LIFE17 CCA/ES/000063

Deliverable Nº 2

BASIC FOREST STRUCTURES

UPV

12/28/2018

This document develops and describes the classification of the main forest structures within the study site, Serra

BASIC FOREST STRUCTURES OF SERRA

ACTION A.1: Updating and modeling of Serra’s forest and biomass management approach

INDEX

Deliverable 1; name: *Basic forest structures*

Beneficiary responsible: UPV

Action A.1: *Updating and modeling of Serra's forest and biomass management approach*

From month 1– month 6

Name of the Deliverable	Number of associated action	Deadline
Basic forest structures	A.1	12/2018

1. Introduction

When using hydrological and/or vegetation models, the discretization of the input information is necessary. Digital Terrain Models (DTM), soil maps and vegetation constitutes the basic information to apply any model. In this sense, the present deliverable pretends stablishing a vegetation classification useful for both, the modelling and the forest management approaches. To that end, the vegetation has been classified into homogeneous forest structures (basic forest structures), according to the hydrological and fire behaviour as well as to the forest management possibilities. It will therefore allow its parametrization within any eco-hydrological model, and therefore its representation within the DSS tool.

Serra's village is located within Carraixet's catchment, whose forest area belongs to the Natural Park La Sierra Calderona. Since the DSS tool is expected to work at catchment scale, the basic forest structures presented here correspond not only to Serra's village, but to the whole upper catchment area.

2. Background

In 2016, Serra's municipality developed a forest inventory of its forest area (Figure 1), which did not include the whole Carraixet's catchment, but just a part of it. According to this forest inventory, 7 basic forest structures were found:

1.- Bush, grassland or wasteland.

2.- *Pinus halepensis* with forest cover higher than 60 %.

3.- *Pinus halepensis* with forest cover between 20 and 60 %.

4.- *Pinus pinaster* and *Pinus halepesis* with forest cover between 20 and 60 %.

5.- *Pinus pinaster* with forest cover higher than 60 %.

6.- Burned area.

7.- Sparse trees.

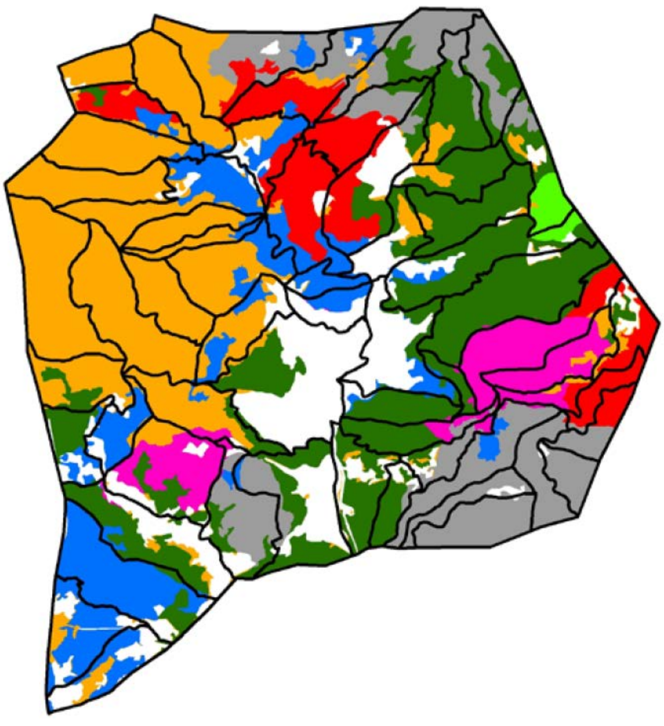

Figure 1: Basic forest structures obtained after Serra's forest inventory in 2016. Orange: Bushes; Dark green: *Pinus halepensis* with forest cover higher than 60 %.; Red: *Pinus halepensis* with forest cover between 20 and 60 %. Grey: Burned area; Pink: Sparse trees; Light green: *Pinus pinaster* with forest cover higher than 60 %; Blue: *Pinus pinaster* and *Pinus halepesis* with forest cover between 20 and 60 %.

This work was used as a basis to develop the forest inventory of Carraixet's catchment.

3. Objectives

The aim of this deliverable is to classify the forest information into basic forest structures making possible the characterization and parametrization of forest-water-soil-climate-fire relationships that will feed the DSS tool.

4. Methodology

The classification of vegetation into basic forest structures used the following information (Figure 2):

- Field campaigns, which include Serra's forest inventory and other field campaigns carried out within the project).
- Forest map (FM) of Valencia's region.
- LiDAR technology.
- Satellite information.

The basic forest structures were identified using FM as basis. Then, remote sensing and field information was used to validate and sub-divide when necessary the structures defined in the FM.

The FM of Valencia's region was developed in 2005 at 1/50000 scale by the public Spanish services. The LiDAR data was collected in 2015 by PNOA (The National Plan of Aerial Ortophotogrammetry, Spanish Government), using an Optech ALS50-II sensor, with a minimum laser pulse rate frequency of 45 kHz, a field of view angle of 500 and a scan rate of 70 Hz. The final density ranged between 0.5 (most of the area) and 2 points m2 177 (flight overlapping). Vertical and planimetric (X, Y) reported errors were lower than 40 and 36 cm, respectively. Finally, Landsat 8 OLI/TIRS images were used to calculate different vegetation indexes (NDVI and NDMI).

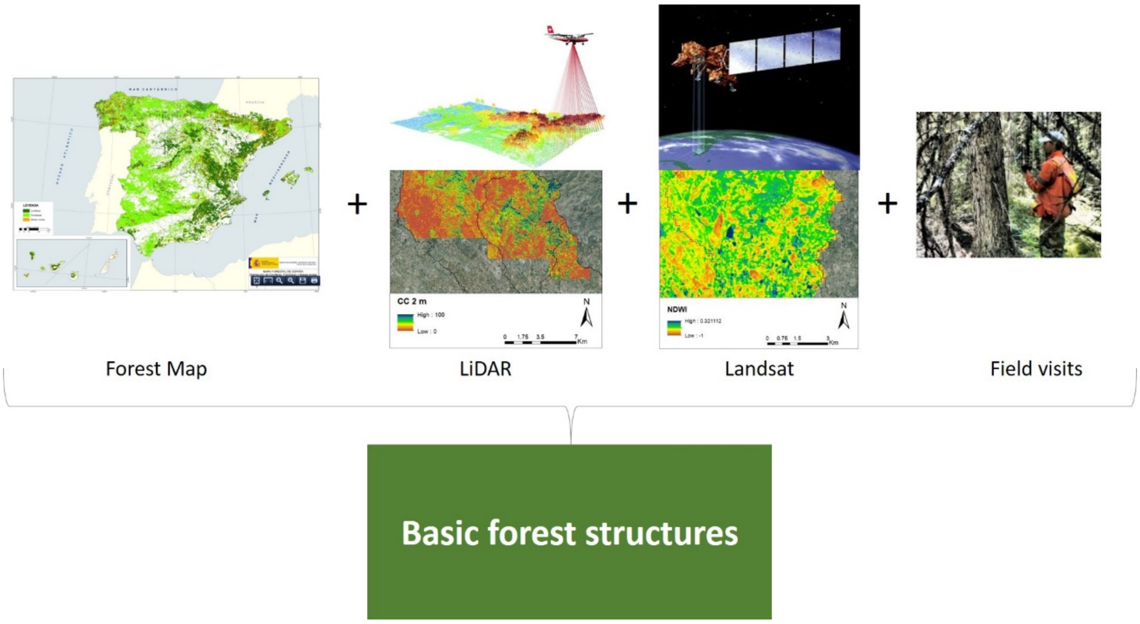

Figure 2: Information used to develop the basic forest structures of Carraixet's catchment.

This FM discretizes the territory into 35 different forest structures (see Table 1), and describes its principal and secondary forest species and its maturity stage. The combination of the forest structure, main species and maturity stage (Figure 3) yields more than 100 different basic forest structures.

Table 1: Terrain discretization of the Spanish forest map.

STRUCTURE	DEFFINITION	STRUCTURE	DEFFINITION	STRUCTURE	DEFFINITION
1	**Forest**	12	**Thicket trees**	13	**Tree lines**
2	**Afforestation**	14	**Disperse trees**	25	**Scattered forest over crops**
3	**Dehesa**	15	**Agriculture**	26	**Scattered forest**
		16	**Artificial**	27	**Scattered shrub over crops**
4	**Forest complements**	17	**Wetland**	28	**Crops with scattered trees**
5	**Logging**	18	**Water**	29	**Park**
6	**Burned**	19	**Sea**	30	**Recreational area**
7	**Forest without trees**	20	**Out of limits**	31	**Lake**
8	**Shrub**	21	**Roads**	32	**Scrubland**
9	**Grass**	22	**Infrastructures**	33	**Scattered shrub**
10	**Desert/semi-desert**	23	**Mining, dumpsite, debris**	34	**Meadow**
11	**Riparian forest**	24	**Meadow with bush**	35	**Grass-shrub**

This classification was validated and modified when necessary by combining LiDAR technology, satellite information and in situ visits. First, the canopy cover (CC) is calculated by using LiDAR data as the proportion of first returns that hit above a specified height threshold (Korhonen et al., 2011), defined in this study as 2 m. It was carried out using gridmetrics tool of Fusion v3.30 software (Fagerberg et al., 2012). Subsequently, the average and standard deviation (SD) of CC was calculated at each forest structure. Then, those forest structures where SD exceeds 60 % of the average, were re-classified by using aerial photograph and field visits until SD < 60 %. Finally, in order to make sure the classification represents homogenous forest structures, average and standard deviation of NDVI and NDWI indexes were calculated using Landsat 8 OLI/TIRS images. Then, the same procedure as with CC was followed, those forest structures where SD exceeds

40 % of the average, were re-classified by using aerial photograph and field visits until SD < 40 %.

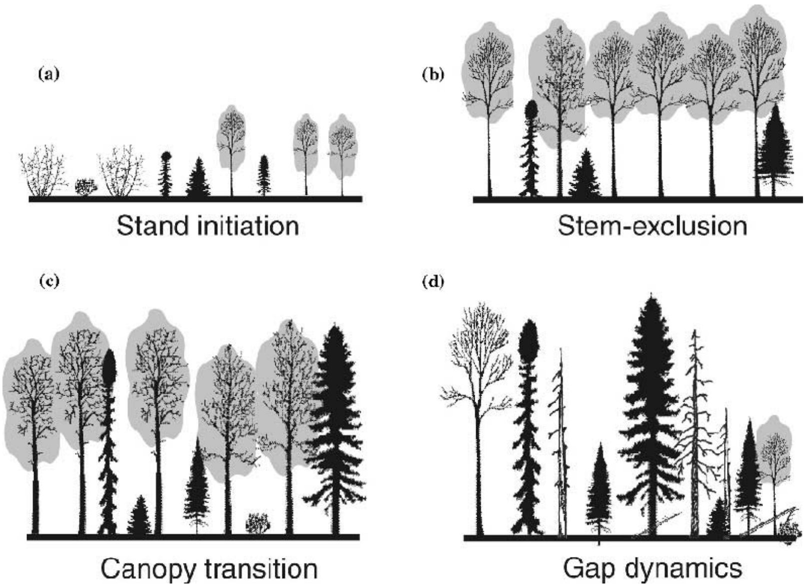

Figure 3: Forest maturity stages.

5. Description of the activities

1.- Analysis of Serra's forest inventory: Serra's municipality shared this information with RESILIENTFORESTS project to assure the good classification of Carraixet's forest area. After a previous analysis of this forest classification by UPV, two meetings with Serra were needed to fully understand and apply the methodology and the obtained results.

2.- Analysis of Forest Map of Valencia's region: this information was freely downloaded () and analysed by means of the software QGIS 2.18.

3.- LiDAR information was used to validate and correct if necessary the forest cover information derived from the previous point. The points cloud derived from the last (2015) LiDAR flight was freely downloaded (http://centrodedescargas.cnig.es/CentroDescargas/index.jsp) with the aim to develop a forest cover map of the different vegetation stratum. To that end, the software FUSION, QGIS 2.18 and RStudio were used. First a Digital Elevation Model was developed by using only the points classified as soil with FUSION software. Subsequently, the first returns at 3 different heights (1, 2 and >2 m) were extracted with FUSION, and analysed using RStudio. As a result, the forest cover of 3 vegetation stratum was obtained and visualised using QGIS 2.18.

4.- Landsat 8 was used to validate the homogeneity of the basic forest structures. Images from 2014 to 2019 were freely downloaded and analysed with RStudio. Several vegetation index were calculated to analyse its temporal trend. A classification of these trends was carried out to obtain homogeneous behaviours.

5.- Information from points 1-4 was combined to develop the classification of basic forest structures of Carraixet's catchment. The combination was carried out by using QGIS 2.18 and RStudio software.

6.- Aerial photographs from PNOA were used to validate and correct if necessary the obtained forest structures derived from the previous point.

7.- Field visits: these were carried out with the aim to validate and correct if necessary the obtained forest structures derived from the previous point.

6. Results and conclusion

After the combination of the above mentioned information, 25 different basic forest structures were obtained. The basic structures are defined in Table 2 and can also be shown in Figure 4.

These structures will be used from now on to develop the DSS tool.

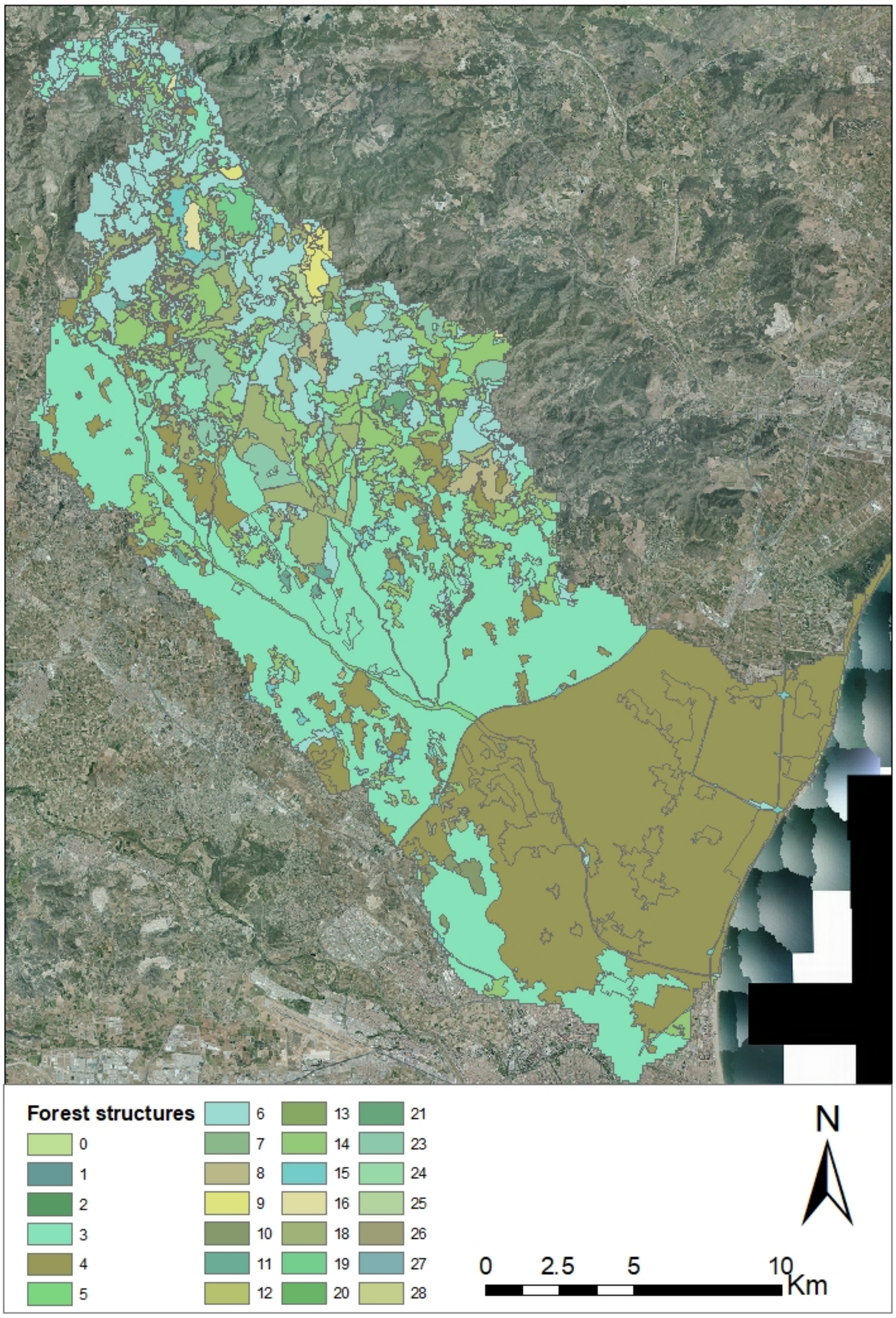

Figure 4: Basic forest structures of Carraixet's catchment.

Table 2: Homogeneous vegetation structures at Carraixet's catchment.

STRUCTURE	DEFFINITION	STRUCTURE	DEFFINITION
3	Crops	16	Mature Pinus pinaster
4	Artificial	18	Stem-exclution Alepo pine stands
5	Water	19	Stem-exclution conifer+hardwood
6	No trees	20	Riparian forest
7	Shrub	21	Olea europea
8	Scattered Aleppo pine	23	Very young Aleppo pine stands
9	Quercus suber	24	Initation Quercus ilex
10	Ceratonioa siliqua crops	25	Initation conifer+ hardwood
11	Mature scattered Aleppo pine	26	Initation Pinus pinaster
12	Pinus pinaster+Quercus ilex	27	Afforestation Aleppo pine
13	Evergreen hardwood forest	28	Afforestation conifer+ hardwood
14	Mature Aleppo pine		