Using LiDAR technology in forestry harvest planning.

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Abstract

Managing forest resources can be highly time and resource demanding and requires significant amount of data collection in the field plus the indispensable filtering necessary to provide the information. High performance LiDAR remote sensing technology has become an effective tool for use in applications on forest harvest planning .In the field of forestry, the LiDAR measurements of the forested areas can provide high quality data on three dimensional characterizations of digital terrain model (DTM). This study presents the accuracy evaluation of the LiDAR DTM data over forest planted field in order to use in forest harvest machinery assignment procedure, to finally delineate harvest units for spatial forest planning.

1. Introduction

Airborne light detection and ranging is emerging as a prominent tool to provide accurate digital terrain models (DTMs) of forest areas, since it can penetrate beneath the forest canopy. This technology is providing a new conception in the forest harvest planning for forest companies transform it in a robust source for the extraction of DTMs.

High resolution of topographic data has the potential to differentiate one of the main morphological features of the landscape its elevation properties. For this study,1 m spatial resolution of DTM was derived from the last pulse LiDAR data obtained by filtering the vegetation points (Leaves, branches, stems, bark), (Slatton et al, 2007). The study was conducted in a property of a forest company located in the center valley in the BioBio region, Chile. The results suggest a suitable capability of LIDAR in the recognition and description of the surface ground elevation, giving the potential to generate digital terrain models.

In previous studies, LiDAR data was used to evaluate the surface roughness as a useful approach to detect landslide areas (McKean and Roering, 2004), and to characterize and differentiate the landslide morphology and activity (Glenn et al, 2006), being a useful technology to be apply on the ground morphology description (James et al, 2006; Storesund and Minear, 2006). The present study analyses the capability of airborne LiDAR-derived data in the recognition of ground morphology to assign with accuracy the forest harvest machinery and allow delineate harvest units for spatial forest planning.

2. Study area

The study area is located in the Eastern of the coast mountain of BioBio region, Chile. This region concentrates most of the forest plantation in the country (52 %) (Figure 1, 2 and 3).

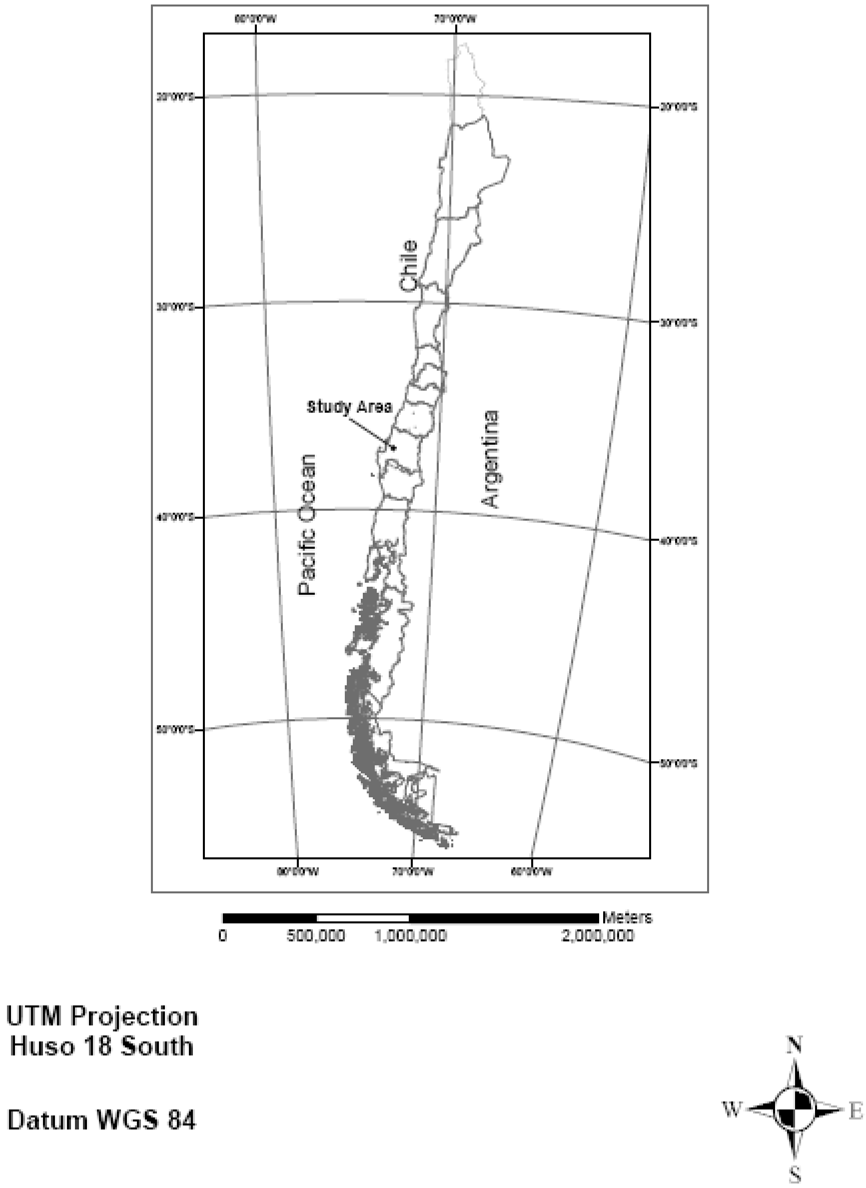

Figure 1: Location of study area.

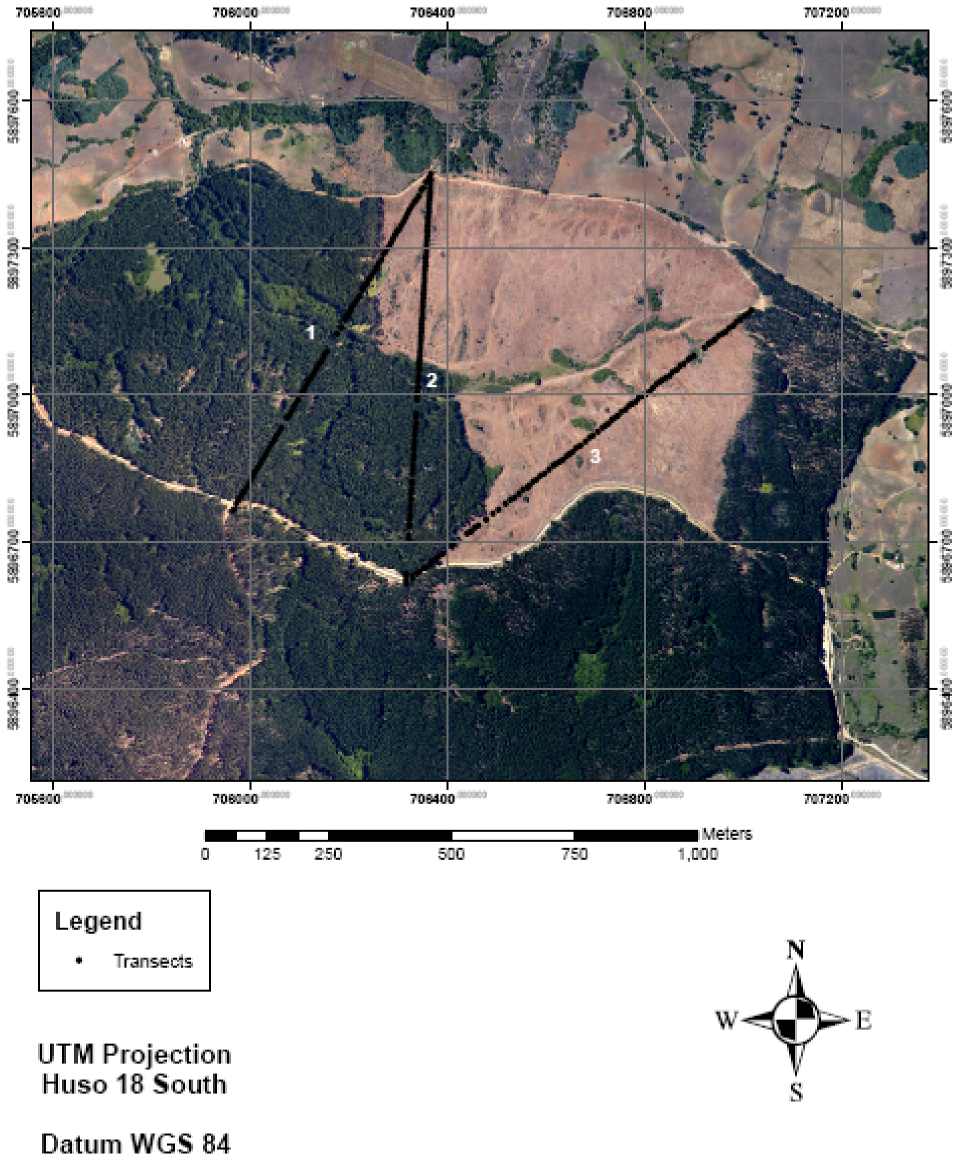

Figure 2: Aerial photo and the three transect location.

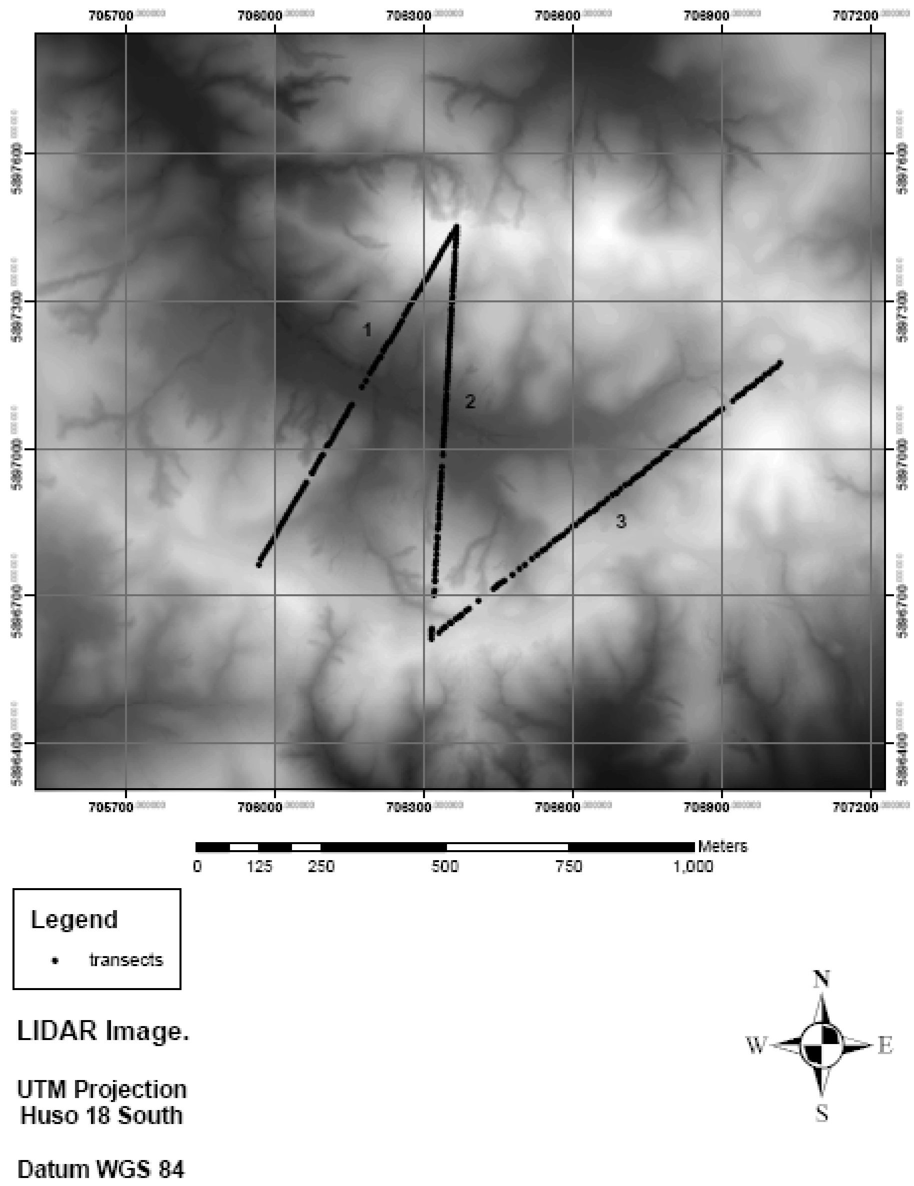

Figure 3: LiDAR imagery and the three transect location.

The LiDAR data was processed by using ArcGis v9.1 software package.

LiDAR data specifications: The LiDAR and photographic data were acquired from a airplane using an ALTM 3100 OPTECH, and Digital camera, flying above ground level during dense forest adult plantations conditions in Summer 2005.

GPS data specifications: The Geodesic GPS double frequency, code P, 18 channels, brand TRIMBLE, model 4000SSi, Everest technology, was utilized to generate the four vertices of the three elevation transects (See Fig. 2, Fig. 3 and table 1) to generate the three elevation profiles showed in following figures 5, 6 and 7. The topographic station that was used to take z variable (elevation axis) within each transect corresponds to LEICA model TC-303.

Morphology data acquisition: The elevation profile for each transect was generated by a topographic station along each of the three transects line, assembly them with GPS in the extreme transects points to link local data from topographic station, and world wide coordinate system (UTM). Thus, were generated a data sets that describe the elevation profile of each one of the three transect under analysis. The criteria used to take z variable using topographic station along the transect was every two meters, at least that the point has bad access, always measuring the forward movement distance along the line.

3. Methods

The three elevation profiles were generated by the use of topographic station along each transects line, assemble with GPS located in the extreme of the transect points. Thus, were generated a data sets that describe in suitable accuracy, the elevation profile of each one of the three transect under the study area using Geodesic cartographic base.

The LiDAR onboard instrument over flu the study area before the forest was clear up. The LiDAR corresponding elevation profile from those three transects were generated assisted by ArgGis software using LiDAR image file using Geodesic cartographic base.

The GPS - topographic station combination work to collect data after the forest was harvested (to reduce the ground measurements error) generate the reference ground data from the three transects. This elevation profile built from the three transects were taken from the field touching the mineral soil, scratching the trash and the branches when it was necessary (Fig. 2, Fig. 3 and Fig. 4).

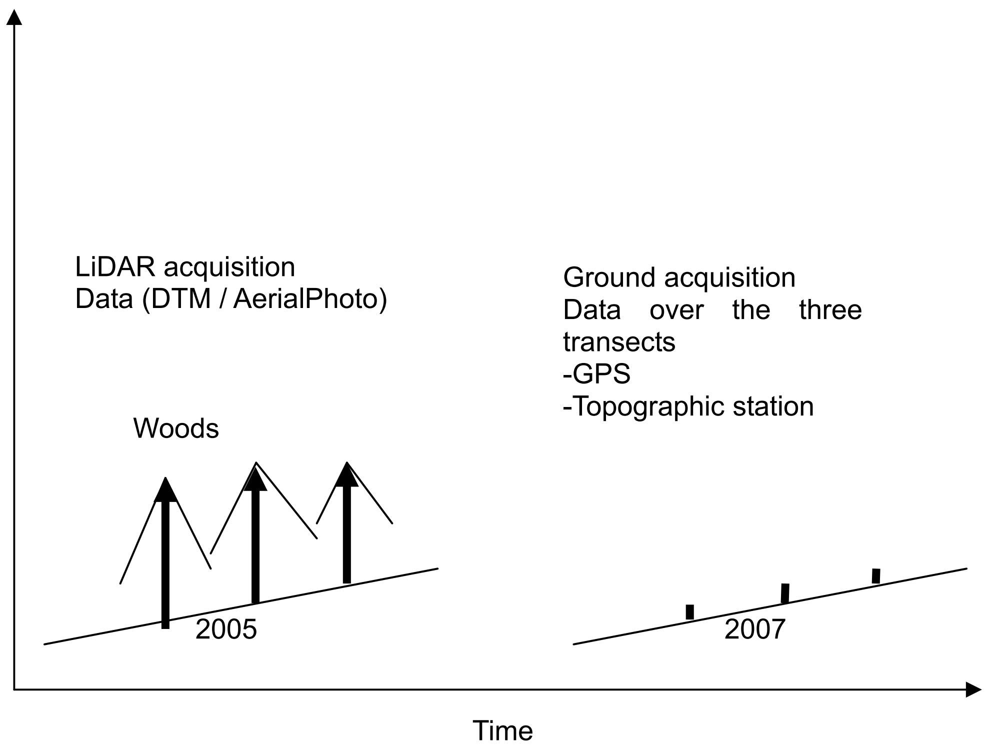

Figure 4: Scheme of data acquisition period from the study site.

4. Results

The Figures 5, 6 and 7 show the elevation profiles of the three transects, from two sources, the reference one that come from geodesic GPS, and other come from LiDAR source. We appreciate the small difference between both sources which is quantified in tables 2, 3 and 4 were it is showed the error distribution in the elevation z exe of the 3D system, where the maximum error distribution of z exe over the three transects is mostly concentrate between 0 to 1 meter. The resume table 5 shows that the 92 % of the data for all distance of the three transects (Table 4) shows an error concentrate between 0 and 1 meter. The 6 % of error is concentrate between 1 and 2 meters and 2 % between 2 and 3 meters.

The source of the error comes mostly from the upper and lowest topographic position, but we do not know the exactly reason of this error distribution.

Were taking 280 sampling points from whole three transect, which are distributed as shows following table 1.

Table 1: Sampling point distribution by transect.

Transect number	Sampling points
1	80
2	120
3	80

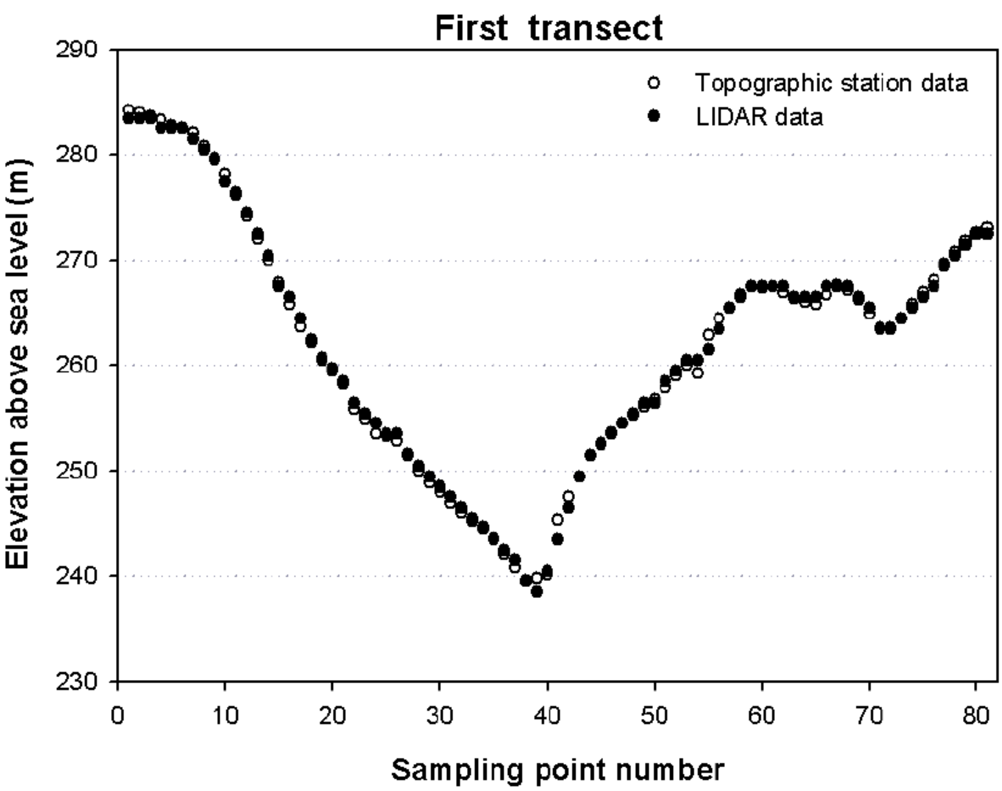

Figure 5: Elevation profile for the transect 1.

Table 2: Error distribution for transect 1.

Error range (m)	Error distribution (%)
0-1	93
1-2	7
2-3	0

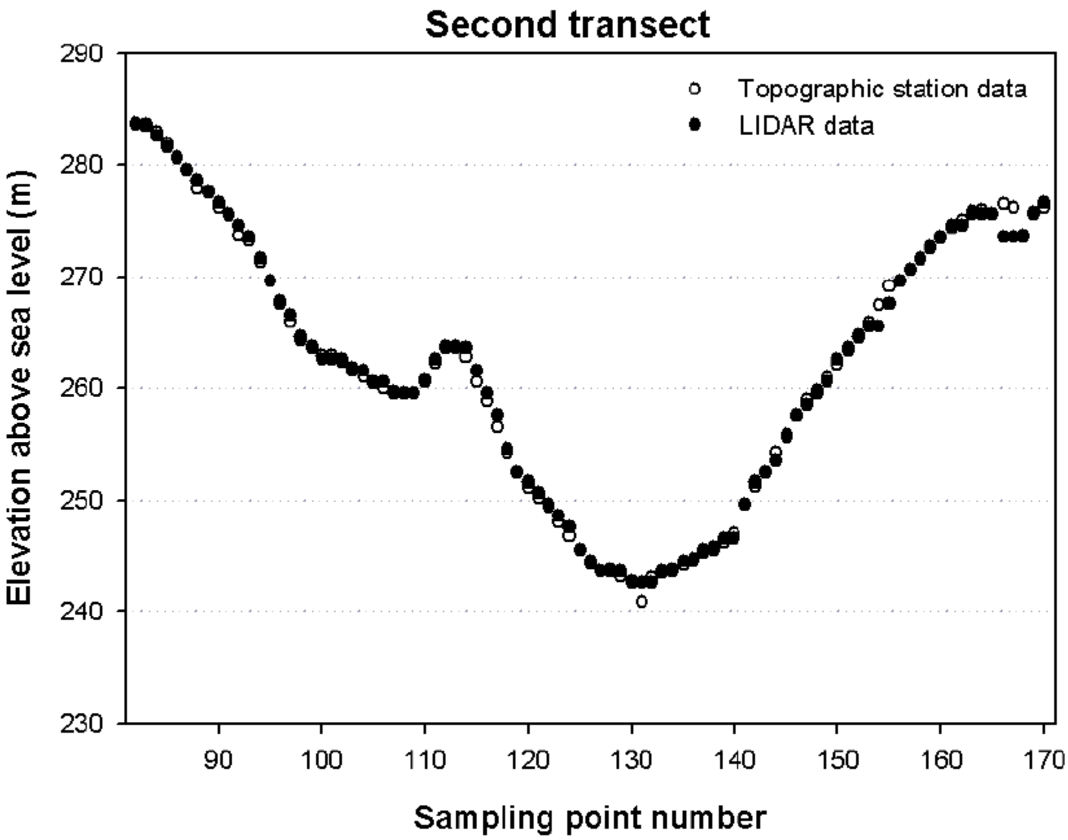

Figure 6: Elevation profile for the transect 2.

Table 3: Error distribution for transect 2.

Error range (m)	Error distribution (%)
0-1	93
1-2	5
2-3	2

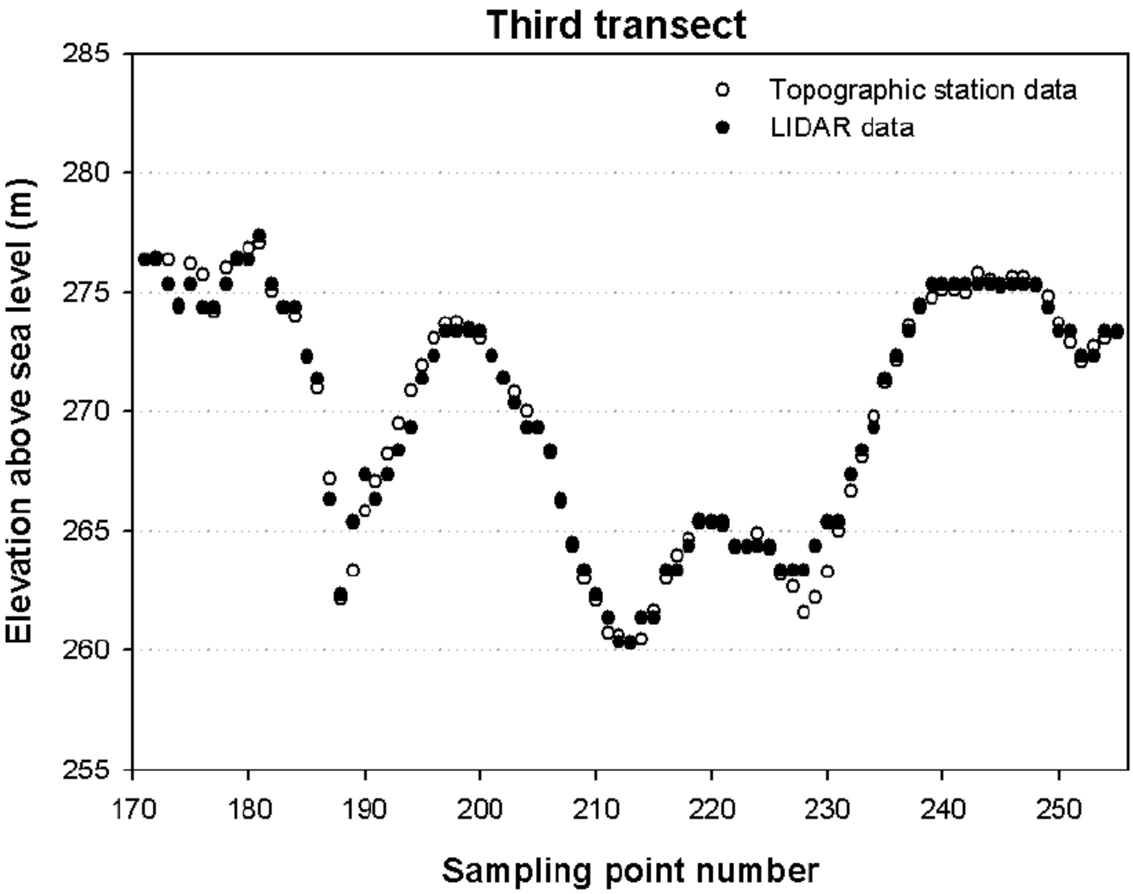

Figure 7: Elevation profile for the transect 3.

Table 4: Error distribution for transect 3.

Error range (m)	Error distribution (%)
0-1	91
1-2	6
2-3	3

Table 5: Total error distribution for the three transects.

Error range (m)	Error distribution (%)
0-1	92
1-2	6
2-3	2

5. Discussion

The results of simple statistical analyses indicate that the results were consistent and well taking. The GPS and topographic data sources are improved its quality because no forest was there at the ground measurement time. In this way we reduce the source of the errors from the ground measurements.

Others researchers work find that the effect of vegetation canopy covers which has different structure and several forest canopy levels are presented in the forest. In this case of our research, there was just one forest canopy cover planted at the same season, which has similar management and same plantation density without under canopy cover vegetation presented in there.

6. Conclusions

DTM LiDAR-derived data allow the recognition of ground morphology to assign with accuracy the forest harvest machinery allowing delineate harvest units for spatial forest planning.

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