R software code to process and extract information from 3D Lidar point clouds

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INTRODUCTION

In the process of electronic canopy characterization, it is necessary to process efficiently point clouds obtained by means of sensors or other capturing information systems. These point clouds may have different origin but they define the main structural characteristics of the scanned crop. In the case of tree crops (vineyard, orchard crops …) the vegetation is usually organized in rows, and therefore it is necessary to extract vegetative parameters for each partial section along those rows. This information extraction procedure is crucial since in many cases large point clouds are analysed, easily containing millions of points. For this reason, a fast, easy-to-configure and precise methodology is necessary to extract such information. The work presented in this poster defines the main features of a procedure carried out with R Software code.

POINT CLOUD DATA

The point cloud has to be saved in a text file. For every point, its coordinates and all its parameters are described in one row. The required information for every point is named in the next list:

- **X UTM:** Coordinate X of the point in meters.
- **Y UTM:** Coordinate Y of the point in meters.
- **Z UTM:** Coordinate Z (height a.s.l.) of the point in meters.
- **Scan Number:** Number that defines the ordering of the each complete scan
- **Beam Number:** laser beam identification corresponding to the reading (multiple beam sensors).
- **Beam angle:** Inside of each scan, the angle of the beam for the reading
- **Alleyway:** Number of the alleyway from where the reading was obtained
- **Row number:** The scanned row number for the reading.

Coordinate values must be in Cartesian format. It is possible to directly use UTM (Universal Transverse Mercator coordinate system) coordinates or, as an alternative to reduce the file size, local coordinates using the same units.

INPUT PARAMETERS

A second file is required to run the process. This file defines the coordinates of the beginning and the end of each ROI-A (Region of interest A) that will be analysed to extract crop parameters (Figure 1). The analysis can be done by separate trees or by row depending on the extension of ROI-A. If the start and the end of each tree are defined, the system will analyse parameters for each tree. Once ROI-A is defined, the analysis is run according to smaller ROIs of *d* increments along the Y axis (ROI-B) and *i* increments along the Z axis (ROI-C). An example of ROI-C processing is exposed in Figure 3 (left).

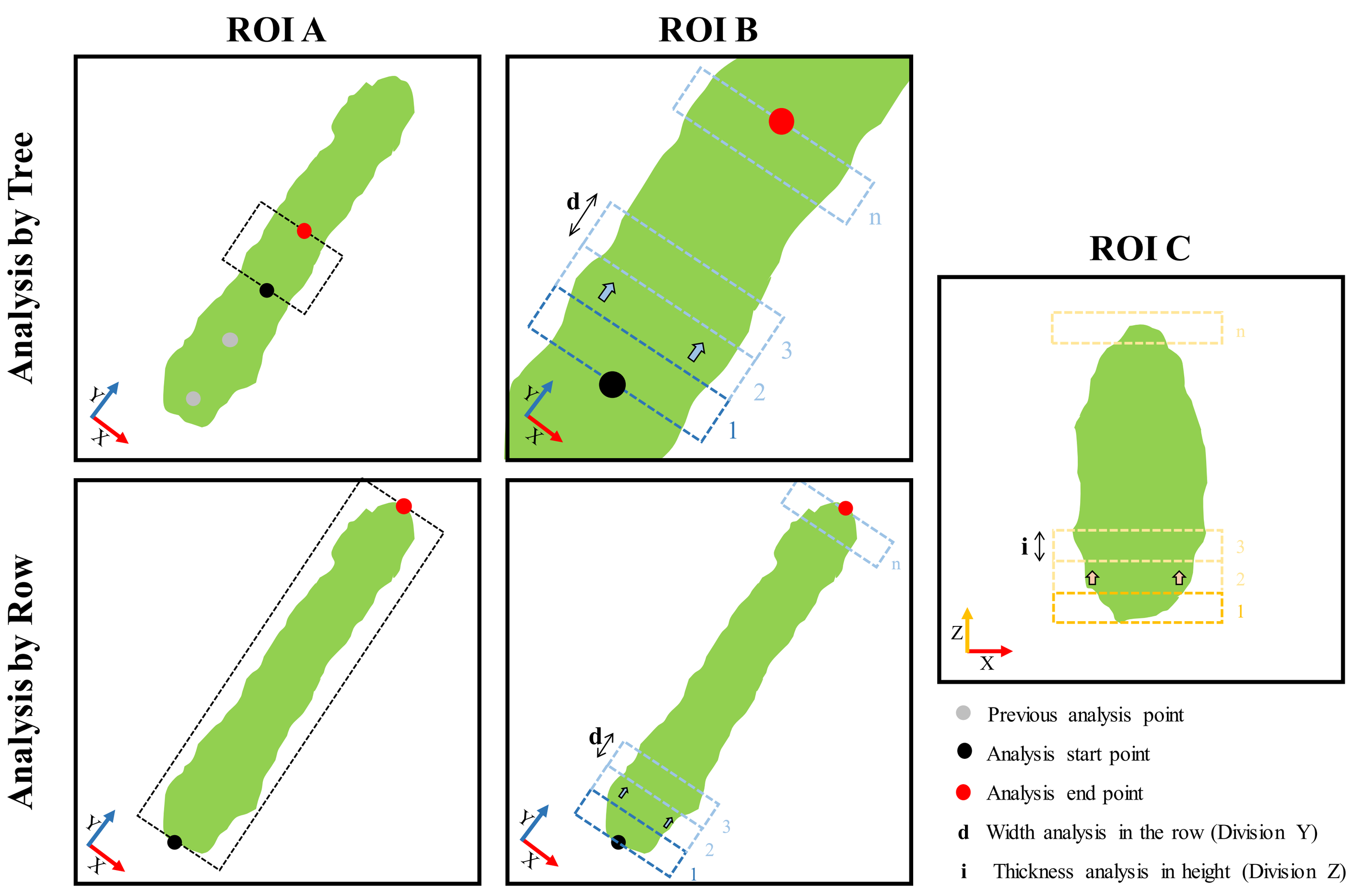

Figure 1. Graphical description of Region Of Interest (A, B and C) used in the process. Top figures in case of analysis by tree and down figures in case of analysis by row.

RESULTS

Figure 3 (left) shows in a graphic all the geometric parameters extracted from one row. In Table 1, we present some processing times with the proposed methodology. Depending on the size of the point cloud and the measuring precision, width and thickness of the ROIs B and C the system needs more or less time to process the results.

Table.1. Results of processing time for different point cloud analysed.

Sensor	Point cloud size (*number of points*)	Scanned crop	Measuring precision (*ROI-B, ROI-C*)	Processing time (*in seconds*)
HOKUYO UTM30-LX-EW 	15.993.805 (1 channel)	5 rows 125 trees	0,5 m ; 0,1 m	465
			0,25 m ; 0,1 m	558
		4 rows	0,5 m ; 0,1 m	121
			0,25 m ; 0,1 m	202
			0,1 m ; 0,1 m	404
VELODYNE VLP-16 	5.222.426 (1 channel)	5 rows 125 trees	0,5 m ; 0,1 m	200
			0,25 m ; 0,1 m	260
	83.383.330 (16 channels)	4 rows	0,5 m ; 0,1 m	56
			0,25 m ; 0,1 m	102
			0,1 m ; 0,1 m	241

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POINT CLOUD ANALYSIS PROCESS

The point cloud process is described in the flow chart that appears in Figure 1. All the process is written in R Software code, under RStudio® Software.

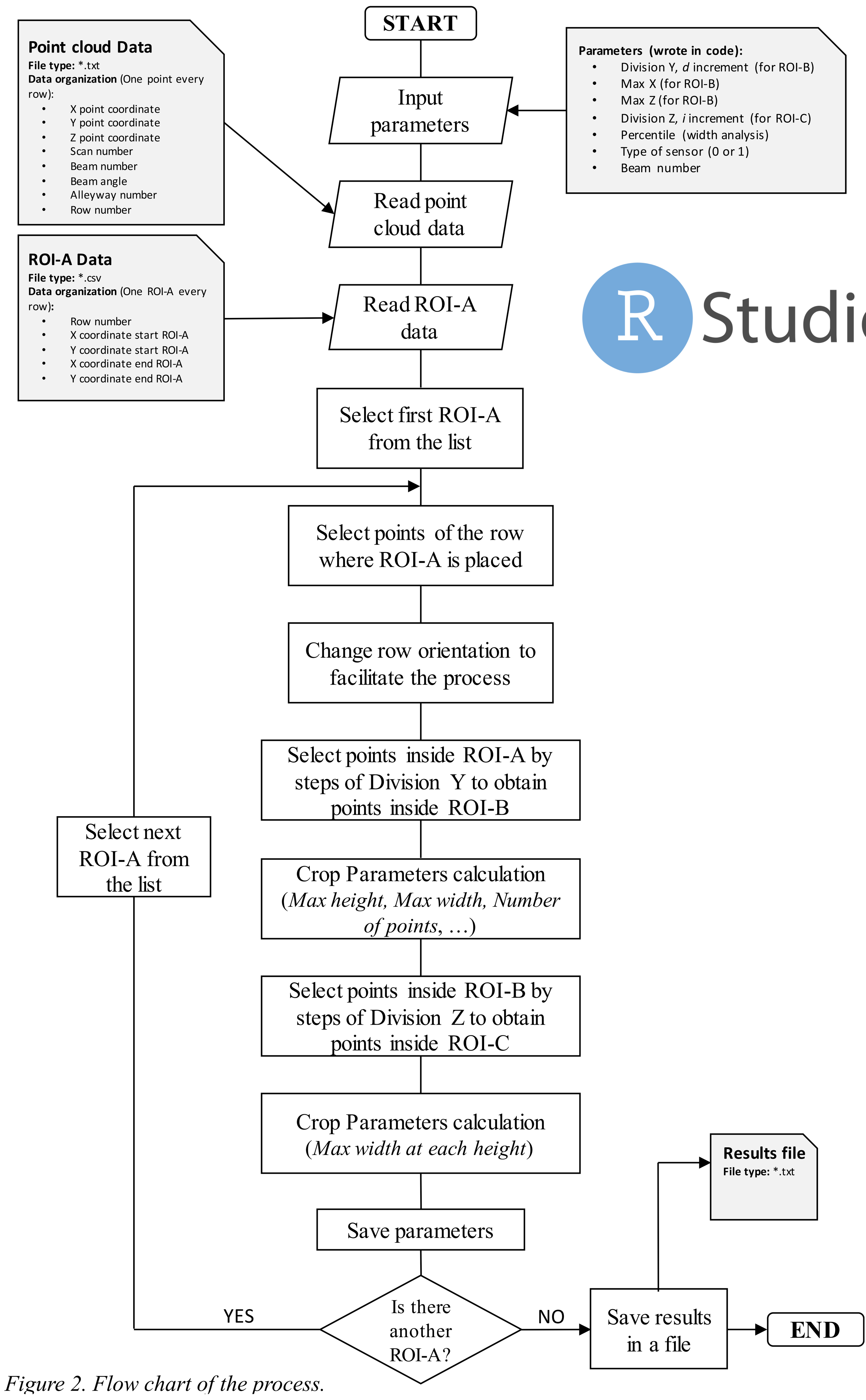

Figure 2. Flow chart of the process.

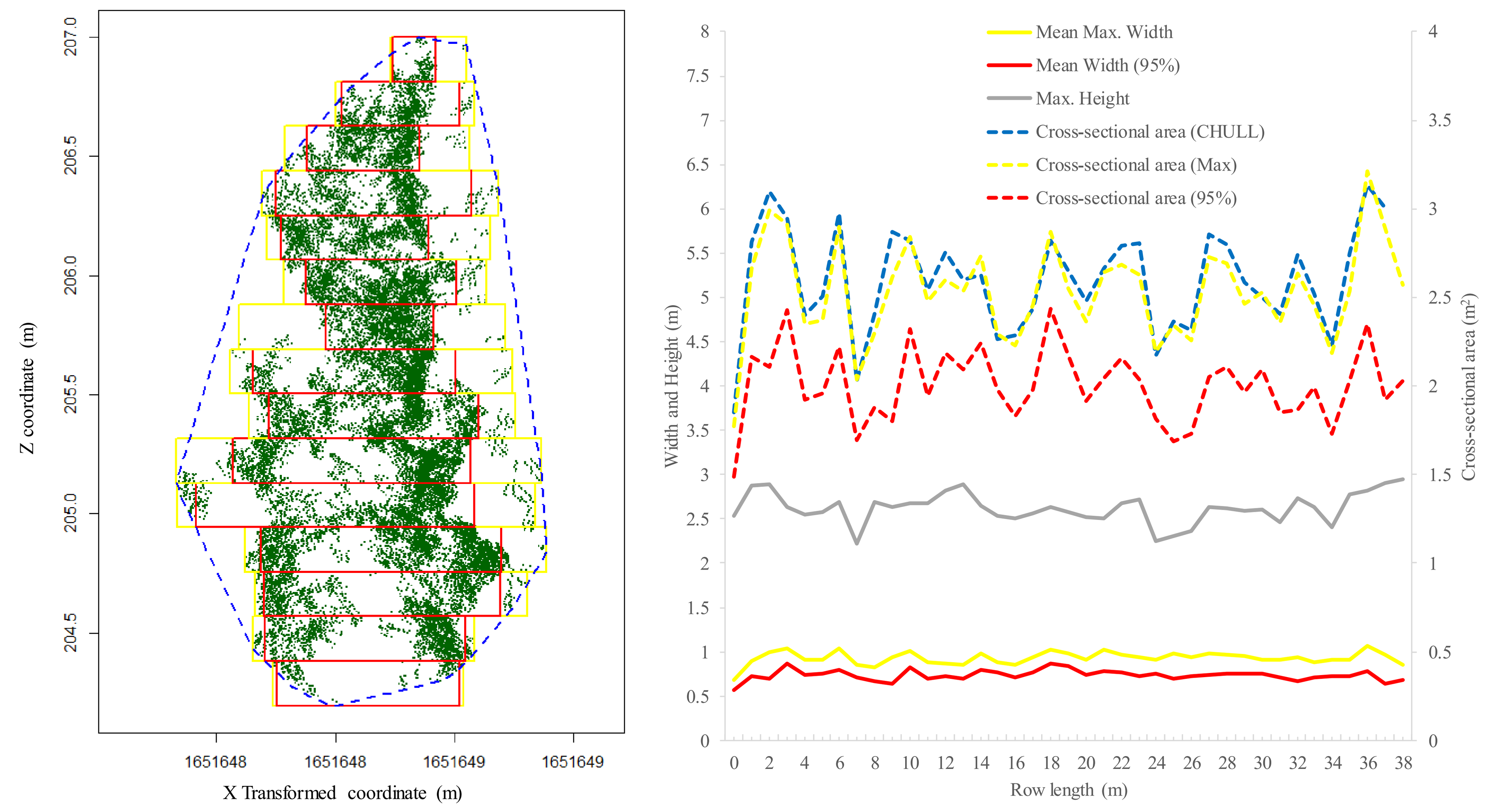

Figure.3. Left, step in the process of analysis, ROI-C. Right, plot of the main results of one row.

CONCLUSIONS

The presented code permits to process point clouds from row crops in an easy and a quick manner. The resulting parameters (width, height and sectional area) are important to characterize tree crops. Apart from the geometry of the canopy, other structural parameters related to leaf density are expected to be obtained in new and improved versions of the code. It is important to underline the ability to process a big point clouds using an open source software like R.

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