).

a) Project activities may include one or a combination of activities eligible as ZERO2NATURE™. In cases of ZERO2NATURE™-PREFOR project activities, the project area can include different kinds of forest, as long as complying with the following definition: "area superior to 0.5ha, with trees taller than 5m and crown cover superior to 10%, or trees capable of reaching these parameters *in situ*, that does not contemplate land predominantly used for urban or agricultural purposes."

b) In cases of ZERO2NATURE™-PREFOR project activities, the eligible area has to be qualified as a forest for a minimum period of ten years.

c) This methodology does not apply to swamps.

The ZERO2NATURE™ project activity applying this methodology shall also conform to the conditions imposed by the related tools, available at www.zero2nature.com.

2.3. Entry into force

The date of entry into force of this version (1.0) of the methodology is September 24, 2012.

3. NORMATIVE REFERENCES

The following documents are indispensable for the application of this methodology:

(a) ZERO2NATURE™ Standard;

(b) Project Document Design – PDD- ZERO2NATURE™;

(c) "Tool to identify the baseline scenario and demonstrate additionality in ZERO2NATURE™-PREFOR project activities";

(d) "Procedure to demonstrate eligibility of lands in ZERO2NATURE™-PREFOR/PREBIO project activities";

(e) "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in ZERO2NATURE™-PREFOR project activities";

(f) "Estimation of carbon stocks and change in carbon stocks of dead wood and waste in ZERO2NATURE™-PREFOR project activities";

(g) "Estimation of carbon stocks and change in carbon stocks of soil organic carbon in ZERO2NATURE™-PREFOR project activities";

(h) "Tool to perform forest management according to ZERO2NATURE™ Standard."

4. TERMS AND DEFINITIONS

The definitions contained in the following documents shall apply:

(a) "Glossary of ZERO2NATURE™ terms";

(b) "ZERO2NATURE™ Standard;

(c) "Harvard Atmospheric Chemistry Modeling Group – www.acmg.seas.harvard.edu.";

(d) "IPCC Good Practice Guidance for LULUCF, 2003".

For the purpose of this methodology and pertaining to ZERO2NATURE™-PREFOR project activities, the following specific definitions also apply:

a) Negative emissions reduction through reduction and or removal of deforestation and forest degradation;
b) Negative emissions reduction through land use, land use change and forestry;
c) Negative emissions reduction through reforestation;
d) Negative emissions reduction through afforestation.

5. BASELINE AND MONITORING METHODOLOGY

5.1 Related to ZERO2NATURE™-PREFOR project activities

The potential negative environmental emitters accountable for purposes of this methodology, can be encountered throughout the ecosystem area were the ZERO2NATURE™ project activity has been proposed. The roll of the emitter, its associated Environmental Impact Potential – EIP and the afflicted ecosystem segment(s) is (are) available at: www.zero2nature.com.

5.2 Baseline scenario identification and demonstration of additionality in ZERO2NATURE™-PREFOR project activities

In order to identify the baseline scenario and to demonstrate the project activity additionality, the following tool shall be applied:

a) "Tool to identify the baseline scenario and demonstrate additionality in ZERO2NATURE™-PREFOR project activities".

5.3 Stratification

In accounting for the negative emissions in any ecosystem segment of the proposed ZERO2NATURE™ project activity, soil and aquatic stratification has to be considered, as per inventory precision. The perspective of different stratifications can be appropriated both to the baseline scenario and project scenario, contributing to a more accurate net negative emissions estimated removals.

5.4 Baseline net negative emissions removals by sinks

The baseline net negative emissions removals by sinks shall be calculated as follows:

$$\Delta \boldsymbol{E}_{\boldsymbol{BL,y}} = \Delta \boldsymbol{E}_{\boldsymbol{Tree\_BL,y}} + \Delta \boldsymbol{E}_{\boldsymbol{Dead\_wood\_BL,y}} + \Delta \boldsymbol{E}_{\boldsymbol{Waste\_BL,y}} + \Delta \boldsymbol{E}_{\boldsymbol{Soil\_organic\_carbon\_BL,y}}$$

Where:

$\Delta \boldsymbol{E}_{\boldsymbol{BL},\boldsymbol{y}}$ = *Baseline net negative emissions removals by sinks in year y, tEIP*

$\Delta \boldsymbol{E}_{\boldsymbol{Tree\_BL},\boldsymbol{y}}$ = *Change in carbon stock in baseline tree biomass within the project boundary in year y, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in ZERO2NATURE™ – PREFOR" project activities, in tEIP*

$\Delta \boldsymbol{E}_{\boldsymbol{Dead\_wood\_BL},\boldsymbol{y}}$ = *Change in carbon stock in baseline dead wood biomass within the project boundary, in year y, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and waste in ZERO2NATURE™ – PREFOR" project activities, in tEIP*

$\Delta \boldsymbol{E}_{\boldsymbol{Waste\_BL},\boldsymbol{y}}$ = *Change in carbon stock in baseline litter biomass within the project boundary, in year y, as estimated in the tool " Estimation of carbon stocks and change in carbon stocks in dead wood and waste in ZERO2NATURE™ – PREFOR" project activities, in tEIP*

$\Delta \boldsymbol{E}_{\boldsymbol{Soil\_organic\_carbon\_BL},\boldsymbol{y}}$ = *Change in carbon stock in baseline soil organic carbon biomass within the project boundary in year y, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in soil organic carbon in ZERO2NATURE™ – PREFOR" project activities, in tEIP*

5.5 Actual net negative emissions removals by sinks

The actual net negative emissions removals by sinks shall be calculated as per the following formula:

$$\Delta E_{Actual,y} = \Delta E_{P,y} - NE_{A,y}$$

Where:

$\Delta E_{Actual,y}$ = *Actual net negative emissions removals by sinks, in year y, in tEIP*

$\Delta E_{P,y}$ = *Change in emmiters stocks (negative emmiters) in project, occurring in the selected pools in year y, in tEIP*

$NE_{A,y}$ = *Increase in negative emissions within the project boundaries, as a result of the*

$implementation\ of\ the\ ZERO2NATURE^{TM}\ project\ activity,\ in\ tEIP$

In case of ZERO2NATURE™-PREFOR afforestation and or reforestation project activities:

a) Changes in the carbon stocks of the project activity, occurring in the selected carbon pools in year y shall be calculated as follows:

$$\Delta C_{P,y} = \Delta C_{Tree\_proj,y} + \Delta C_{Shrub\_proj,y} + \Delta C_{DW\_proj,y} + \Delta SOC_{AL,y}$$

Where:

$\Delta C_{P,y} =$ $Change\ in\ the\ carbon\ stocks\ in\ project, occurring\ in\ the\ selected\ carbon\ pools, in\ year\ y;\ t\ EIP$

$\Delta C_{Tree\_proj,y} =$ $Change\ in\ carbon\ stock\ in\ tree\ biomass\ in\ project\ in\ year\ y, as\ estimated\ in\ the\ tool$ $"Estimation\ of\ carbon\ stocks\ and\ change\ in\ carbon\ stocks\ of\ trees\ and\ shrubs\ in\ ZERO2NATURE^{TM}$-$PREFOR"\ project\ activities, in\ tEIP$

$\Delta C_{Shrub\_proj,y} =$ $Change\ in\ carbon\ stock\ in\ shrub\ biomass\ in\ project\ in\ year\ y, as\ estimated\ in\ the\ tool$ $"Estimation\ of\ carbon\ stocks\ and\ change\ in\ carbon\ stocks\ of\ trees\ and\ shrubs\ in\ ZERO2NATURE^{TM} - PREFOR"\ project\ activities, in\ tEIP$

$\Delta C_{DW\_proj,y} =$ $Change\ in\ carbon\ stock\ in\ dead\ wood\ biomass\ in\ project\ in\ year\ y, as\ estimated\ in\ the$ $tool\ "Estimations\ of\ carbon\ stocks\ and\ change\ in\ carbon\ stocks\ in\ dead\ wood\ and\ waste\ in$ $ZERO2NATURE^{TM} - PREFOR\ project\ activities, in\ tEIP$

$\Delta SOC_{AL} =$ $Change\ in\ carbon\ stock\ in\ SOC\ in\ project, in\ year\ y, in\ areas\ of\ land\ meeting\ the\ applicability$ $conditions\ of\ the\ tool\ "Estimation\ of\ carbon\ stocks\ and\ change\ in\ carbon\ stocks\ of\ soil\ organic\ carbon$ $in\ ZERO2NATURE^{TM} - PREFOR\ project\ activities, in\ tEIP$

b) The change in carbon stock in the SOC pool within the project boundary, in year t, shall be estimated as follows:

$$\Delta SOC_{Proj}, y = \frac{44}{12} \times \sum_{y=1}^{y} A_{PLANT,y} \times dSOC_{,y} \times 1\ year$$

Where:

$\Delta SOC_{Proj}, y =$ $Change\ in\ SOC\ stock\ within\ the\ project\ boundary, in\ year\ y, in\ tEIP$

$$\sum_{y=1}^{y} A_{PLANT,y} = Area\ planted\ in\ year\ y, in\ ha$$

$$dSOC_{,y} = The\ change\ of\ rate\ in\ SOC\ stocks\ within\ the\ project\ boudary, in\ year\ y, in\ tC ha^{-1}\ yr^{-1}$$

The following default value is used unless transparent and verifiable information can be provided to justify a different value:

(i) $dSOC_{,y} = 0{,}5\ t\ C\ ha^{-1}\ yr^{-1}\ for\ y = y_{plant}\ to\ y_{\ plant} + 10\ years; where\ y_{plant}\ is\ the\ year\ in\ which\ planting\ takes\ place;$

$(ii)\ dSOC_{,y} = 0\ t\ C\ ha^{-1}\ yr^{-1}\ for\ y > y_{\ plant} + 10\ years$

5.6 Leakage

ZERO2NATURE™ negative emissions leakage can be estimated (by source) based on specific data related to the ZERO2NATURE™ – PREFOR project activity and/or dedicated scientific literature.

5.7 Net anthropic negative emissions removals by sinks

Net anthropic negative emissions removals by sinks shall be calculated through the application of the following formula:

$$\Delta E_{AR\_02NATURE,y} = \Delta E_{Actual,y} - \Delta E_{BL,y} - Leakage_y$$

Where:

$\Delta E_{AR\_02NATURE,y} = anthropic\ negative\ emissions\ removals\ by\ sinks, in\ year\ y, in\ tEIP$

$\Delta E_{Actual,y} = \ Actual\ negative\ emissions\ removals\ by\ sinks, in\ year\ y, em\ tEIP$

$\Delta E_{BL,y} = Baseline\ negative\ emissions\ removals\ by\ sinks, in\ year\ y, in\ tEIP$

$Leakage_y = Negative\ emissions\ due\ to\ leakage, in\ year\ y, in\ tEIP$

5.8 Calculation of 02NCs

The issuance of the 02NCs occurs by means of the technical committee verification report evaluation. The verification report shall be emitted by a ZERO2NATURE™ designated certifier. Once approved, the total amount of verified and certified 02NCs will be deposited in the project proponent(s) ZERO2NATURE™ registry account.

6. MONITORING PROCEDURE

6.1 Monitoring plan

The monitoring plan shall provide for a collection of all relevant data necessary for:

a) Verification that the applicability conditions listed under paragraphs 3 and 4 of this methodology have been met;

b) Verification of changes in emitter stocks (negative emissions) of the selected pools and

c) Verification of project emissions and leakage emissions.

The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity.

6.2 Monitoring of project implementation

Information shall be provided, and recorded in the project design document PDD-ZERO2NATURE™, to establish that the commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded and applied. In the ZERO2NATURE™-PREFOR project activities, the "IPCC good Practice Guidance for Land Use, Land Use Change and Forestry 2003" is recommended.

6.3 Parameters

For this methodology, the following parameters are applicable:

Parameter 1 - Land area	
Parameter/datum:	Sampling area
Measure unit:	Ha
Description:	Description of the area where the sampling took place
Datum source:	Field measurement
Measurement procedures (if applicable):	Host Country procedures related to forest inventory shall be applied. In its absence the IPCC GPG LULUCF 2003 shall be used
Frequence of monitoring:	In the Validation process and every Verification process.
QA/QC:	The procedures related to quality assurance/quality control related to national forest inventory shall be applied. In its absence, the IPCC GPG LULUCF 2003 shall be applied

Parameter 2 - Forest canopy	
Parameter/datum:	Trees biomass stock
Measure unit:	Adimensional
Description:	Baseline trees biomass stocks
Datum source:	Field measurement
Measurement procedures (if applicable):	biomass stored in the trees of the project, a simple measure would be the ocular estimate. Another method such as transverse line or the use of Relaskop also applies
Frequence of monitoring:	Measured only once (in the beginning of the project)
QA/QC:	Host Country procedures related to forest inventory shall be applied. In its absence the IPCC GPG LULUCF 2003 shall be used
Coment:	When land is subject to periodic cycles that directly influence the biomass of trees, ranging between maximum and minimum values of the baseline, the value of this parameter should be set as equal to half the biomass of the three largest trees found in the sampling perimeter

6.4 Data requirements under this methodology

Description of data and parameters can be found in the tools used in this methodology.

Data and parameters obtained from measurement shall be monitored as required in the tools.

6.5 Forest management

The forest management is allowed in the project activity area, once the forest management area lies within the 10% of environmental change allowed by the ZERO2NATURE™ Standard. The forest management implementation has to meet the requirements of the "Tool to perform forest management within the ZERO2NATURE™ Standard".

APPENDIX I – METHODS OF PLOT BIOMASS MEASUREMENT

This appendix provides methods for measurement of tree biomass per hectare in a sample plot (the plot biomass value). Plot biomass values are estimated from direct or indirect measurements conducted on trees in the sample plot. Table 1 presents the type of measurements and the methods for converting these measurements into tree biomass.

TABLE 1. PLOT MEASUREMENTS AND THEIR CONVERSION TO TREE BIOMASS

Step	Fixed area plots	Variable area plots
Step 1: measurement	Individual tree dimension	Basal area per hectare
Step2: Conversion (how measurements are converted into tree biomass	1.Using allometric equations based on tree dimensions; or 2. Using biomass expansion factors; or 3. Combination of 1 and 2	1. Using allometric equations based on basal area; or 2. Using biomass expansion factors; or 3. Combination of 1 and 2

Note. Sampling by variable area plot method is also termed as 'angle count sampling' in forest inventory literature.

1. Measurement of fixed area plots

In this method, sample plots of the same size (e.g. 1/10 or 1/20 of a hectare) are installed in a stratum. All trees in a sample plot above a minimum dimension are measured and the biomass of each tree is estimated. The minimum dimension selected can be low (e.g. a diameter of 2 cm) or high (e.g. a diameter of 10 cm) depending upon the applicability of models (e.g. allometric equations or volume equations) to be used for conversion of the tree dimension into tree volume or tree biomass, and upon cost-effectiveness of measurement.

The biomass of the individual trees is added and the sum is divided by the area of the sample plot to obtain the plot biomass value.

Note. Where the number of saplings with diameter below the range of diameter applicable to the allometric equation is high, the mean biomass of the saplings in a sample plot can be estimated as follows: (1) Determine the diameter mid-way between the diameter of the smallest sapling existing and the smallest diameter allowed by the allometric equation. (2) Harvest from outside the plot area a few saplings having diameter close to the mid-way diameter and obtain the mean biomass per sapling; (3) Count all the saplings in the sample plot and multiply this number by the mean sapling biomass to obtain their contribution to the plot biomass.

The plot biomass value (i.e. per-hectare tree biomass at the centre of the plot) is estimated as follows (all time-dependent variables relate to the time of measurement):

$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}}$$ Equation (1)

$$B_{TREE,p,i} = \sum_{j} B_{TREE,j,p,i}$$ Equation (2)

$$B_{TREE,j,p,i} = \sum_{l} B_{TREE,l,j,p,i}$$ Equation (3)

Where:

$b_{TREE,p,i}$	=	Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha^{-1}
$B_{TREE,p,i}$	=	Tree biomass in sample plot *p* of stratum *i*; t d.m.
$A_{PLOT,i}$	=	Size of sample plot in stratum *i*; ha
$B_{TREE,j,p,i}$	=	Biomass of trees of species *j* in sample plot *p* of stratum *i*; t d.m.
$B_{TREE,l,j,p,i}$	=	Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*; t d.m.

Biomass of a tree in a sample plot is estimated by using one of the following equations:

$$B_{TREE,l,j,p,i} = f_j(x_{1,l}, x_{2,l}, x_{3,l}, \ldots) \times (1 + R_j) \quad \text{Equation (4)}$$

$$B_{TREE,l,j,p,i} = V_{TREE,j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots) \times D_j \times BEF_{2,j} \times (1 + R_j) \quad \text{Equation (5)}$$

Where:

$B_{TREE,l,j,p,i}$	=	Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*; t d.m.
$f_j(x_{1,l}, x_{2,l}, x_{3,l}, \ldots)$	=	Above-ground biomass of the tree returned by the allometric equation for species *j* relating the measurements of tree *l* to the above-ground biomass of the tree; t d.m. Note. The allometric equation used may be based on different units of inputs and outputs. For example, input values of diameter at breast height (dbh) may be in inches and output of biomass may be in pounds, rather than dbh in cm and biomass in kg or t d.m. In such a case, the function should be applied consistently (e.g. convert the dbh values from centimetre to inch units, obtain the tree biomass in pound, and then convert the biomass into metric tonne).
R_j	=	Root-shoot ratio for tree species *j*; dimensionless The value of R_j is estimated as $R_j = \frac{e^{(-1.085+0.9256\times\ln b)}}{b}$ where b is the above-ground tree biomass per hectare (in t d.m. ha^{-1}), unless transparent and verifiable information can be provided to justify a different value. Note. If trees have grown as coppice regeneration after a harvest, then the value of R_j should be multiplied by a factor equal to $v_{HARVEST}/v_{TREE}$ or 1, whichever is greater, where $v_{HARVEST}$ is the volume per hectare of trees harvested and v_{TREE} is the volume per hectare of trees standing in the plot at the time of measurement.

$V_{TREE,j}(x_{1,l}, x_{2,l}, x_{3,l}, \dots)$	=	Stem volume of tree *l* of species *j* in sample plot *p* of stratum *i*, estimated from the tree dimension(s) as entry data into a volume table or volume equation; m^3 Note. Where the volume table or volume equation predicts under-bark volume (i.e. wood volume, rather than gross stem volume), suitable correction should be applied to estimate the over-bark volume.
D_j	=	Density (over-bark) of tree species *j*; t d.m. m^{-3} Values are taken from Table 3A.1.9 of IPCC GPG-LULUCF 2003 unless transparent and verifiable information can be provided to justify different values. Note. Where density (specific gravity) of the bark of a tree species is different from the density of the wood, suitable correction should be applied to estimate a conservative value of the overall (over-bark) density of tree stem.
$BEF_{2,j}$	=	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species *j*; dimensionless For ex-ante estimation, the value of $BEF_{2,j}$ is selected by applying, *mutatis mutandis*, the procedure described in paragraph 7 below. For ex-post estimation the conservative default value of 1.15 is used, unless transparent and verifiable information can be provided to justify a different value.

For ex ante estimation the allometric equation or volume table or volume equation applied to a tree species is selected from the following sources:

(a) Existing data applicable to local situation (e.g. represented by similar ecological conditions);

(b) National data (e.g. from national forest inventory or national greenhouse gas (GHG) inventory);

(c) Data from neighbouring countries with similar conditions;

(d) Globally applicable data.

2. Measurement of variable plots

This method estimates tree biomass per hectare from the basal area per hectare and therefore does not require individual tree measurements. Tree basal area is obtained at the centre of a sample plot using an angle-count instrument (e.g. a wedge prism or a relascope).

Tree biomass in a plot is estimated as follows:

$$b_{TREE,p,i} = \sum_{j} b_{TREE,j,p,i}$$ Equation (6)

Where:

$b_{TREE,p,i}$	=	Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha^{-1}
$b_{TREE,j,p,i}$	=	Tree biomass per hectare of species *j* in sample plot *p* of stratum *i*; t d.m. ha^{-1}

Tree biomass per hectare of a species in a sample plot is estimated by using one of the following equations:

$$b_{TREE,j,p,i} = f_j(BA_{p,i}) \times (1 + R_j)$$ Equation (7)

$$b_{TREE,j,p,i} = v_{TREE,j}(BA_{p,i}) \times D_j \times BEF_{2,j} \times (1 + R_j)$$ Equation (8)

Where:

$b_{TREE,j,p,i}$	=	Tree biomass per hectare of species *j* in sample plot *p* of stratum *i*; t d.m. ha^{-1}
$f_j(BA_{p,i})$	=	Above-ground tree biomass per hectare in plot *p* returned by the allometric equation for species *j* relating the basal area of the plot to the above-ground tree biomass per hectare; t d.m. ha^{-1}
$v_{TREE,j}(BA_{p,i})$	=	Stem volume per hectare of trees of species *j* in sample plot *p* of stratum *i* estimated by using the basal area of the plot as entry data into a volume table or volume equation; m^3 ha^{-1}

APPENDIX 2 – APPLYING UNCERTAINTY DISCOUNT

Estimates with high uncertainty can be used in methodologies only if such estimates are conservative. This appendix provides a procedure for applying discount factors in order to make the mean estimated values of parameters conservative.

When the uncertainty in the estimated mean value of a parameter is more than 10 per cent, the estimated mean value is either increased or decreased by a percentage of the uncertainty. Table 1 provides the uncertainty discount factors to be applied for different ranges of uncertainty.

Table 1. Uncertainty discount factors

Uncertainty	Discount (% of U)	How applied
U ≤ 10%	0%	*Example:* Estimated mean = 60±9 t d.m ha^{-1} i.e. U=9/60x100 = 15% Discount = 25% x 9 = 2.25 t d.m ha^{-1} Discounted conservative mean: In baseline = 60+2.25 = 62.25 t d.m ha^{-1} In project = 60-2.25 = 57.75 t d.m ha^{-1}
10 < U ≤ 15	25%	
15 < U ≤ 20	50%	
20 < U ≤ 30	75%	
U > 30	100%	

APPENDIX 3 – CALCULATING CORRELATION COEFFICIENT AND SLOPE OF REGRESSION

This appendix provides the formulae for calculation of the coefficient of correlation and the slope of regression line between two data sets. The formulae provided here can also be found in any textbook or reference book of statistics. It is only for convenience of the users and for avoiding any ambiguity in definition of these parameters that these formulae are provided here. These coefficients may also be calculated using commercial or open source computer software (e.g. statistical packages).

For two linearly related data sets of equal size, the correlation coefficient and the slope of regression line are calculated as follows:

$$\beta = \rho \times \frac{s_y}{s_x} \qquad \text{Equation (1)}$$

$$\rho = \frac{\sum_{i=1}^{n}\{(x_i - \bar{x})(y_i - \bar{y})\}}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \times \sum_{i=1}^{n}(y_i - \bar{y})^2}} \qquad \text{Equation (2)}$$

Where:

β	=	Slope of regression line of the dependent variable (y) against the independent variable (x)
ρ	=	Sample correlation coefficient between the dependent variable (y) and the independent variable (x)
s_y, s_x	=	Sample standard deviation of the dependent variable (y) values and the independent variable (x) values respectively
x_i	=	Independent variable (x) values
$\bar{x}$	=	Mean of the independent variable (x) values
y_i	=	Dependent variable (y) values
$\bar{y}$	=	Mean of the dependent variable (y) values
n	=	Number of data values in each data set

	Document information	
Version	**Date**	**Description**
1.0	September 24, 2012	Methodology