BLUEPRINT PROJECT FOR A SUSTAINABLE LANDSCAPE

GIS replication protocol - Land Cover Interpretation for Monitoring a Productive Landscape

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Objectives

The goals of this protocol for replication are:

- Summarize the steps to replicate the land cover analysis in the same pilot area (Zona Bananera municipality, Magdalena, Colombia) as general guidance to apply it in other productive agricultural regions in tropical or subtropical zones.
- Facilitate the development of a land use cover monitoring system in accordance with the objective, scale, and level of local studies to be implemented over time.

Conceptual and Methodological Model

Figure 1 summarizes the methodological process of the project "Blueprint - Development of a landscape sustainability assessment framework with a pilot phase in the Zona Bananera municipality, department of Magdalena, Colombia".

During the project period (2019-2022), the different levels of analysis and characteristics of the land use cover information obtained through different interpretation methods and cartographic interpretation scales were evaluated.

For further details of the methodological process and evaluation of methods, images and results, consult the reports "*Landuse Cover interpretation for Zona Bananera and comparison of two scales August 2021.pdf*" and "*GIS land cover type analysis for Zona Bananera May 2022.pdf*" in the Blueprint Dashboard library.

The following sections explain the eight development steps for land cover interpretation processes according to the flowchart in Figure 1 (page 4):

1. Scope
2. Analysis Type
3. Scale
4. Image Type Selection
5. Analysis Preparation
6. Interpretation process
7. Final product
8. Next stages of monitoring

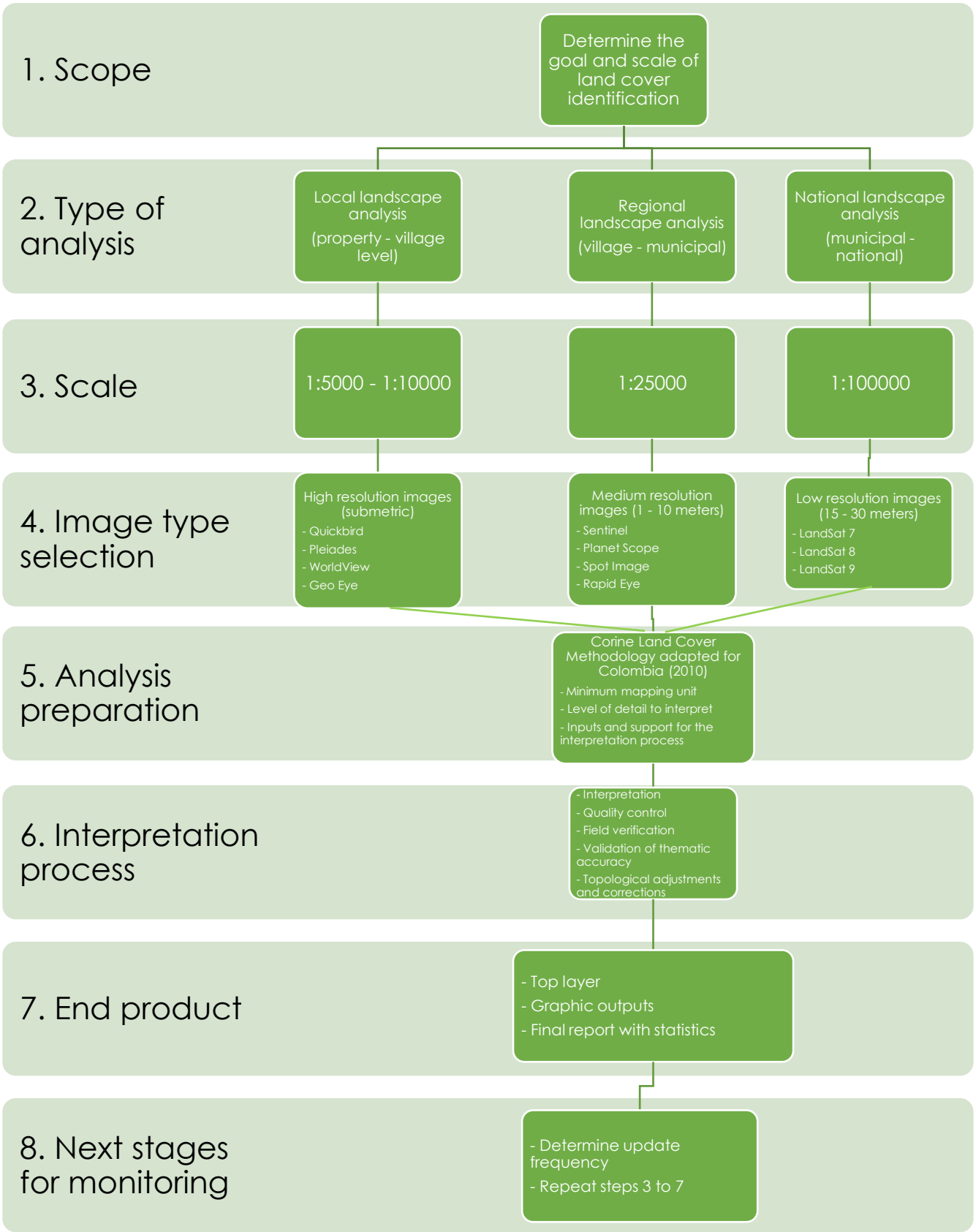

FIGURE 1. PROTOCOL FOR DEVELOPING LAND COVER INTERPRETATION.

Protocol for Developing Land Cover Interpretation

1. Scope

As a first stage in a process of characterizing the land use types present in a landscape, it is necessary and a priority to define the objective, geographical scope and level of detail that is desired to obtain the information for decision making, planning, or monitoring of the processes of transformation of a landscape.

2. Type of Analysis

The actors of the territory or coordinators of the project should determine if the study intends to obtain information for decision-making at the farm, village, municipal, regional, or national level.

3. Scale

Depending on this spatial scope, the scale for the interpretation of the coverages and the images to be acquired should be defined.

4. Image Type Selection

Once the scale is defined, the satellite images are acquired through purchase or download on open access platforms.

The images should be geometrically and radiometrically corrected to obtain clear digital levels with respect to the earth's surface. This process is normally developed by providers or platforms. If not, an expert professional is required to carry out this calibration and atmospheric correction process.

For greater detail in the levels of classified land use covers, it is necessary invest in the acquisition and purchase of submetric images with Quickbird, Pleiades, World View, or Geo Eye.

For intermediate scales of 1:25,000 it is possible to obtain free images such as Sentinel with a resolution of 10 meters. Better resolution but paid images below 5 meters spatial resolution are also available, such as Planet Scope, Spot Image, or Rapid Eye.

The national interpretation scales are made with lower resolution images with a lower level of land use cover detail and information precision: LandSat 7, LandSat 8 or LandSat 9. These less precise images are freely accessible.

5. Analysis Preparation

Once the scale is established, the minimum land use cover separation unit is determined during the interpretation process and the level of land use cover classes to be separated according to

the Corine Land methodology adapted for Colombia (IDEAM, IGAC Y CORMAGDALENA, IGAC y CORMAGDALENA 2008[1]).

6. Interpretation process

During the interpretation process, it should be guaranteed that the delineation and delimitation of the classes of coverage is carried out with the image object of interpretation.

Although additional support can be obtained from higher resolution images, the process should be started once the input object image has been obtained.

The CORINE land use cover methodology recommends the support of a second professional to carry out the quality control process. However, depending on the budget and costs of the project, this validation activity can also be attended by field verification of the land cover types with a GPS validation of the thematic accuracy of the interpretation process.

The quality control and field validation stages are two processes developed once the first interpretation of the land cover is obtained. It is a necessary stage to increase the level of thematic accuracy of the interpreted coverage classes. If there are errors, these should be adjusted in the interpretation process.

7. Final product

Before obtaining the final layer of land use cover types, it is necessary to carry out the topological correction activity, which consists of avoiding holes/gaps or overlapping polygons that generate errors in the calculation of areas and the quality of the generated cartographic information. Once this activity has been carried out, the graphic outputs of the interpretation process are generated and the respective statistics are calculated.

8. Next stages for monitoring

For the future monitoring and follow-up process of land use cover type interpretation, and to identify changes, the same steps should be carried out for the next previously defined period (the following time frame).

Similarly, it should be guaranteed to do so on the same scale and, as far as possible, in the same type of satellite image or in a homologous image in terms of spatial resolution.

After the interpretation process, for a second or other temporalities, a spatial analysis of differences and changes in the coverage of land use or in the percentage distribution of the land use cover type present in the area under study will be carried out.

[1] IDEAM, IGAC y CORMAGDALENA. 2008. Mapa de Cobertura de la Tierra Cuenca Magdalena-Cauca: Metodología CORINE Land Cover adaptada para Colombia a escala 1:100000. Instituto de Hidrología, Meteorología y Estudios Ambientales, Instituto Geográfico Agustín Codazzi y Corporación Autónoma Regional del río Grande de Magdalena. Bogotá, D.C., 200 p. + 164 hojas cartográficas.

Interpretation methods used during the 2019-2022 Blueprint project

The main criteria, decisions and inputs applied during the project are described below:

1. **Analysis unit**

   Three types of analyzes were carried out at scales: farm, window and municipality. The minimum mapping unit for farm and window was 1000 square meters, for the municipal scale it was one hectare and for the national scale it was 25 hectares according to the national map (IDEAM, IGAC Y CORMAGDALENA, 2008).

2. **Scales analyzed**

   The land cover classification scales were compared at 1:5,000, 1:25,000 and 1:100,000 scales. In relation to a landscape monitoring process, it is necessary and required to determine the scale of analysis to be monitored in the landscape, in order to obtain comparable results from one date to another.

3. **Image types**

   The images for tracking or monitoring are satellite images Land Sat with spatial resolution of 30 meters for the entire planet and will be used for studies on a scale of 1:75,000 to 1:100,000. The use of satellite images of medium to high spatial resolution, with a spatial resolution of 3 to 10 meters and for scales of 1:15,000 to 1:25,000, is with free access, paid or purchased images. For monitoring at a local scale, high spatial resolution images were obtained, submetric or below one meter of spatial resolution, which facilitated interpretation at scales 1:1,000 to 1:5,000.

4. **Types of interpretation**

   As a suggestion for other similar studies in the future, it is ideal to consider an intermediate scale of 1:10,000 in order to provide more details of coverage to decision makers at the local level. In this way, less time is spent than that required for the analysis at a 1:5,000 scale, obtaining similar results, but less detail in some coverages.

   For the Blueprint version , in future replicas, it is recommended:

   1. Regarding the analysis time: if the resources are limited, it is suggested to carry out a supervised classification.
   2. If greater precision and detail of the covers are required, as is necessary for landscapes dominated by agricultural uses, visual classification with field verification for two different scales is suggested:
      a. Scale of the entire municipality for territorial planning objectives 1:25,000
      b. Windows with a specific focus defined by local actors or project managers should be worked at a scale of 1:5,000.

5. **Geoservices:** Based on the comparative results between the use of Geoservices and the spatial analysis carried out by the project at scales of 1:5000, it is not recommended to use any available Geoservice due to its limited precision and low thematic accuracy when differentiating coverage. of land between some crops (for example, oil palm or banana), forests and transformed areas.

Base layers

As base layers for the interpretation process, it is important to consult the secondary information available for the area under study. In terms of interpreted land covers, present ecosystems and socioeconomic information on the production systems that are generated there, it is important to have the base cartographic information of contour lines, drainages, roads and toponymy associated with the region under study.

The main geographic layers considered during the interpretation process are described below:

a. Polygons of the municipality, polygons of the villages
b. Municipal property grid
c. Water network – Simple drainage
d. Water network – Double drains
e. Road network
f. Population centers
g. Coverage of the municipality at a scale of 1:25,000
h. Windows with covers at 1:5000 scale
i. Coverage of the municipality (IDEAM, IGAC Y CORMAGDALENA, 2008) at a scale of 1:100,000
j. Water yield coefficient (TNC) at 1:100,000 scale
k. Soil suitability map (IGAC) at a scale of 1:100,000
l. Soil salinization map (IGAC) at a scale of 1:100,000
m. Flood map (MADS) at a scale of 1:100,000
n. International geoservices such as Global Forest Change and the Sentinel imagery platform in the EO Browser
o. Google Earth Pro.

Tips for future monitoring with Blueprint

1. **Unit of analysis:** The unit of analysis should be defined according to the type of study to be carried out and according to the actors to be linked. For this project, it is suggested that the unit of analysis be at the village and municipality levels at a scale of 1:25,000. It is recommended to carry out the visual interpretation on screen with the Corine Land Use Cover methodology for the entire municipality with a medium resolution image of 5 meters and ideally from the same Planet Scope sensor. In the case of the 1:5,000 analyses carried out in the geographic scope window, it is recommended to continue monitoring them over time to evaluate the changes and dynamics that may occur at local scales, to obtain information on the main trends and evaluate small elements in the landscape that allow maintaining a minimum degree of biodiversity in matrices transformed for productive use.
2. **Scales:** According to the results, it is suggested to carry out future analyses at a scale of 1:10,000 and compare with the cartography made for the year 2021. The results of this study should be updated with this scale as an intermediate point to facilitate decision-making both to the owners of properties and the Community Action Boards, as well as to institutions, such as the mayor's office, departmental planning units, autonomous corporations, or production sector unions.
3. **Type of images to use**: It is ideal to have the same type of images with which the coverage study was carried out: Planet Scope. If there are no free images at the time of the analysis, it is recommended to have images whose main characteristics are similar to a spatial resolution of 3 to 5 meters or, alternatively, submetric images of a smaller scale (1:10,000 or 1:5,000).
4. **Types of interpretation:** Although costs may increase, analysis through visual interpretation on screen is suggested and include field corroboration of those coverages with uncertainty to facilitate greater thematic accuracy and differentiate small patches of natural and semi-natural land use cover types present in private properties.
5. **Updating of land use cover:** All future land use cover analyses should have as a baseline the land use cover layer made for the geographic scope windows under study to make the comparison between the land use cover of both reliable periods and avoid biases due to the delimitation in the interpretation and analysis processes. These analyses should be carried out on the same analysis scale determined for each study.
6. **Verification:** In all cases, it is suggested to carry out the field verification with random sampling of the different land use cover types and with complete analyses of all the points where there are doubts with respect to land use cover types. By building the capacity of local actors, the costs of this activity can be reduced. In the case of supervised classifications or with an automated process, it is important to carry out the verification activity. However, this type of classification does not allow many classes of coverage to be differentiated.
7. **Calculate changes for comparison and interpretation:** To calculate the changes, a multi-temporal analysis should be conducted between the result of the 2021 mapping with that of the year of the land use cover analysis update. For this, it is important to use satellite images with the same spatial resolution characteristics and use the same interpretation methodology.