ASES ON-CHAIN PROTOCOL

METHODOLOGY FOR CARBON CAPTURE MONITORING

Monitoring methodologies V1.0

July 2023

www.nat5.bio

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

INTRODUCTION

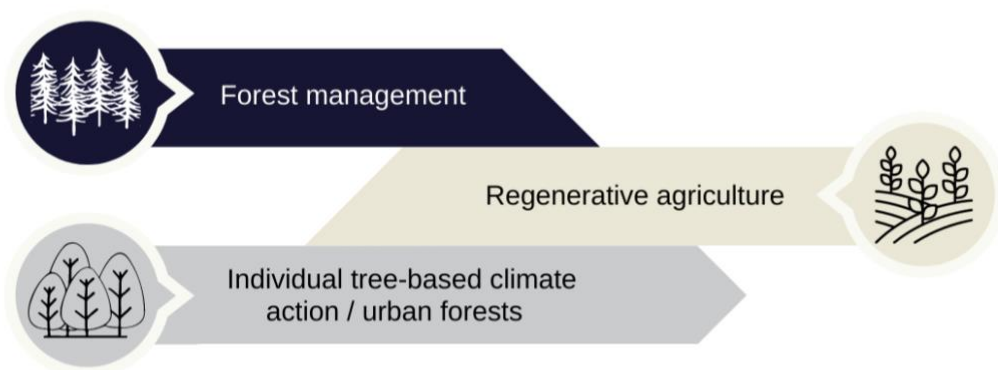
The document describes the methodology for monitoring the carbon sequestration of the projects, which should be applied in the timeframe established by the Monitoring Plan, which will periodically evaluate whether the project is giving the expected results.

This guide narrates how the carbon inventory should be carried out depending on the type of stock. For this exercise, the carbon of secondary vegetation stocks such as grasses, and shrubs, among others, will be taken into account. In addition, the stocks of reforested trees were taken into account. For both cases, we are guided by the recommendations for the above-ground biomass.

I. APPLICABILITY CONDITIONS

The following conditions apply to the methodology:

a) The type of Project is:



b) The project has been certified by the aOCP;
c) The project Monitoring Plan specifies the periodicity of carbon sequestration monitoring.

II. METHODOLOGICAL CONSIDERATIONS

III.1. APPLICATION OF METHODOLOGY

The projects included in the following table must apply the methodology for monitoring carbon capture.

TABLE 1. APPLICATION OF METHODOLOGY BY PROJECT

Type of project	Use of methodologies			
	Carbon in vegetation	GHG emission	Biodiversity	Water
Regenerative agriculture	✓			
Forest management	✓			
Silvopastoral				
Urban forest	✓			
Water flow restoration				

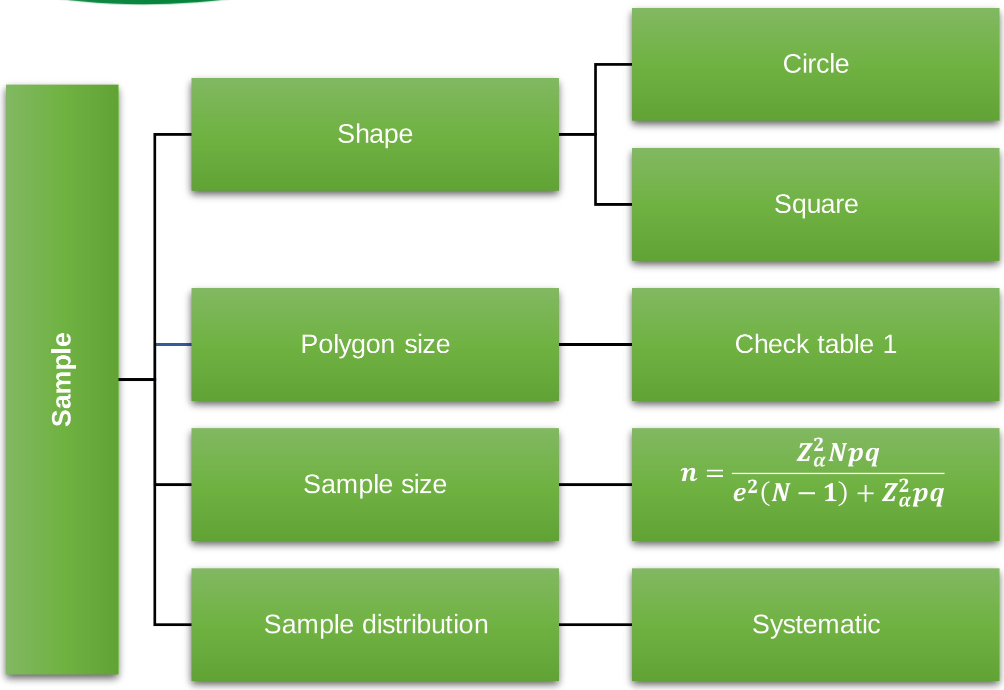
III. METHODOLOGICAL PROCESS

The methodology is divided into three sections. The first is the generation of the sample, the second section is obtaining the information of the sample, and, the third part is the calculation of the CO_2 captured by the project.

III.1. SAMPLE

One of the first steps we must do is the determination of the sample. The sample is a portion of the land that we are going to evaluate. Since, taking a census of all the trees in the entire property is impractical due to the time, money, and effort that it takes. In this case, the sample will be a series of small polygons where the amount of carbon sequestered within them will be calculated.

However, in order to have a good sample, which represents the terrain as well as possible, it is necessary to keep in mind the shape of the polygons, the size of the polygons, the number of polygons, and the way in which they will be distributed. In this first stage, we described how each of the qualities of the sample was calculated or generated. The following chart presents a resume of the methodology explained in this section.



III.1.1. Polygon Shape

In general, in this type of exercise, circles or squares are used for the samples (Figure 1).

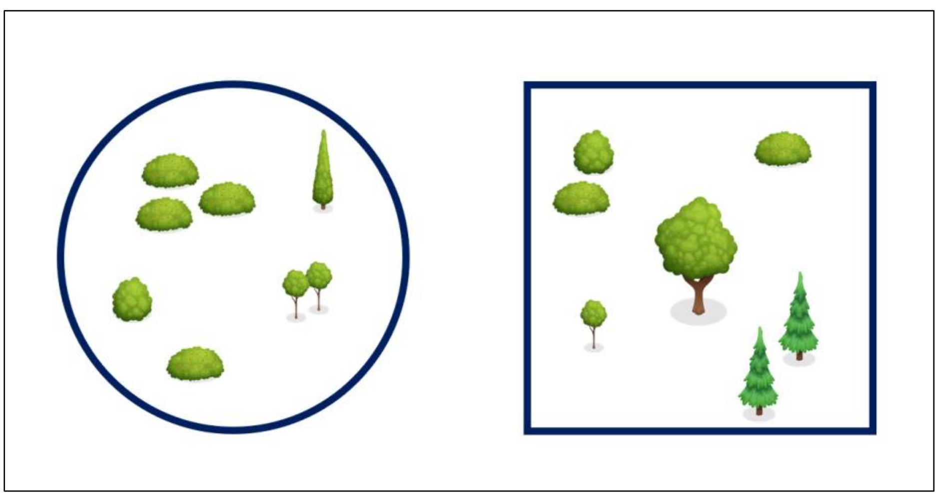


Figure 1. Census polygons

We suggest a sample based on squares systematically distributed throughout the property. This is because its limits are easier to locate in the field than a circle.

III.1.2. Size of the Polygon

Regarding the size of each object in the sample, the guide suggests the measurements in Table 1. The dimensions of the figure depend on the diameter of the trees on the property. For example, if the trees have diameters less than 5, it is suggested that in circular figures the radius should be 1 meter, while in squares the sides should be 2 meters.

TABLE 2. SIZE OF THE SAMPLE POLYGONS

Tree diameter	Circle radius (m)	Square polygon (m per side)
<5	1	2x2
5-20	4	7x7
21-50	14	25x25
>50	20	35x35

III.1.3. SIZE OF THE SAMPLE

To determine the sample size, the following formula should be used:

$$n = \frac{Z_\alpha^2 Npq}{e^2(N-1) + Z_\alpha^2 pq}$$

Where:

N: is the size of the population or universe (total number of possible respondents).

Zα: is a constant that depends on the level of confidence that we assign.

Value of Zα	1.28	1.65	1.69	1.75	1.81	1.88	1.96
Confidence level	80%	90%	91%	92%	93%	94%	95%

e: is the desired sampling error, as a percentage.

The guide comments that 10% precision and 95% confidentiality are usually used.

p: is the proportion of individuals in the population that possess the study characteristic. This data is generally unknown and it is usually assumed that p=q=0.5, which is the safest option.

q: proportion of individuals that do not possess that characteristic, that is,1-p.

To obtain the population size, a series of processes are carried out using Arcgis. To begin with, we generate the fishnet on top of the study area. Then, all the squares that lie entirely within the polygon were selected. These polygons are the study population (N). The other polygons were deleted.

For example, with 95% (Zα=1.96) reliability and10% error (e=10) for a population of 80, we must take a census of 44 polygons.

III.1.4. Sample distribution

We suggest you to use a sample with systematic distribution. This type of distribution is based on taking samples in a direct and orderly manner (Figure 2). This type was chosen because it gives the property more representativeness because the sample is spread over almost the entire polygon. In addition, we avoid that the sampled polygons get crowded all together.

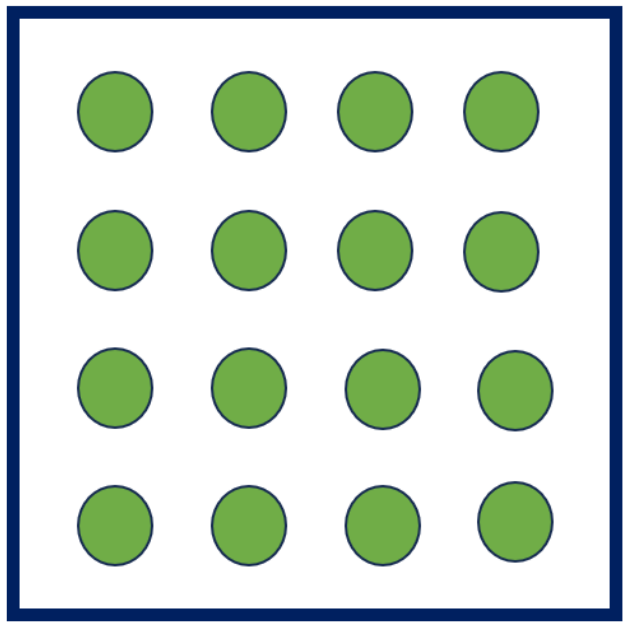
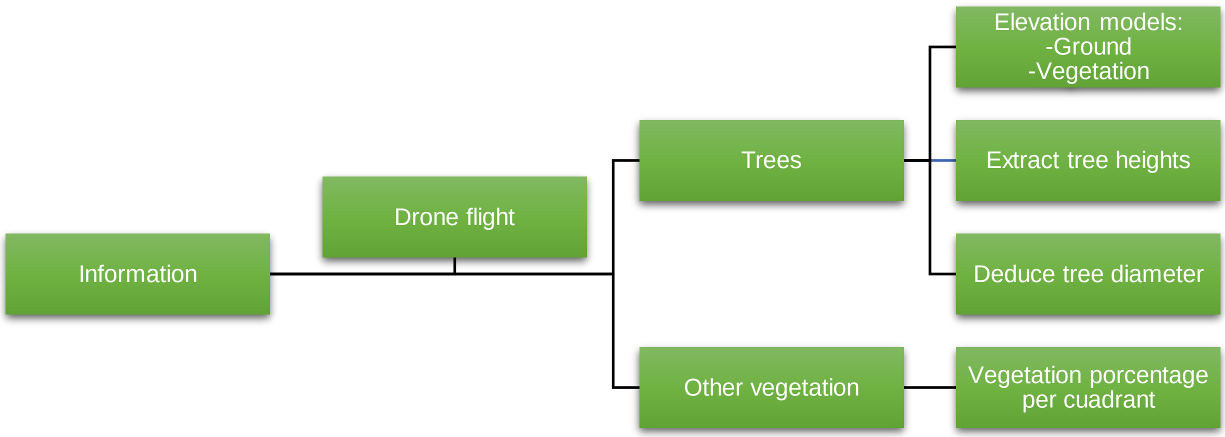


Figure 2. Systematic distribution

III.2. Obtaining the information

This section describes the methodology that will be applied to obtain the information necessary to calculate the carbon sequestrated by the trees and vegetation. The chart below resumes the methodology of this section.



III.2.1. TREE HEIGHTS

To obtain the height of the vegetation, a drone flight shall be done (Figure 4). Then, the points are classified depending on their elevation. We will do two elevation models. One with the points classified as ground and another one with the vegetation points. Next, to have the approximate height of the vegetation, the soil model was subtracted from the vegetation.

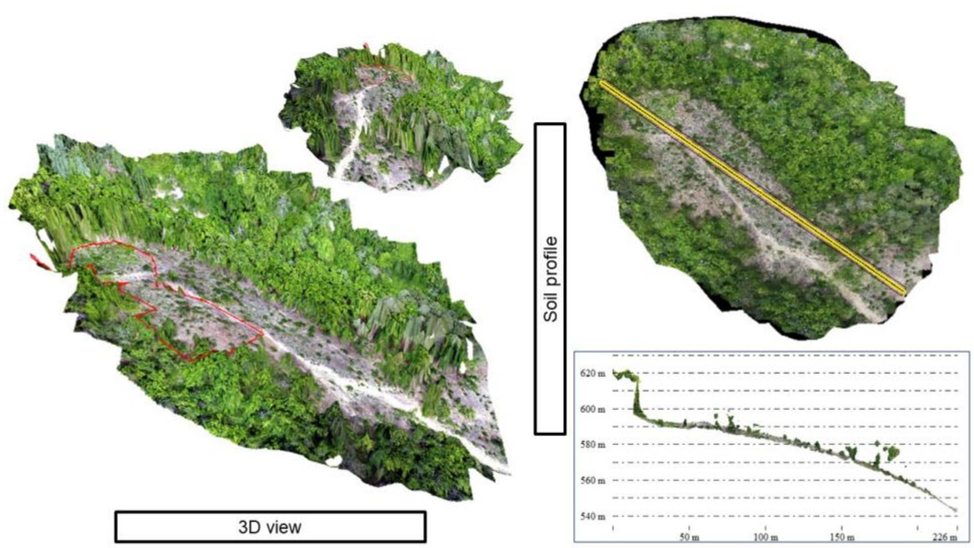


FIGURE 3. . DRONE FLIGHT

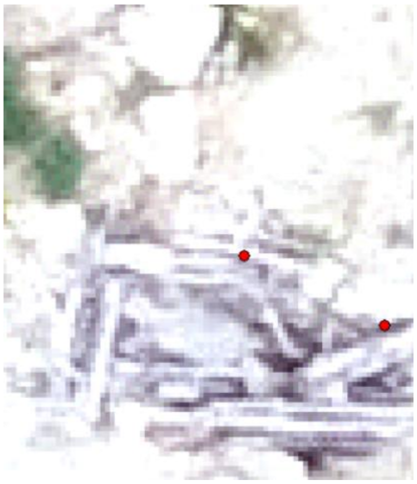
Finally, we extract the values of the heights of the georeferenced trees that fall within the squares of the sample.

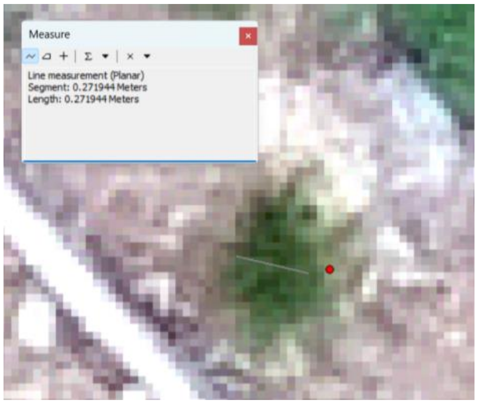
III.2.2. TREE DIAMETER

The diameter of the trees is established by photo interpretation using the orthomosaic generated with the drone. There are two possible situations that can occur.

In the first, the points can fall on trees in the orthomosaic, the diameter, in this case, shall be measured.

On the other hand, in those that did not appear as a tree, you need to assign a diameter depending on the observed field or the surrounding vegetation.

Example	Assigned diameter
	2 cm because there isn't vegetation and field observation.
	5 cm because there is a lot of vegetation and field observation

	2.7 cm because it got measured

III.2.3. Percentage of vegetation

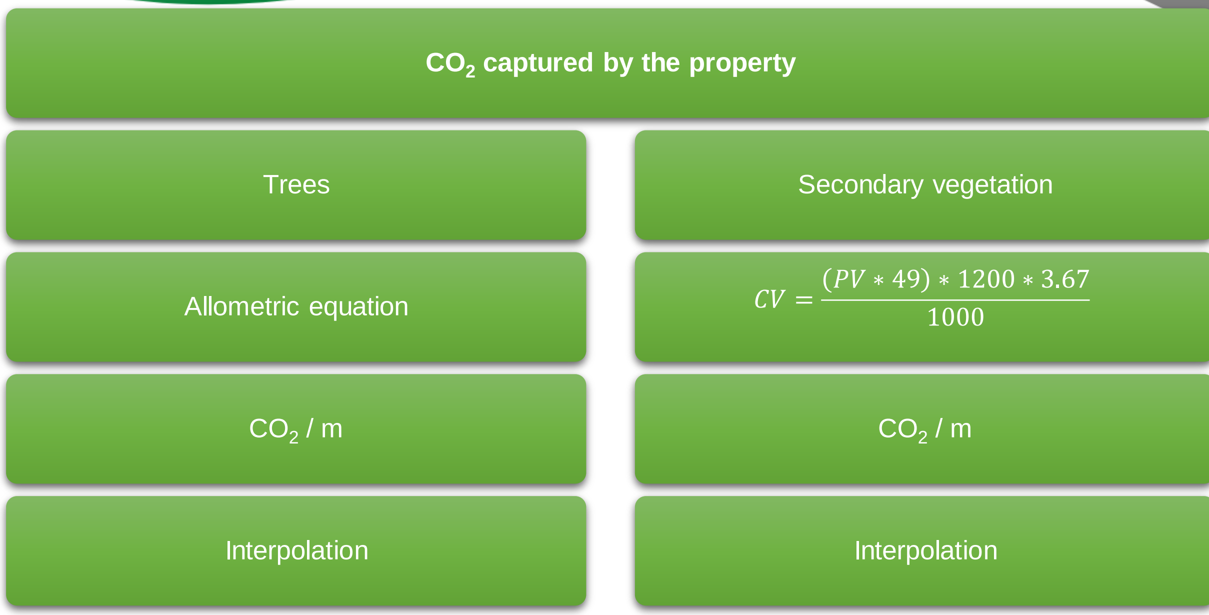
Regarding secondary vegetation such as shrubs or grasses, their percentage will be established by photointerpretation. An approximate percentage is assigned to each quadrant depending on how green it was.

Example	Assigned percentage
	15%

	1%
	75%

III.3. Calculation of carbon sequestration

This third section shows the methodology to calculate the CO_2 captured by the project. This methodology is resumed in the following chart.



III.3.1. TREES

To calculate the carbon sequestration of the trees, we need to apply the allometric equations used in the baseline for each species.

III.3.2. SECONDARY VEGETATION

To obtain the carbon sequestered by secondary vegetation, the number of square meters of vegetation in each quadrat was first calculated (multiplying the percentage by $49m^2$ of each quadrat). Then it was multiplied by 1,200, which is the number of grams of dry matter per square meter, and then by 3.67 to convert it into sequestered carbon. Finally, it was divided by 1000 to have them in kilograms. This process is reflected in the following equation:

$$CV = \frac{(PV * 49) * 1200 * 3.67}{1000}$$

Where:

CV= Carbon sequestered from secondary vegetation

PV = Proportion of vegetation per quadrat (0 to 1)

Final sequestration of vegetation

Having the carbon sequestered by both the trees and the other vegetation, the total of each one will be divided by 49 to have how much carbon is sequestered per square meter in each polygon.

Then, the centroids of each polygon are obtained and the value of carbon sequestered per square meter is extracted in both cases. Later, this data will be interpolated using the IDW algorithm for the entire polygon, in order to calculate the carbon sequestration that occurs throughout the property by trees and vegetation. Finally, the two models will be added.

Finally, calculate how many CO_2 is captured by square meter in the project.

	DOCUMENT HISTORY	
Version	**Date**	**Comments**
V1.0	15/07/2023	● First version released for review by the aOCP Steering Committee