USE OF SATELLITE IMAGES FOR AGRICULTURAL STATISTICS

National Administrative Department of Statistics

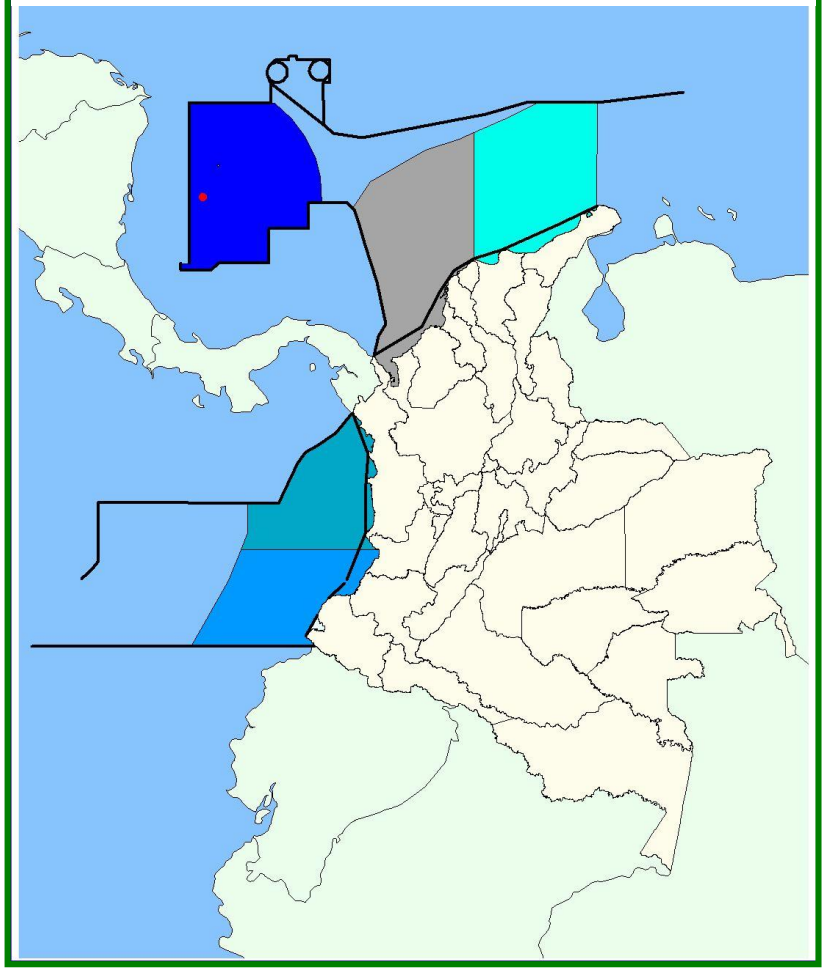
DANE – Colombia

Geostatistical Department

September 2014

Colombian land and maritime borders

COLOMBIAN LAND AND MARITIME BORDERS



LAND AREA: 1’141.748 Km^2

WATER AREA: 928.660 Km^2
Of which 18.060,87 Km2
are bodies of water (1.6%)

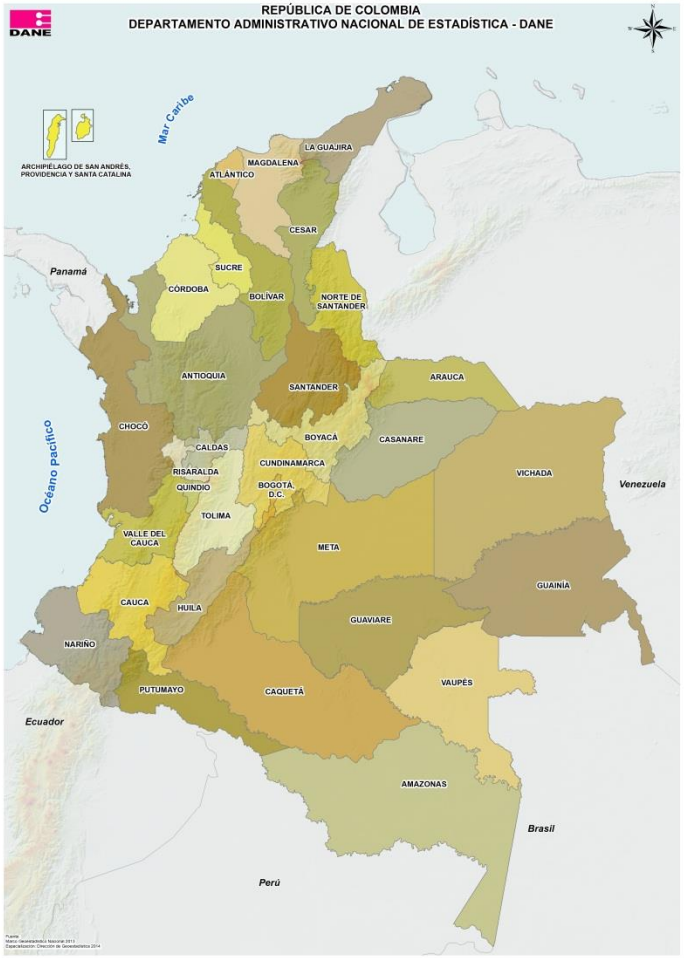
TOTAL: 2’070.408 Km^2

Is defined by three big mountain system, seas and rainforests.

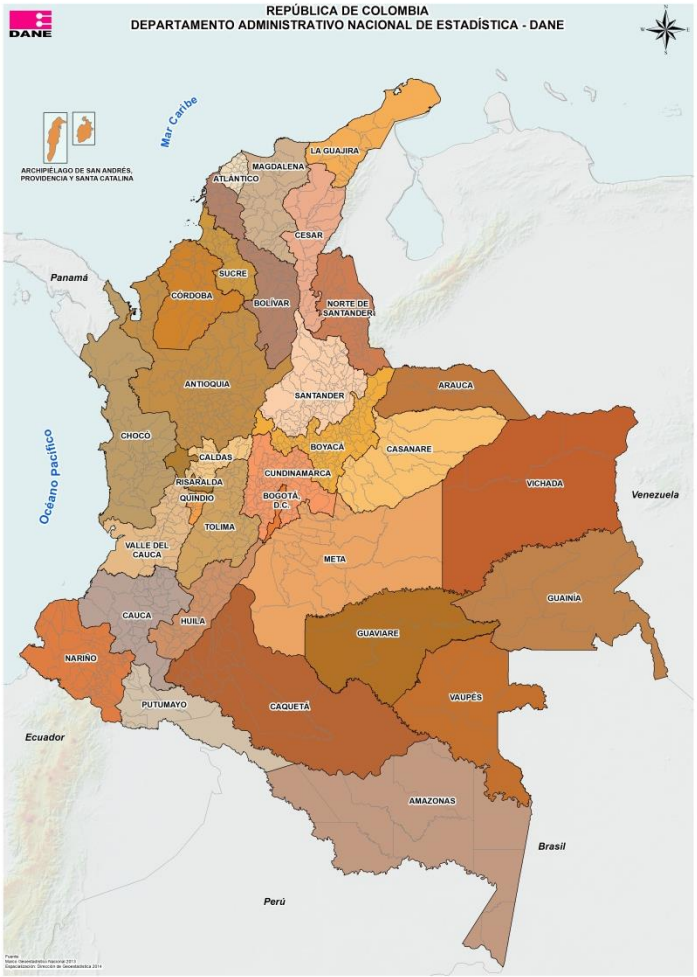
Presents differents thermal levels.

Creating different geographical zones.,

Political Administrative Division

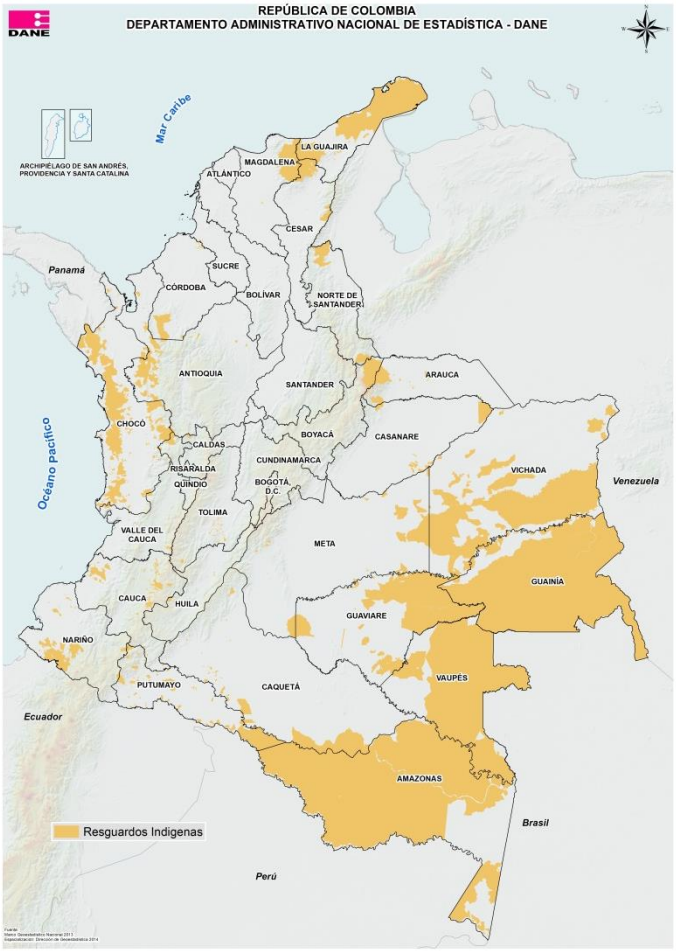


32 Departments



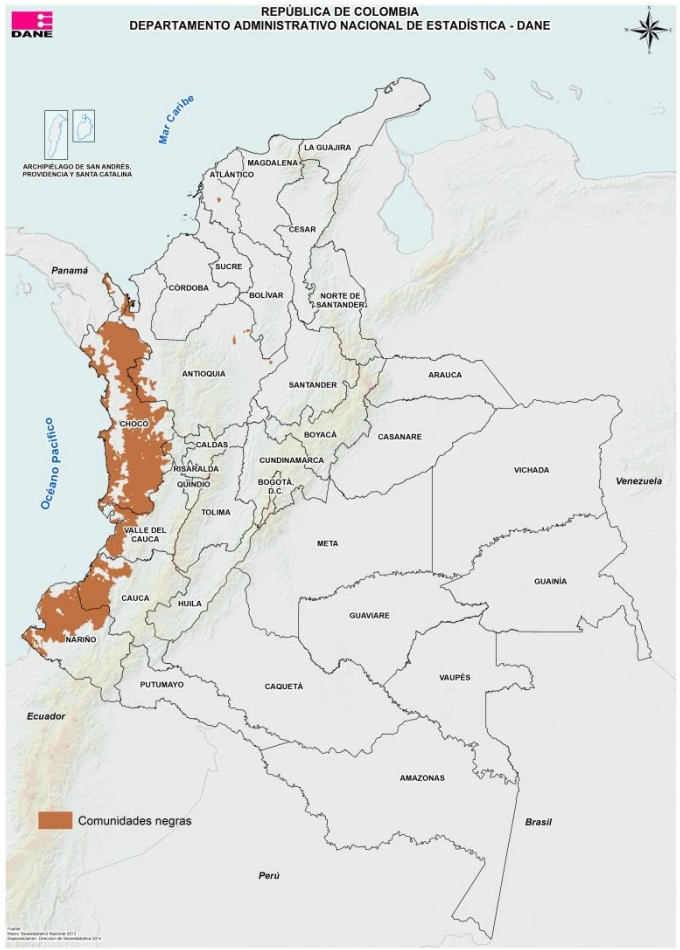
1.101 Municipalities

Political Administrative Division



770 Indigenous Reservations

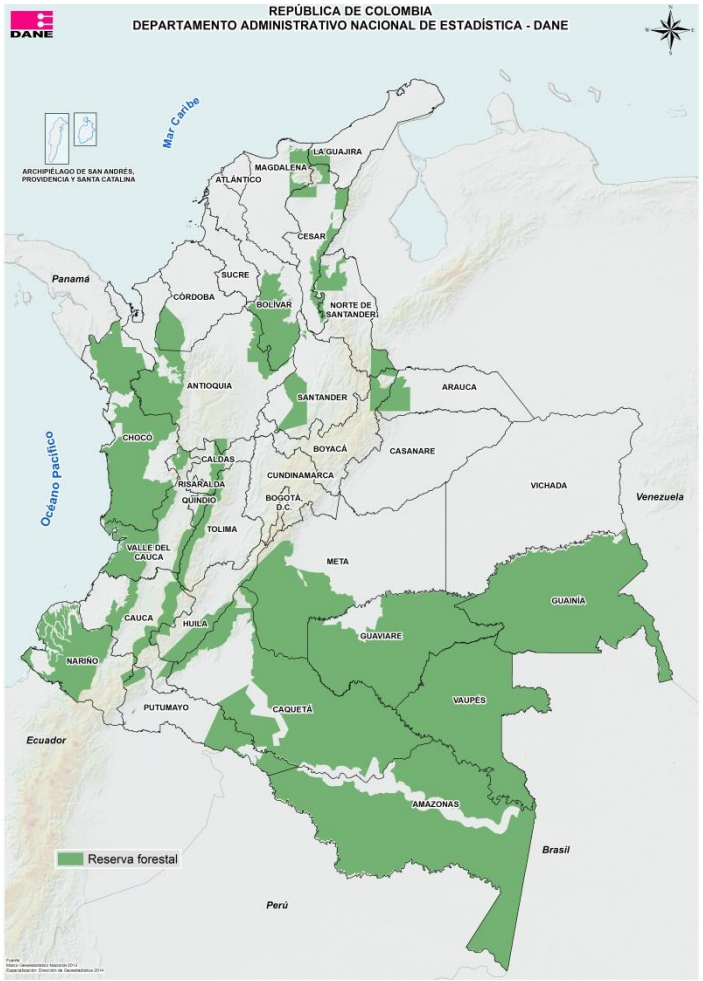
(322.982 Km^2)



182 Afro-Descendant Communities Lands

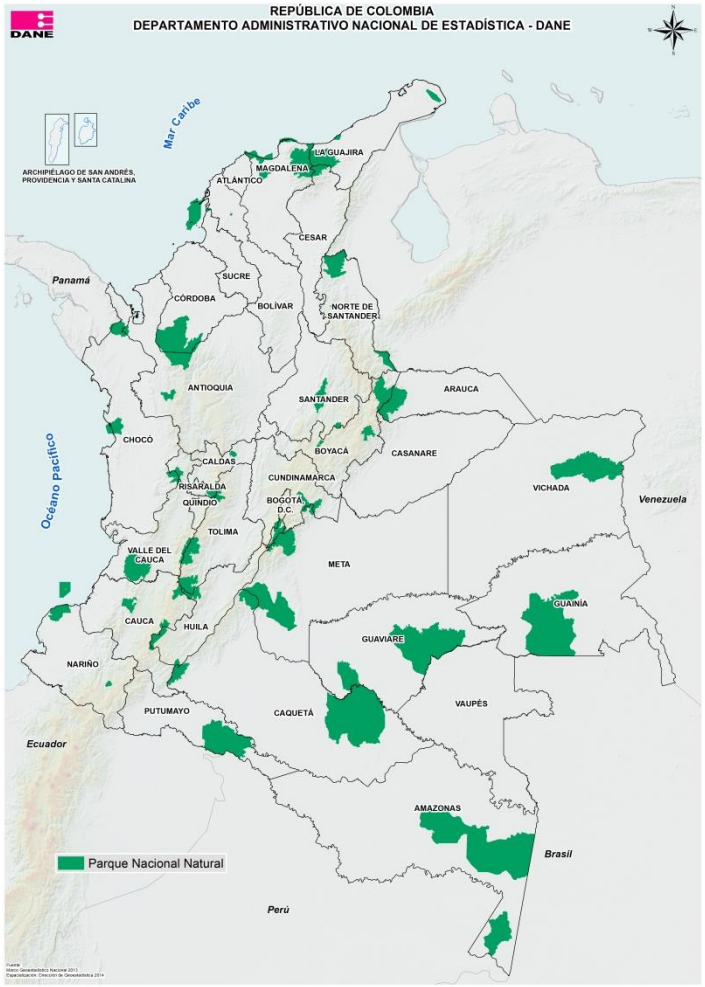
(53.229 Km^2)

Protected areas



Forest reserve

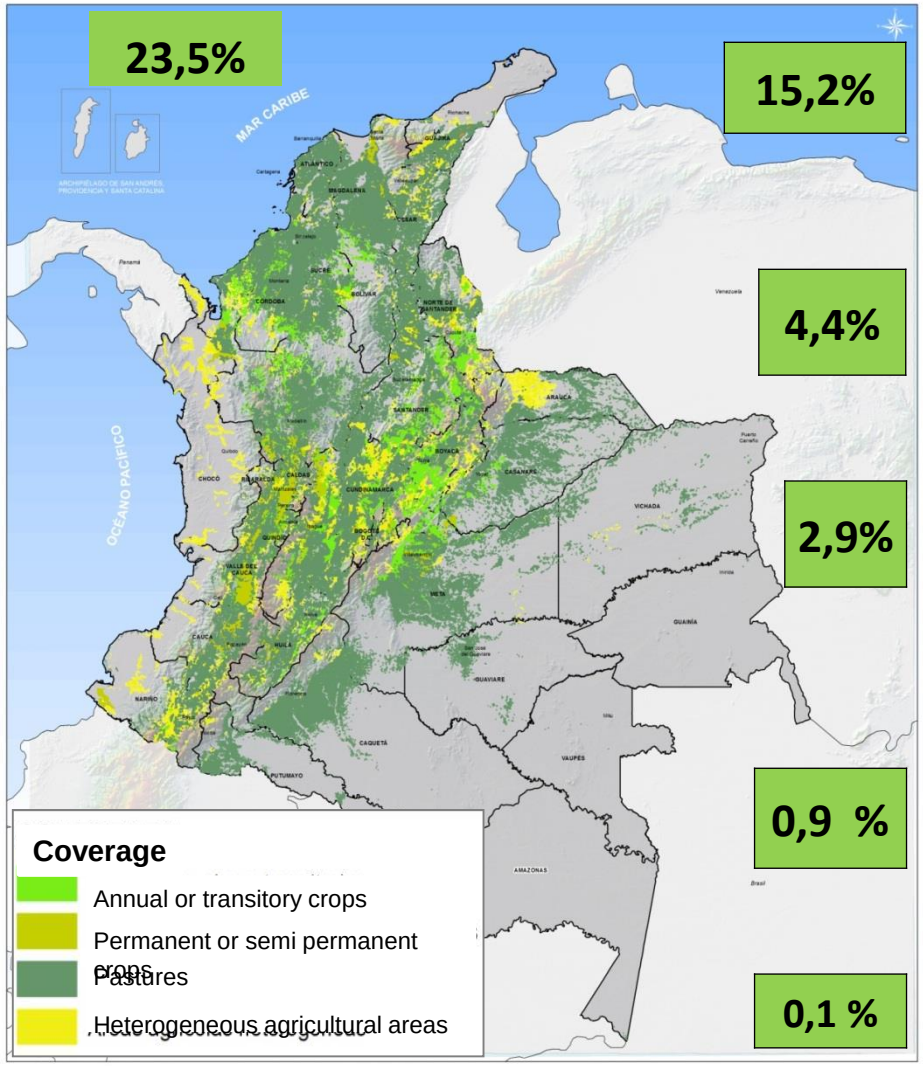
(322.982,72 Km^2)



National Parks System

(113.909,94 Km^2)

Land Cover



- **Pastures:**
The herbaceous species coverage that have been planted, generally used for livestock activities. They can be clean pastures, woodlands, weedy or stubble land.

- **Heterogeneous agricultural areas:**
Areas with mixture of different types of crops, as a mosaic of annual and permanent crops; pastures and crops; crops, pastures and natural areas.

- **Annual or transitory crops:**
Occupied areas with crops whose growth cycle lasts one year or less, even can be a few months. They are mainly characterized because after the harvest, it is necessary to sow or plant to keep producing.

- **Semipermanent and permanent crops:**
Lands dedicated to crops whose growth cycle is superior than a year, and where they produce various harvests without the need to plant again (Melo y Camacho, 2005). Exist permanent crops like sugarcane, brown sugarcane, plantain and banana.

- **Planted forest:**
Planted broadleaved and conifer forests.

SOURCE: IDEAM, IGAC, 2010

3rd National Agricultural Census

- The last census was realized on 1970.
- The National Agricultural census is included in The Development Plan 2010-2014 "PROSPERITY FOR ALL".
- Is realized by the National Administrative Department of Statistics (DANE) and The Ministry of Agriculture and Rural Development (MADR).
- The derived information is required for The Land Laws and rural development.

3rd NATIONAL AGRICULTURAL CENSUS

MinAgricultura · DANE 60 AÑOS · PROSPERIDAD PARA TODOS

Study universe

Continental rural surface:

113.985.800 Ha

It belongs to:

1.101 Municipalities

20 Departmental Parish

San Andrés and providencia Island

Land tenure:

Rural Piece of land: 3.814.747.

(76.762.927 Ha)

Afro-Descendant Communities Lands: 182

(5.224.655 Ha)

Indigenous Reservations: 770

(31.998.218 Ha)

Agricultural Frontier:

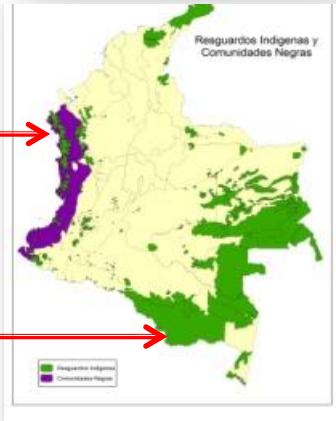
51.000.000 Ha

Agricultural area: 4,9 millones de Ha.

Pasture area:

39,2 million Ha.

Forests natural area: 59,1 million de Ha.



Use of satellite images for agricultural statistics

Use of satellite images

- Upgrade and integration frameworks
  - Identification of unit of analysis
- Framework to complement agricultural census
  - Thematic information souce

DEFINITION

Integrate the DANE's statistical framework since cadastral property with the goal of have a **minimum unit in common to identification, localization and access to the observation statistical units**.

This process consider the urban area as well as the rural area, and it will use satellite images and the cadastral property information from the National Register and the Decentralized Register of Bogotá, Cali, Medellín and Antioquia.

Integration project of DANE's statistical framework

General Objective

Integrate the area framework, list and multiple that DANE require to his statistical research since the cadastral property as an minimum access unit to the observation units.

Specific Objectives

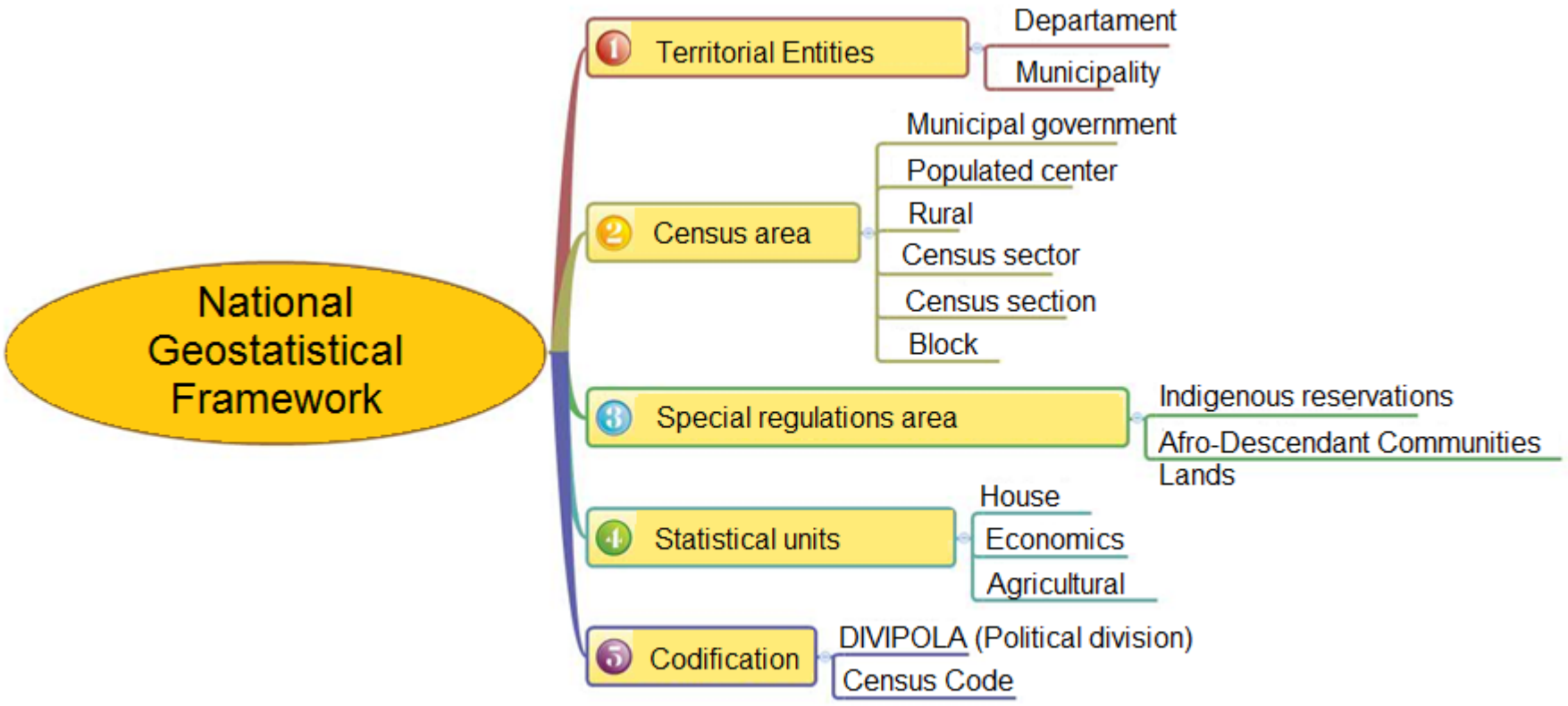
1. Integrate to the National Geostatistical Framework, the cadastral property as an minimum access unit to the observation units.

2. Improve the identification and location of DANE's statistics units from the smallest unit of cadastral piece of land.

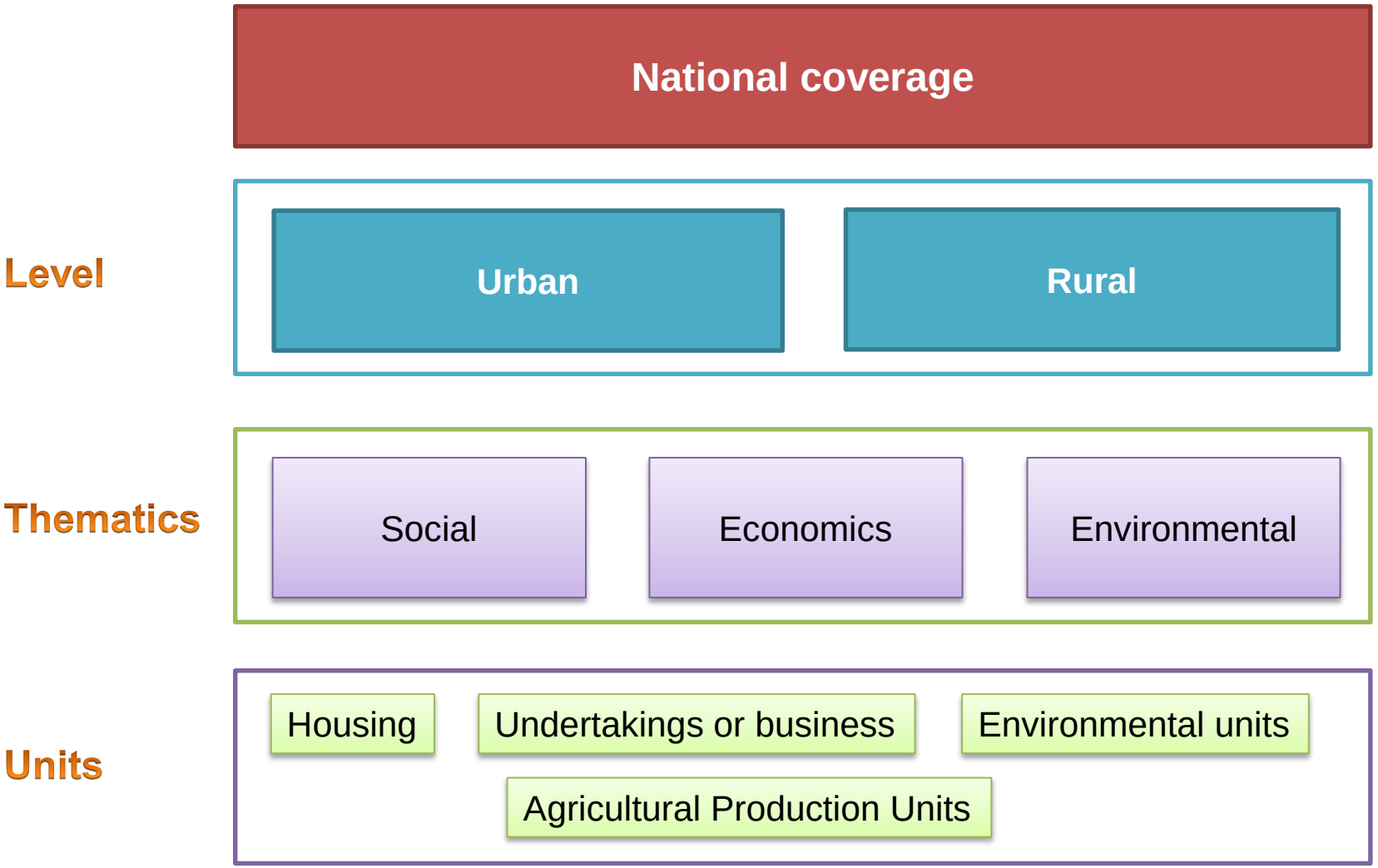
3. Update the geographic levels from the geostatistical framework with information from the cadastre, the ortho-photographs and satellite images and POT (Territorial Management Plan).

National Geostatistical Framework

It's main feature is that all of the elements that comprise it, are georeferenced, means it identify and locate geographically the elements of the target population. This consists of:



Integration of statistical frameworks



Sources of information

Basic cartography
1:100.000 y 1:25.000

Cadastre
(Farm information – Records)

Borders of territorial entities
RI y TCCN

Image bank
(Satellite imagery,
Ortho-photo
mosaic)

DANE's
Census
Mapping
1:25.000

Sources of Information

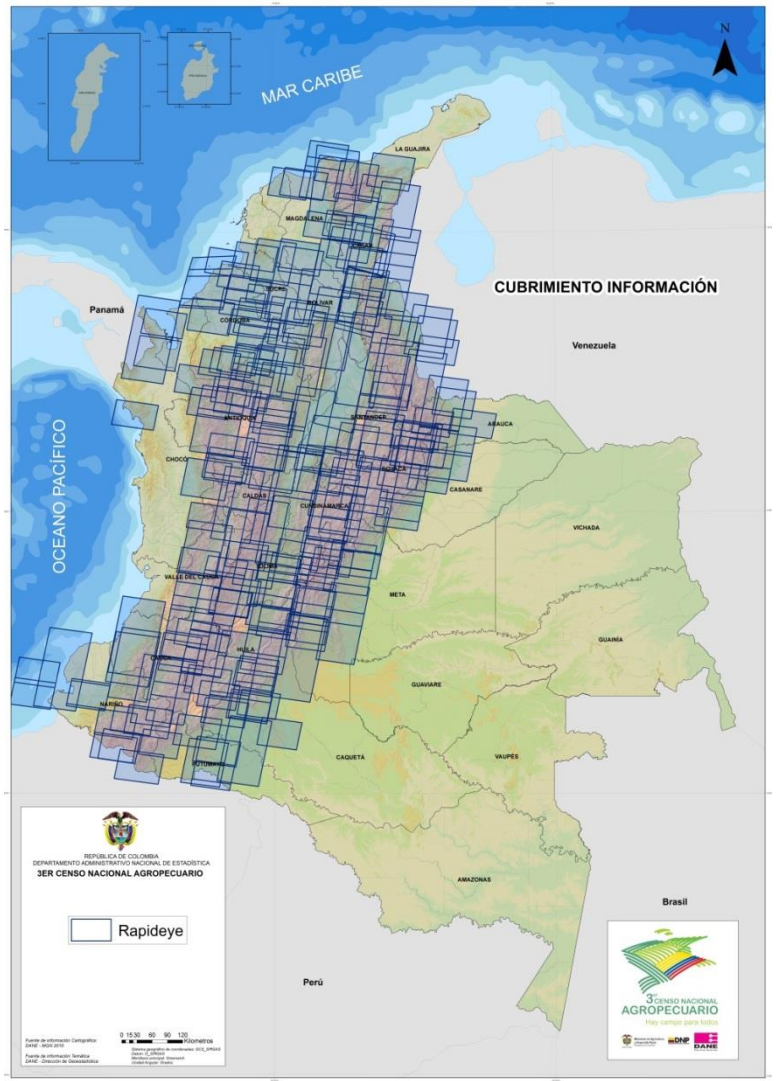
Composition between satellite images and thematic levels

Rapideye imagery

Spatial resolution: 7m

Mapping scale: 1:25.000
Relief scale: 1:50.000

Dates of acquisition:
From 2009 to 2011



Source: IGAC

Sources of Information

Composition between satellite images and thematic levels

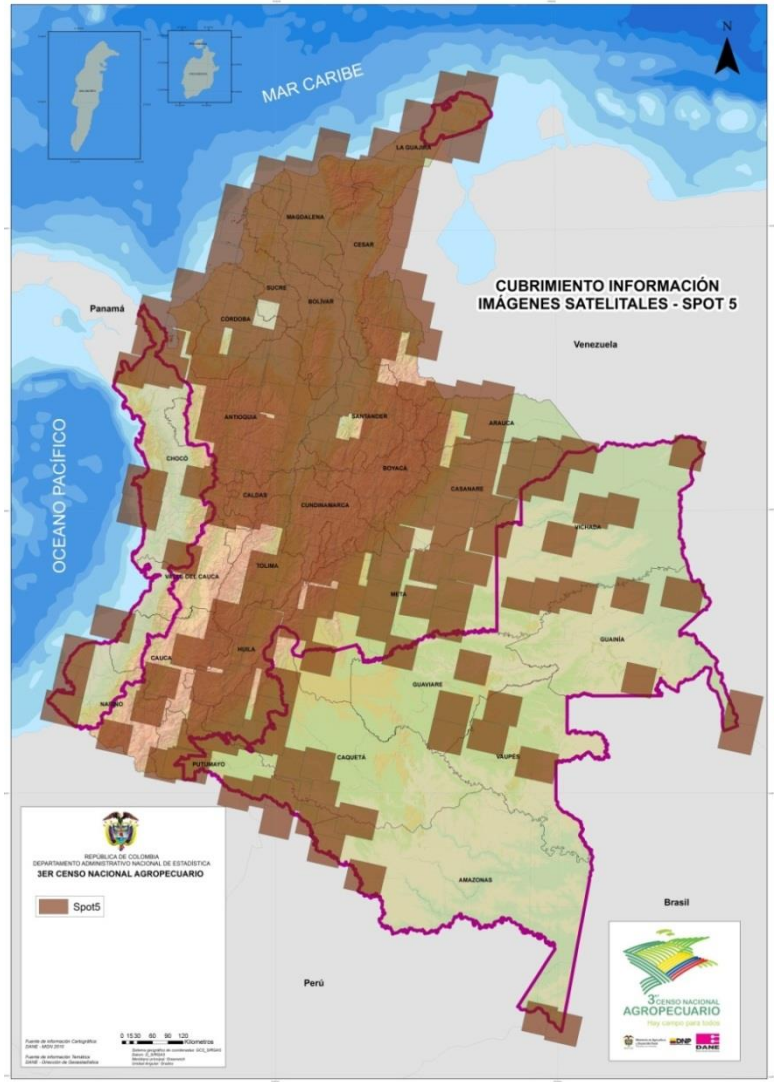
SPOT

Imagery

Spatial resolution: 5m

Mapping scale: 1:25.000
Relief scale: 1:50.000

Dates of acquisition :
From 1996 to 2009



Source: IGAC

Sources of Information

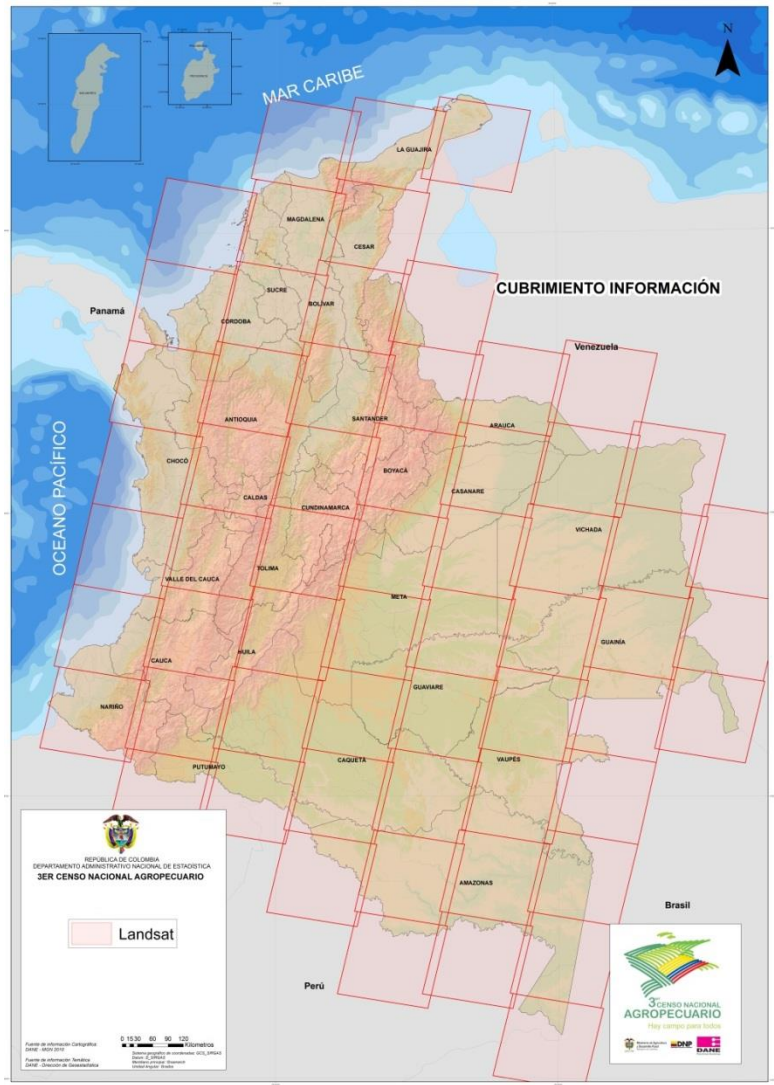
Composition between satellite images and thematic levels

Landsat Imagery

Resolution: 30m

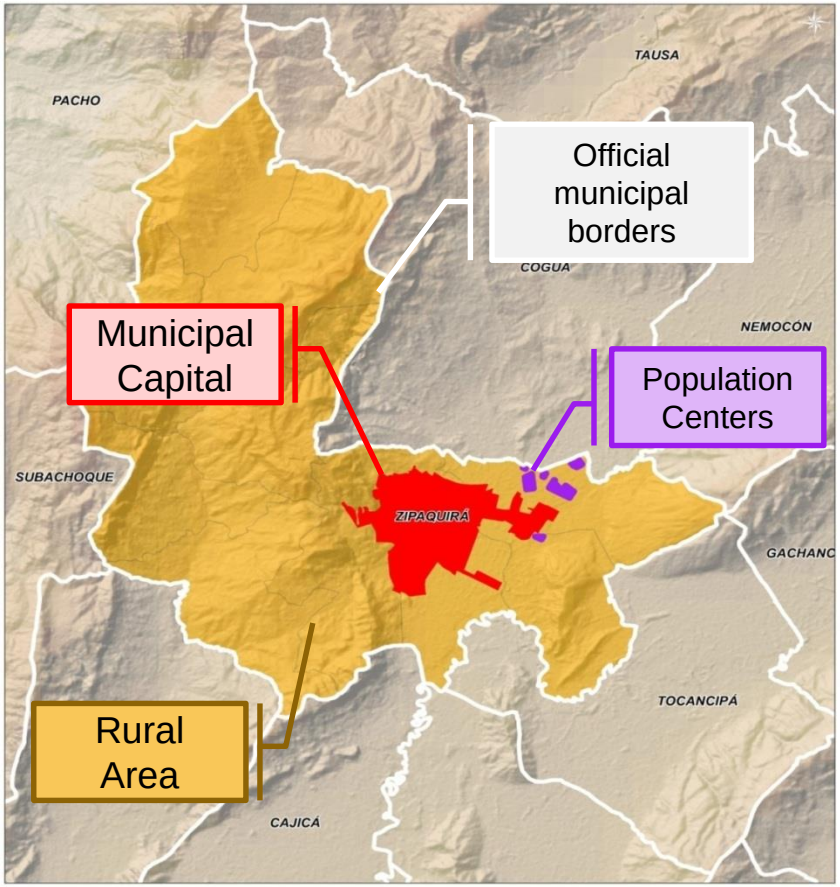
Scale: 1:100.000

Dates of acquisition:
From 2000 to 2003

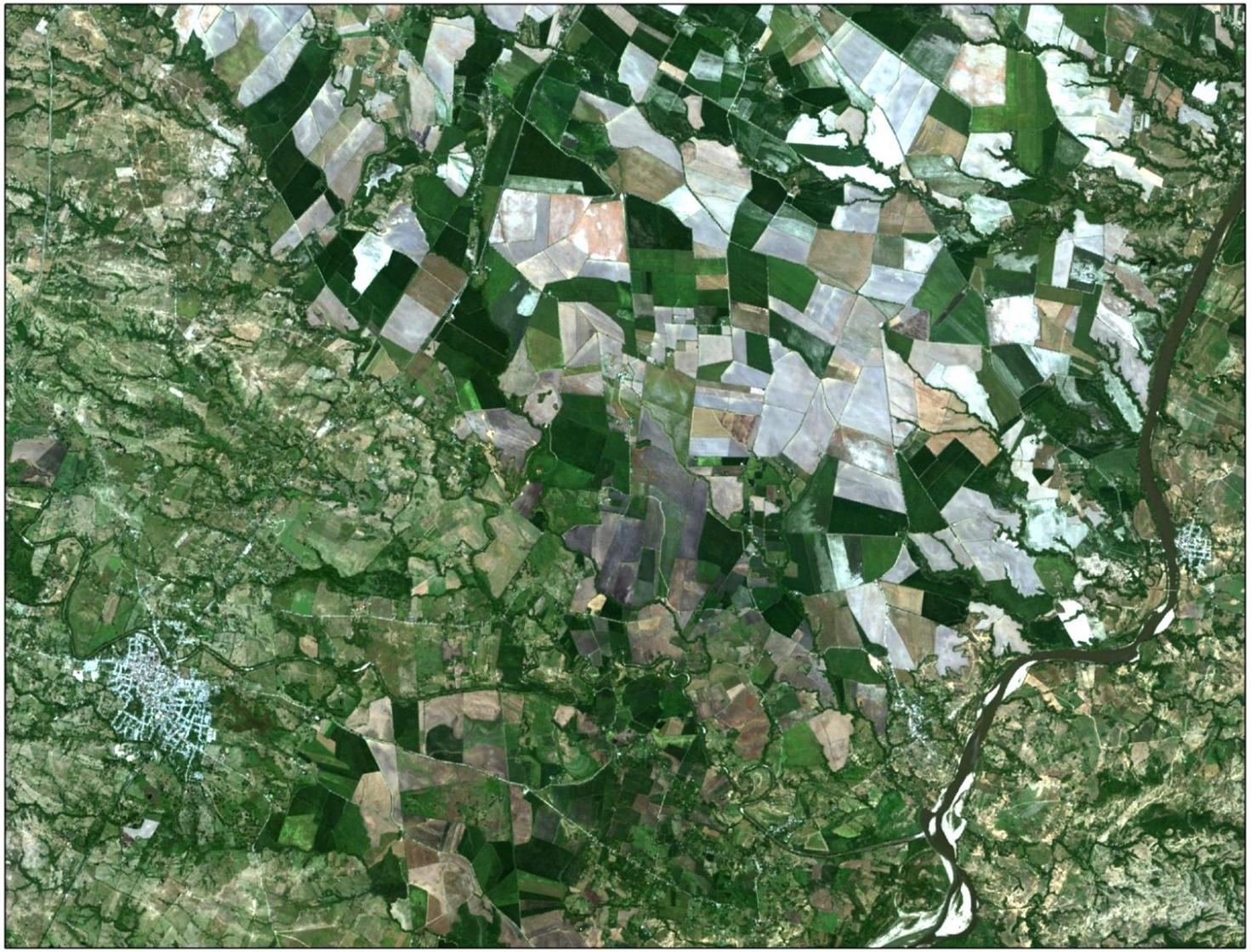


Source: IGAC

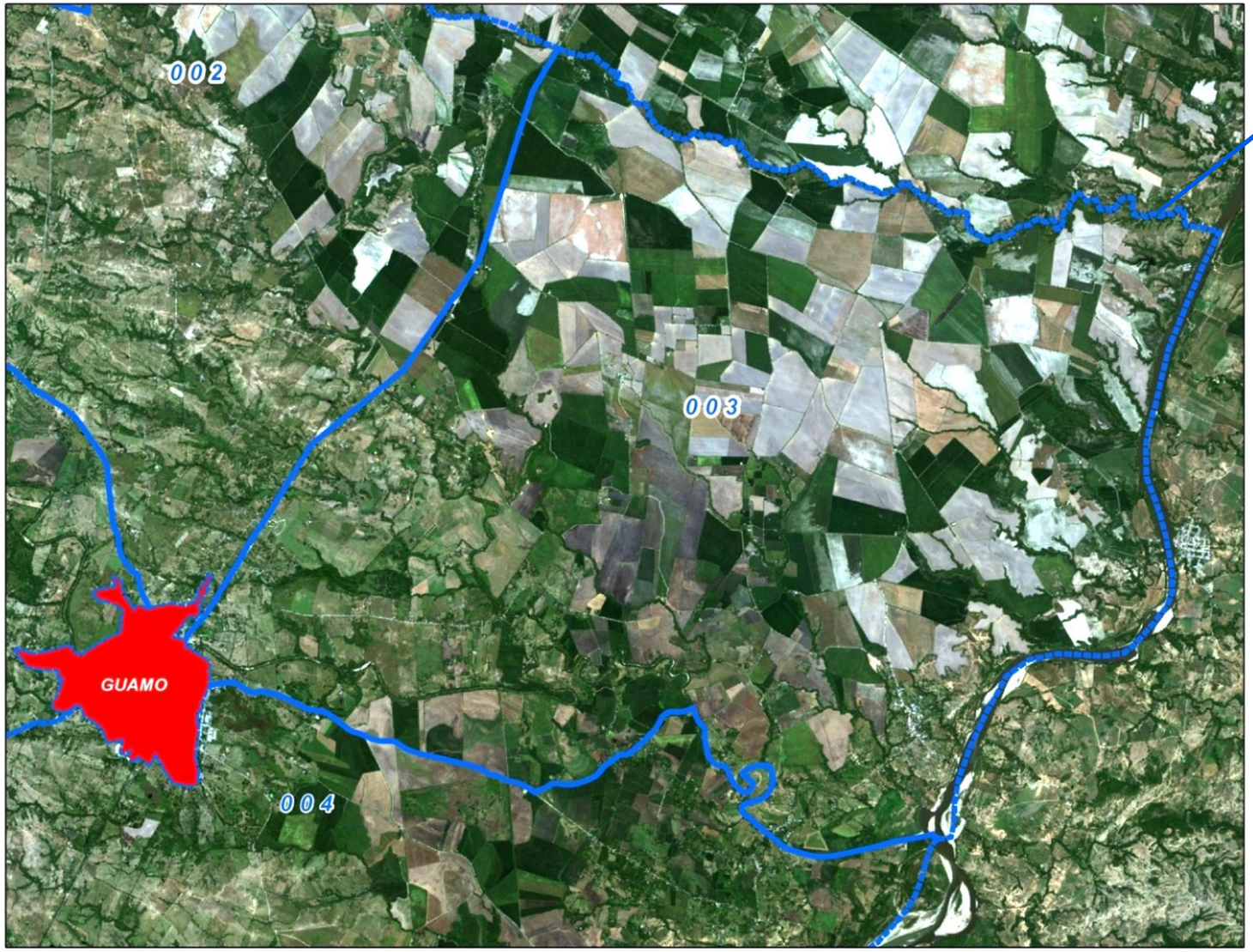
Current composition of the National Geostatistical framework



Current conformation of the National Geostatistical Framework in rural areas



Current conformation of the National Geostatistical Framework in rural areas

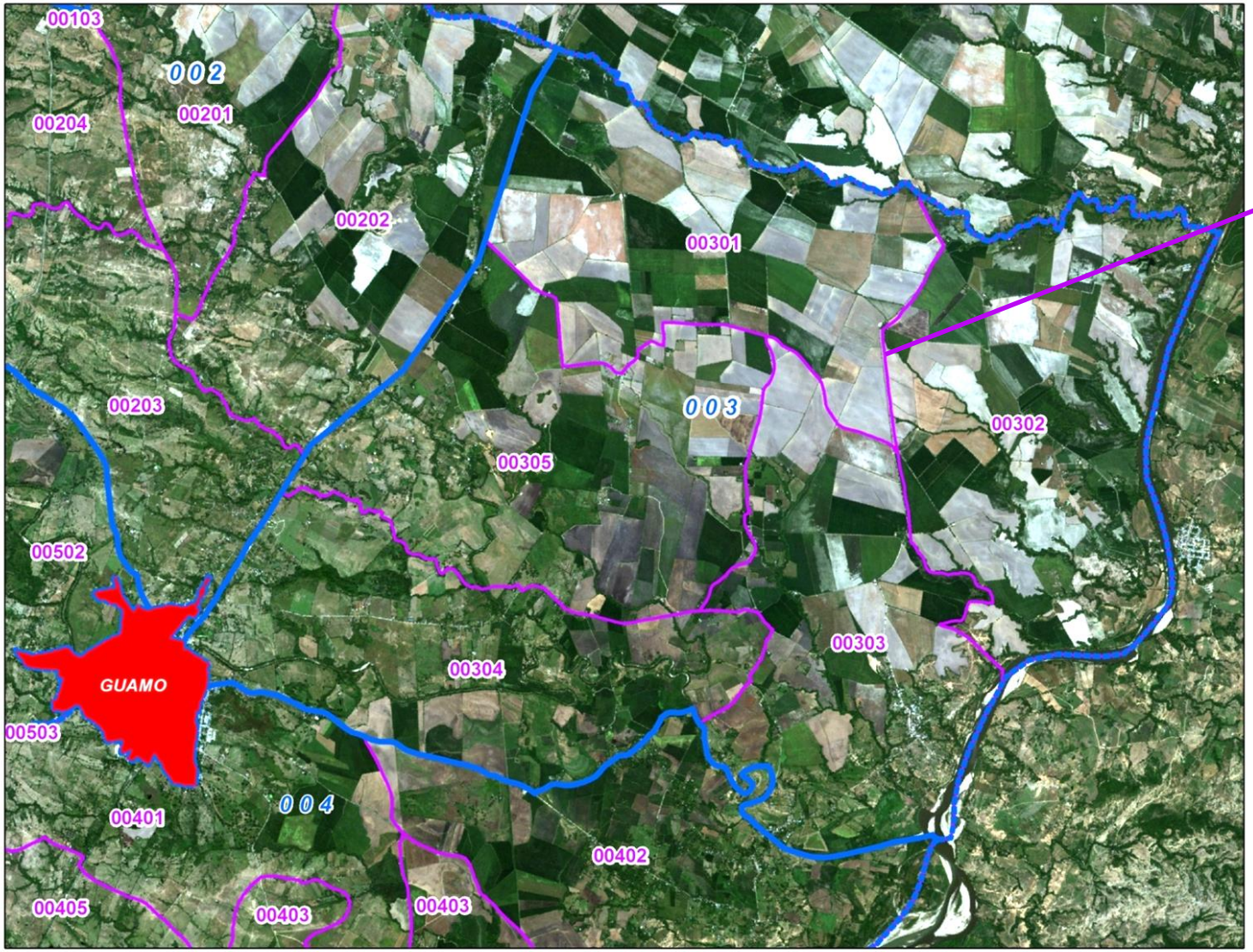


Rural Census Tracts

7.299

Census Tracts (Sectors)

Current conformation of the National Geostatistical Framework in rural areas



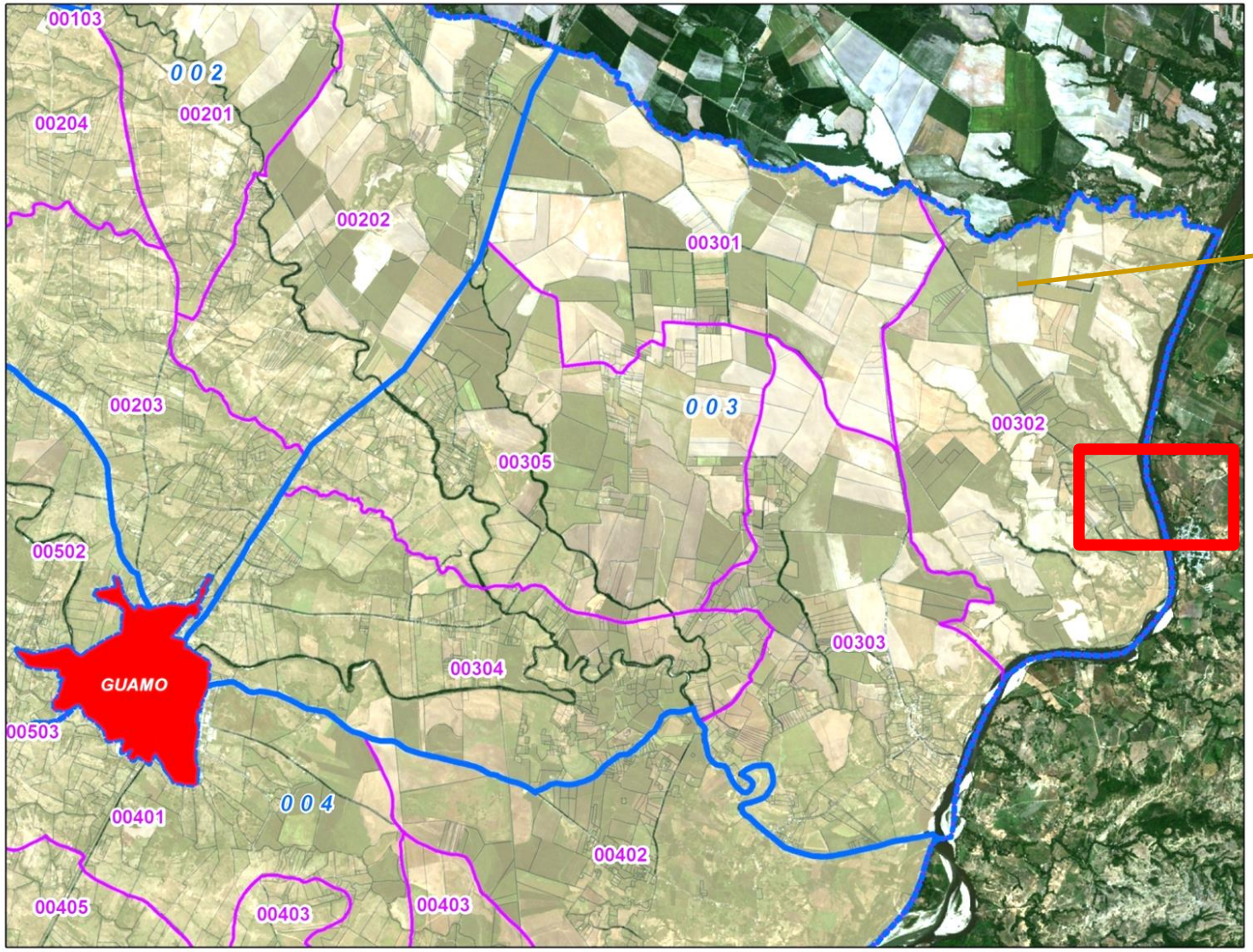
Rural Census Tracts

35.173

Census tracts (Sections)

Minimum mappeable unit Census 2005 equivalent to 20 Km²

Current conformation of the National Geostatistical Framework in rural areas



Farm integration

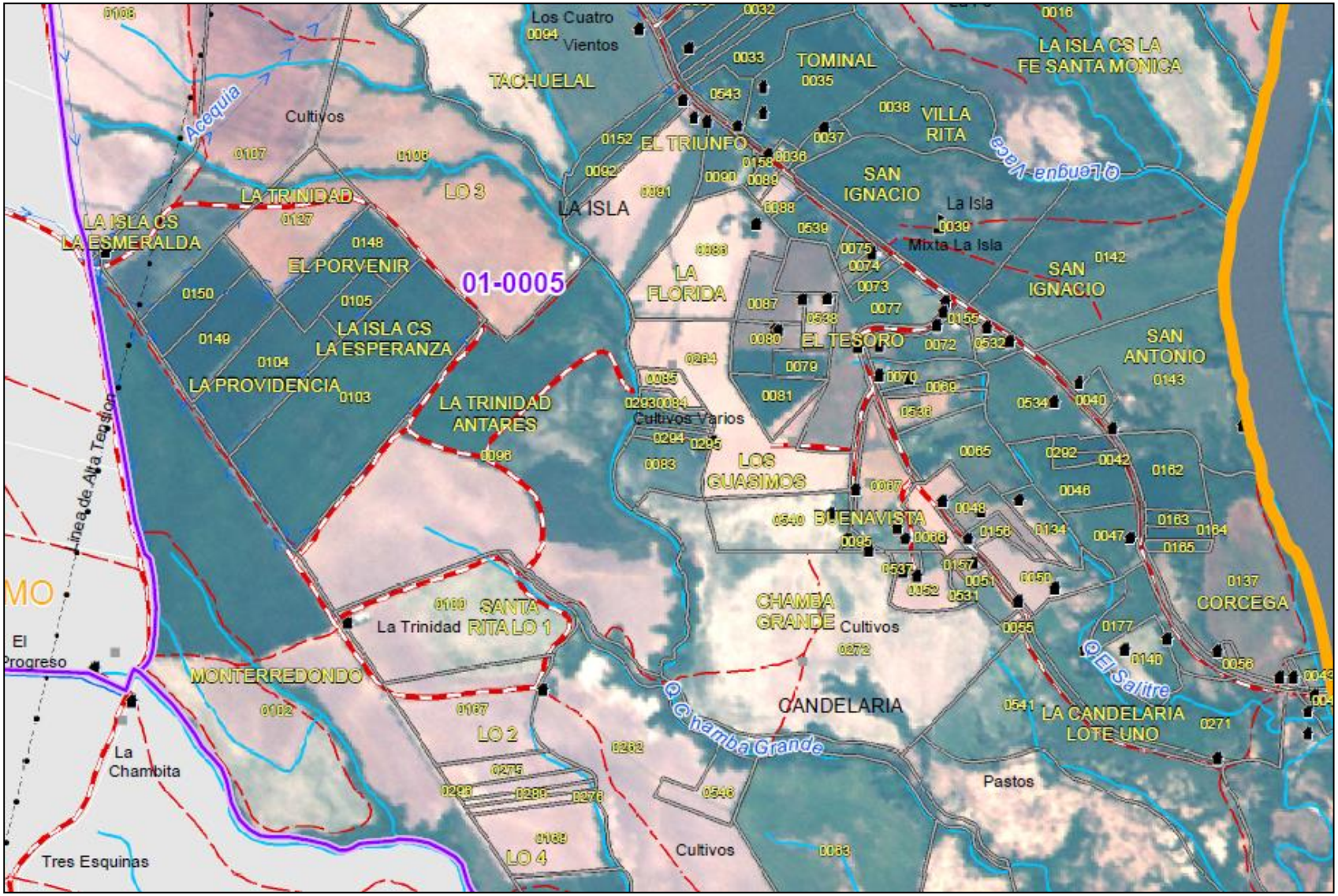
3.770.944

Rural Farms

Minimum mappeable unit Third NAC 2014

Source:
Cadastral cartography farm – IGAC and Descentralized Cadastres 2012.

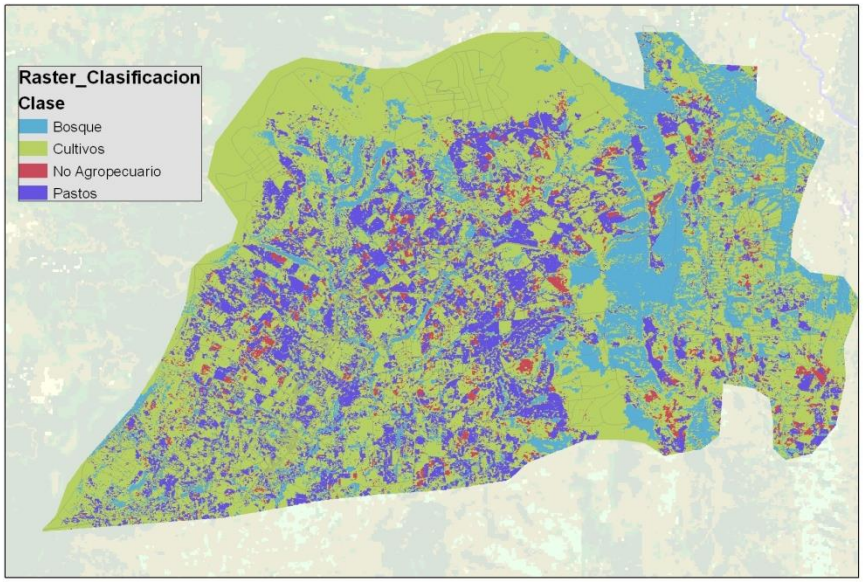
Census mapping Rural farm integration and use of images



Complement the framework of the national agricultural census

DEFINITION

In order to answer from the technical point of view a series of needs related with Agricultural Framework, derivative of the 3rd National Agricultural Census, DANE working on a proposal to complementing the Framework.



Complement the framework of the national agricultural census

General Objective

Propose possible alternatives to complement the information in areas not surveyed on the National Agropecuarian Census, based on the spatial component and supplementary information.

Submit recommendations on the proposed alternatives.

Expected versus obtained

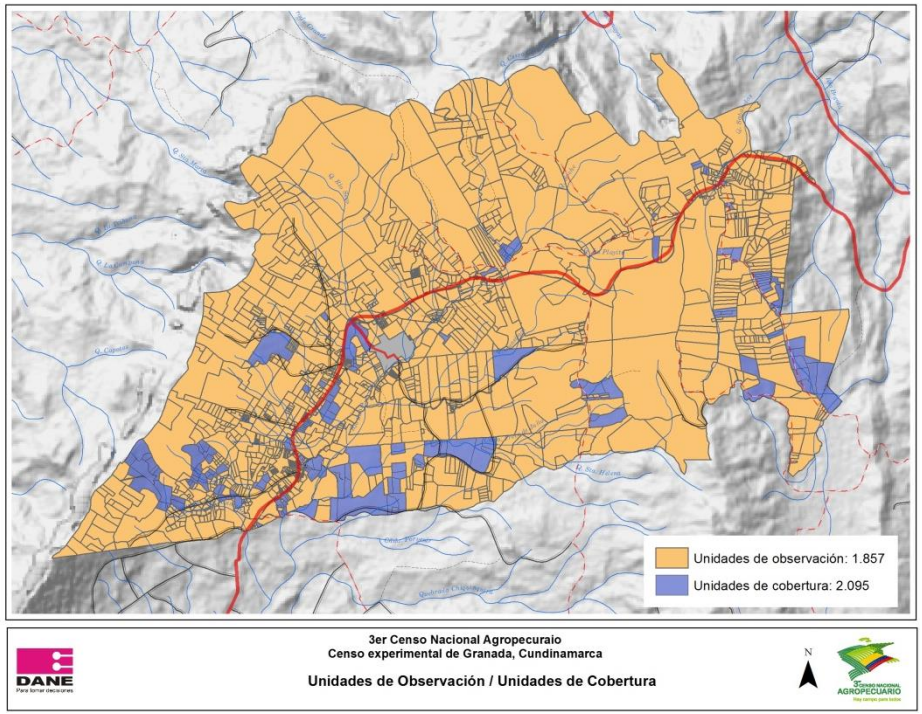
IDEAL

- High percentage of information.
- Total coverages areas.
- Quality of information.

REALITY

- Missing information.
- Areas of difficult access.
- Omission of information.

Diagnosis - Identification of spatial patterns



Scattered distribution of the observation units without information (blue).

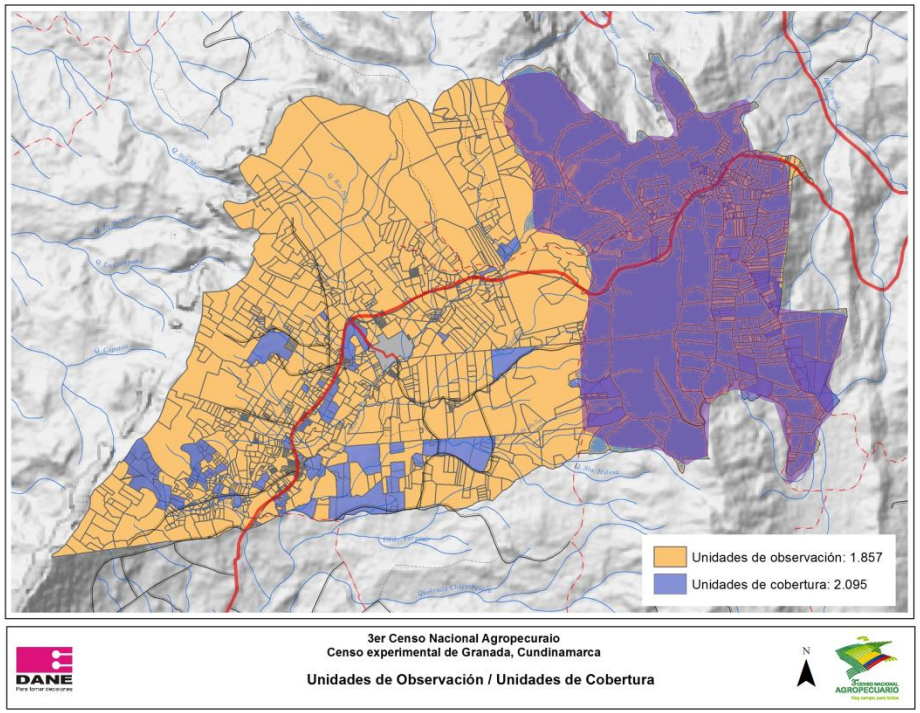
Scatter omission

Scattered areas where the observation units without information, are surrounded by others with information

Techniques:

- Statistical imputation
- Spatial analysis

Diagnosis - Identification of spatial patterns



Concentrated distribution of the observation units without information (blue).

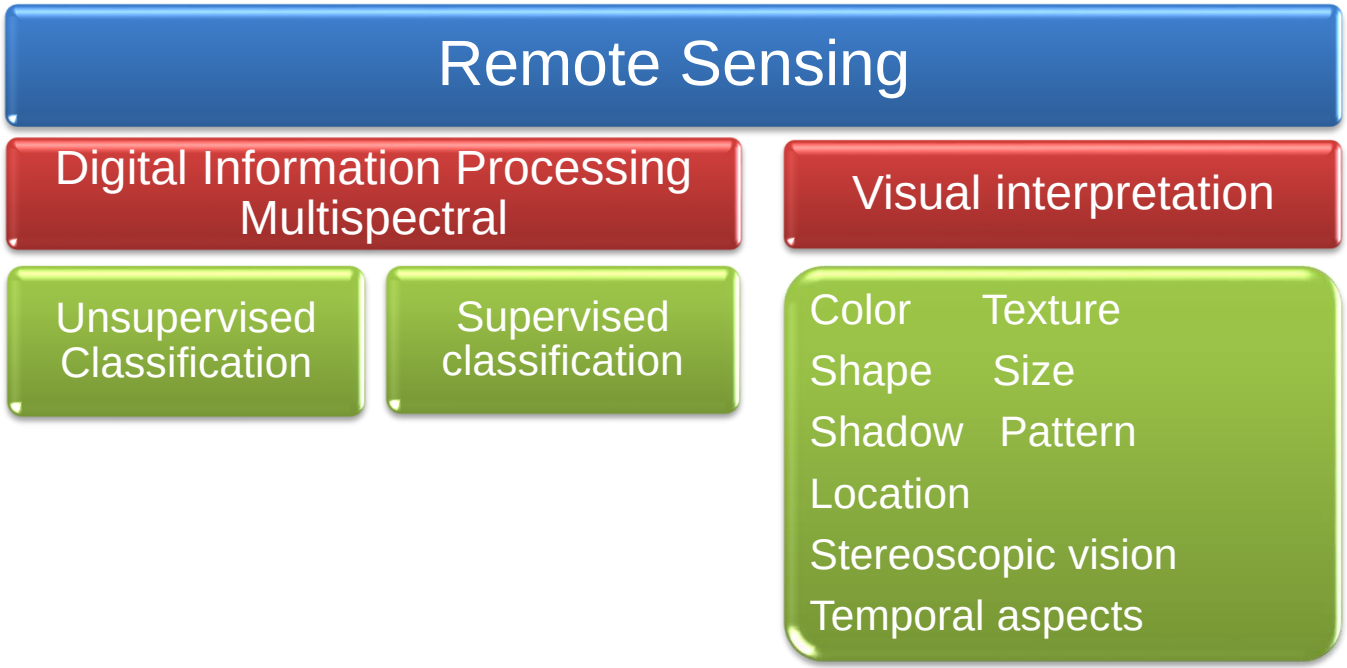
Concentrated omission

Occurs when the observation units without information are located in a specific area

Techniques:

- Image interpretation

Phase 1: Diagnosis - Remote Sensing



SOFTWARE	USE
ERDAS	Supervised and unsupervised classification of digital images.
ArcGIS 10.1	Image Analysis Module. Supervised and unsupervised classification of digital images.

Phase 2 Implementation - Remote sensing techniques

Considered Techniques:

- **Image Interpretation**
  - ✓ Multitemporal analysis. Determination of land use trends
  - ✓ Unsupervised classification. Testing software
  - ✓ Supervised classification. Determination of spectral signatures

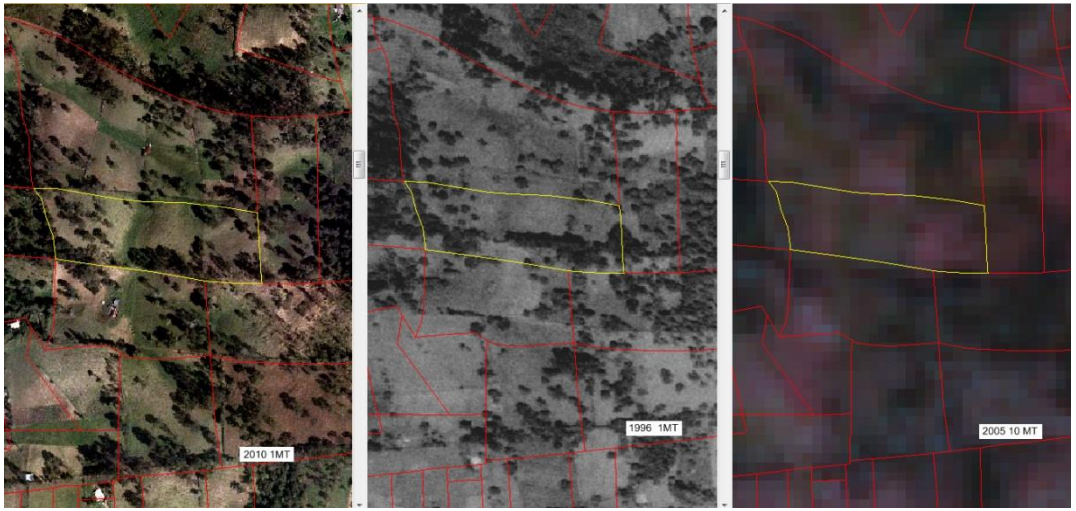
TYPE OF USE	SPECTRAL SIGNATURE
Crop 4	
Crop 5	
Forests 1	
Crop 6	
Grassland 2	
Forests 2	
Nonagricultural	
Forests 3	

Visual verification

RESULTS OBTAINED

- Allowed to extract information from images having as main criteria the relationship of tones, colors and spatial patterns that occur there.

- This process depends on the quality and, in particular, the spatial resolution of the image.



(a) Ultracam Image (b) AIRPHOTO (c) SPOT

Comparison of spatial resolution of Granada images (Department of Cundinamarca)

RESULTS OBTAINED

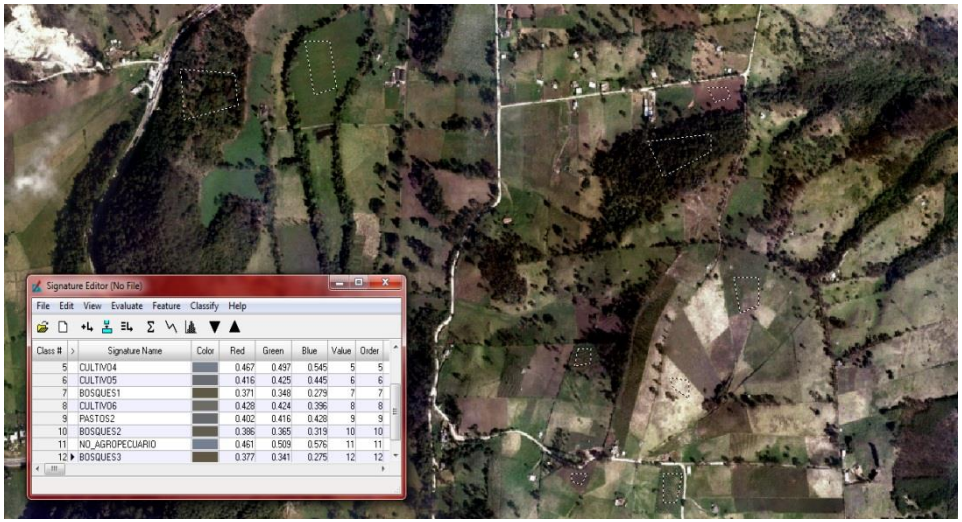
- No discrimination between (permanent and temporary) crops and grassland.
- The classification is widespread.
- Because the image has noise, the fact that the process is unsupervised, it influences the generalization of the classification.
- The result of unsupervised digital image classification doesn't match the information in land use.

The image on the left shows the unsupervised generalization, including shadows of clouds. The image on the left is the original mosaic.

RESULTS OBTAINED

- For each of the entities to be classified, it was use the values of the digital levels
- The interpretation of the image doesn't need further data for their development.
- The classification results do not take into account the criterion of 70% usage to assign the predominant use Observation Units.
- Classification for land use interpretation doesn't allow to characterize the transient and permanent crops.

- The results from the supervised classification differs from the Predominant Use of the observation unit because this is a declarative and conclusive data.
- Land uses that allows for the classification of images is reduced to three: Forest, Crop and Grassland.



Generation of spectral signatures. Boxes with dotted lines correspond to the taken samples

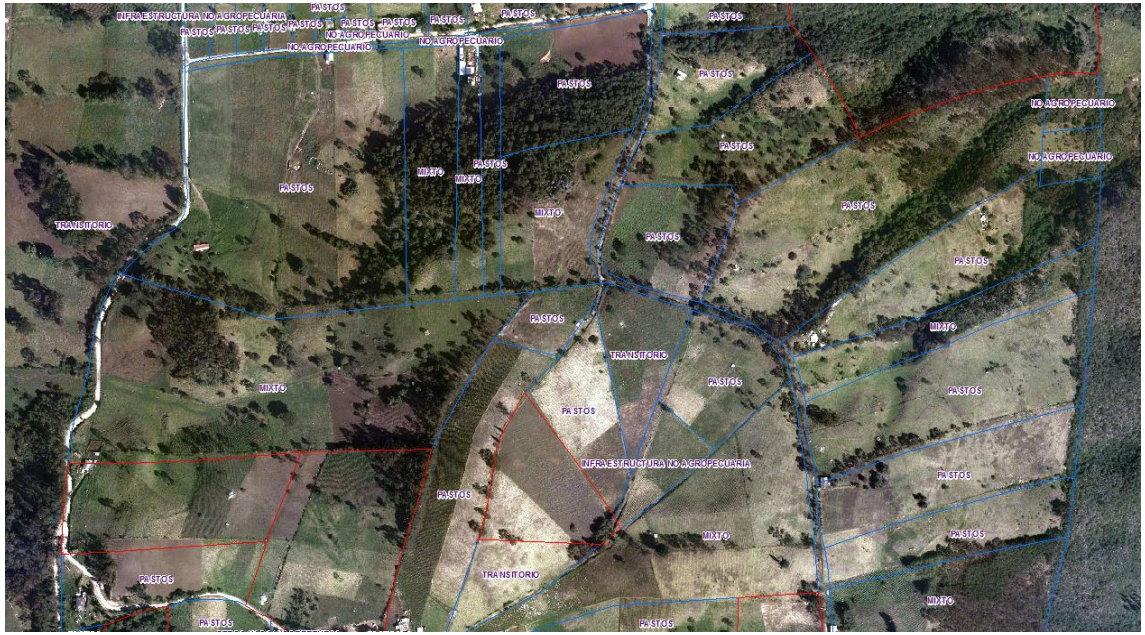
Conclusions

- Using satellite images can set use changes or trends in the study area.
- Whenever there is availability of images of the area in different years, it's recommended that a study to establish multitemporal use changes that are or if you can set a trend or a definite shift of the study variable.
- This work also serves as a basis for determining spectral signatures, as well as knowledge of the area by the people involved in this process.

Visual interpretation

You must make a preliminary visual interpretation of the study area to determine land use

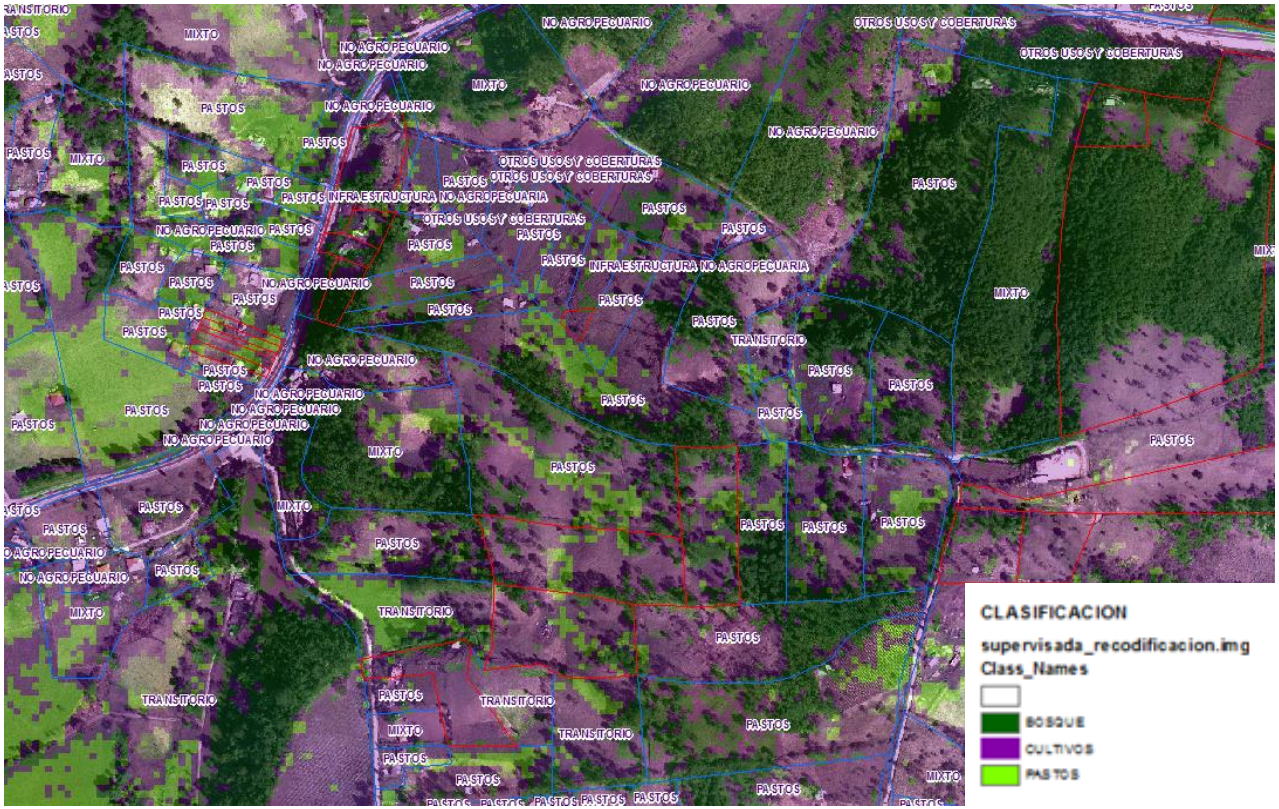
It is best to use images that have: the latest shooting date and the best both spatial and spectral resolution



Contrast digital mosaic of Granada and geographic layer Predominant Use of Observation Unit.

Conclusions

This image shows the result of the digital interpretation of images using the supervised classification:



Characteristics and use of remote sensing application

SENSOR	SPATIAL RESOLUTION	SPECTRO/BANDS	SCENE SIZE	IDENTIFIABLE CROPS	COMMENTS
SPOT	10 m	multispectral - 3 bands	60 km x 60 km	Agroindustrial	Crops of great extension can be identified: plam, export banana, coffee, rice, sorghum, sugar cane, forest plantation, pastures
	5 m	monospectral - 1 band			
RAPIDEYE	7 m	multiespectral - 5 bands	83 km 50 km a 86 km x 238km	Agroindustrial	
LANDSAT	15 m	monospectral - 5 band	185 km x 185 km	Agroindustrial	
TERRASAR	1 m	monospectral - 1 band	30 km x 50 km a 30 km x 246 km	Agroindustrial	
RADAR-SAR	5 m	monospectral - 1 band	110 km x 110 km	Agroindustrial	
AIRPHOTOS	0,5 a 5 m	monospectral - 1 band	2 km x 2 km a 14 km x 14 km	Agroindustrial crops and food crops	Large, medium and small extension crops are identified
IKONOS	1 m a 2,5 m	monospectral - 3 bands	11 km x 11 km		
QUICKBIRD	1 m	multispectral - 3 bands	11 km x 11 km		
GEOEYE	50 cm	multispectral - 3 bands	14 km x 14 km a 14 km x 28 km		
ULTRACAM	0,1 cm a 0,5 m	multispectral - 3 bands	3,5 km x 10 km		

NOTE: WE CAN USE THE SERVICE GOOGLE EARTH GEOGRAPHICAL AND TECHNICAL SPECIFICATIONS ARE

SENSOR	SPATIAL RESOLUTION	SPECTRO/BANDS	SCENE SIZE	IDENTIFIABLE CROPS	COMMENTS
GOOGLE EARTH	50 cm	multispectral - 3 bands		Agroindustrial crops and food crops	


REPÚBLICA
DE COLOMBIA


DANE
Para tomar decisiones


PROSPERIDAD
PARA TODOS

Thank you