



The Estimation of Extraction (Haulage) Distance for Forest Harvesting Using Terrain Model of 3D Virtual Globe of GoogleEarth®

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Determining the optimal logging systems for a timber harvest area is a difficult task because many considerations need to be taken into account including timber volume and distribution, terrain and environmental conditions, costs and productivity, and the existing road infrastructures.

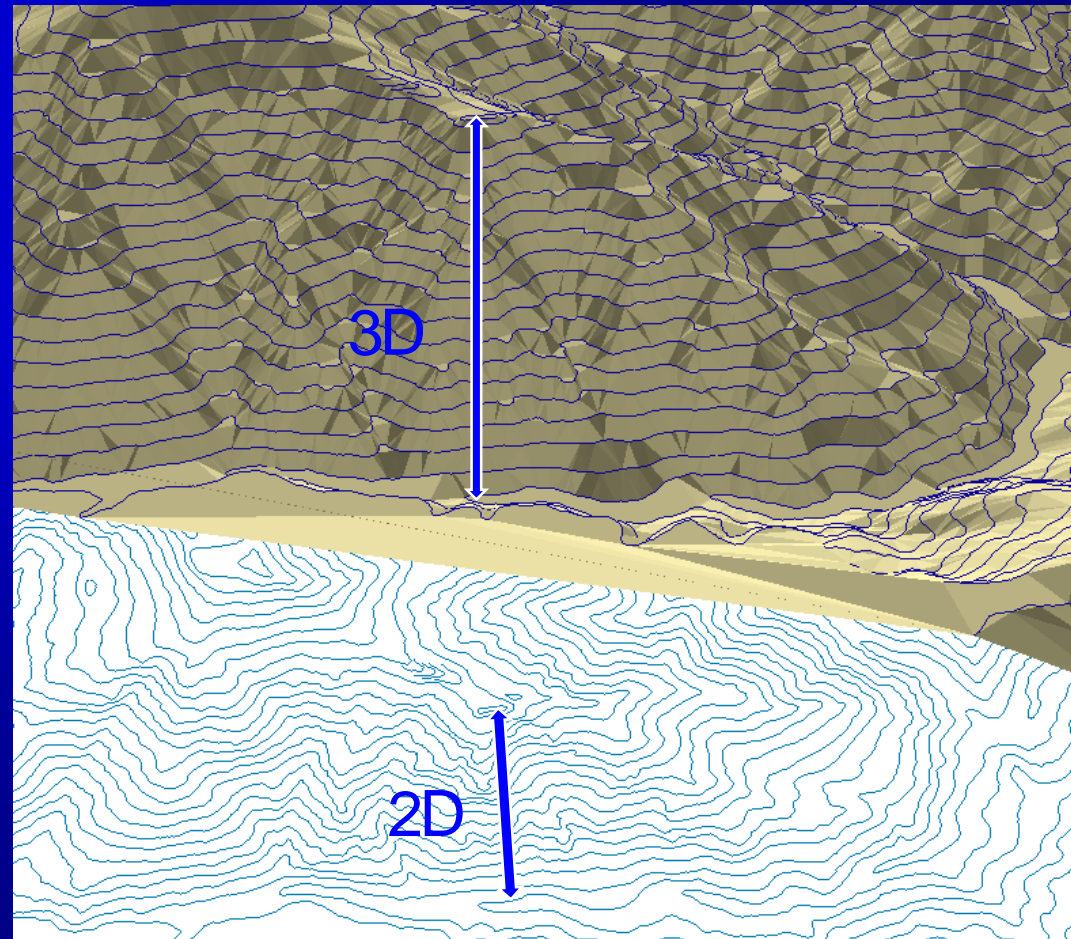
The best logging practices had three primary objectives in planning the logging operation: 1. reduce damage to the residual stand, 2. reduce unnecessary waste of timber, and 3. improve the efficiency of extraction operations.

One of the most important factors affecting extraction productivity is extraction distance. Extraction costs are primarily dependent on the applied skidding method and extraction distances.



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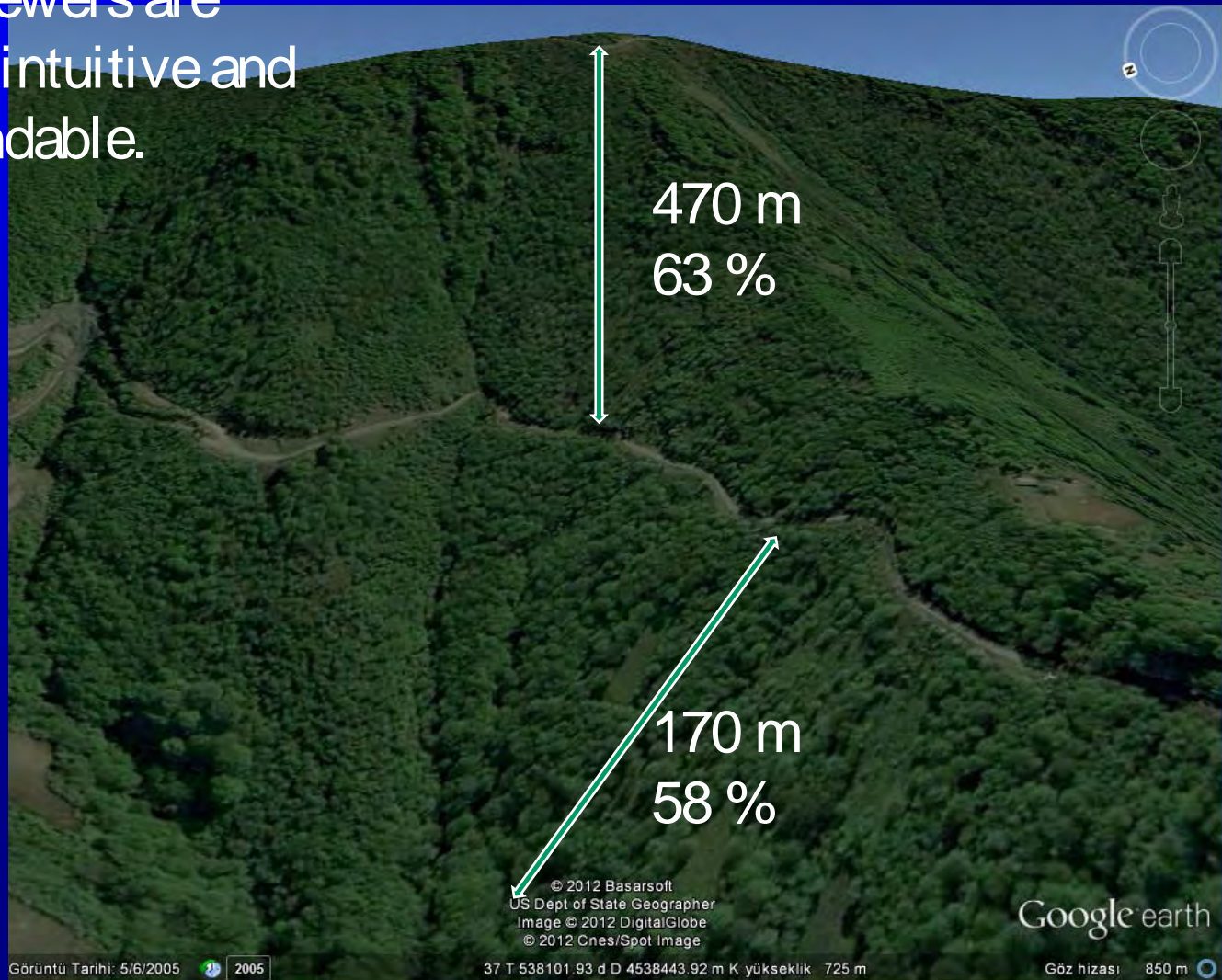
Accurate estimation of extraction distance is very important in logging planning for the success of forest harvest plans. In most of the recent studies, logging planning has been made on 2D planar maps or GIS environment using vector or raster data sets. 2D horizontal distance shows a different value from the actual value under influence of terrain slopes.





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Digital globe viewers are appealing, very intuitive and easily understandable.





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Geospatial data which can be operated online tools is becoming increasingly important for many uses, from expert scientific domains to social media interaction. Martinez-Grana and his friends have been presented a fast and efficient method for transforming traditional 2D maps to 3D maps using the tools available within the GE virtual globe.

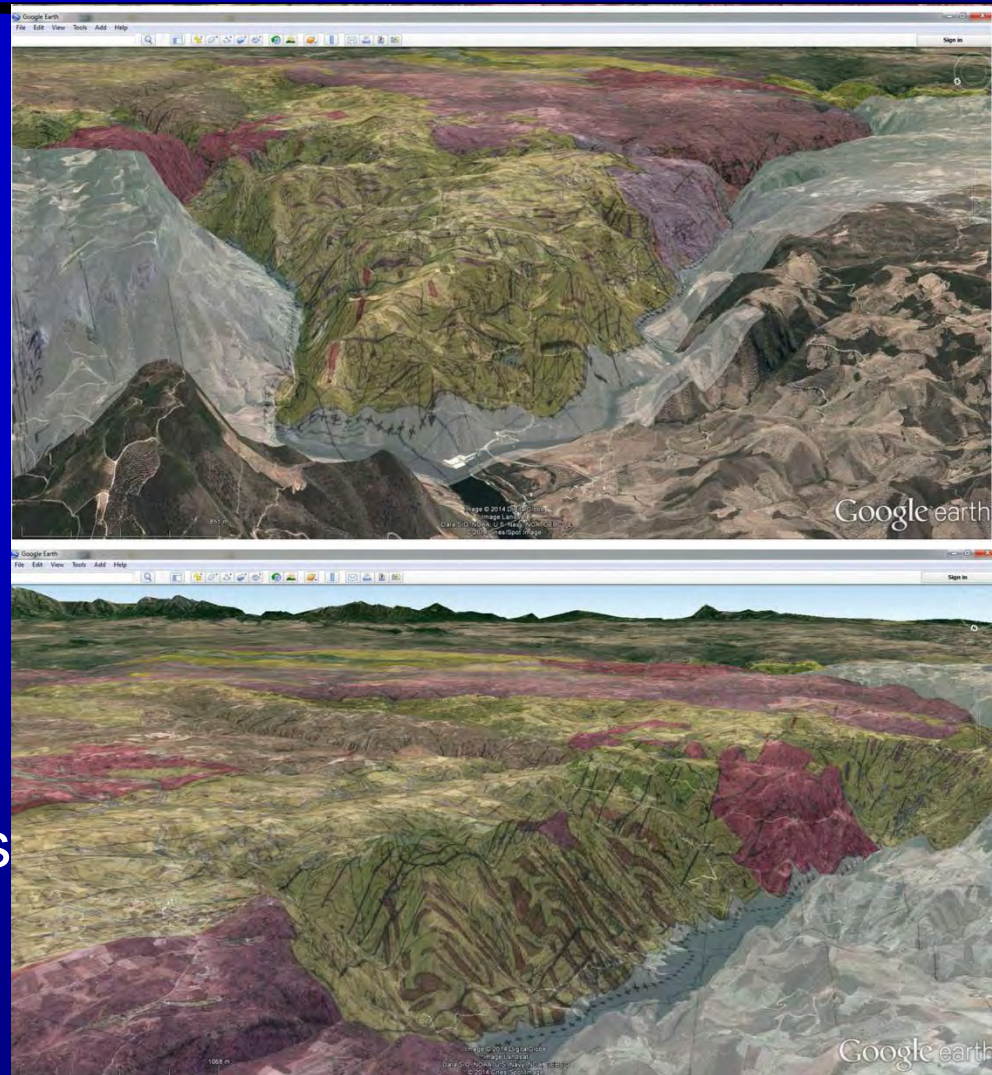
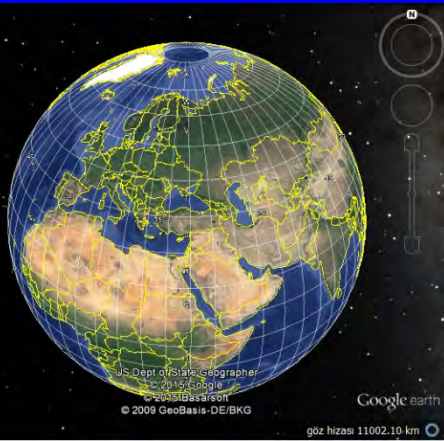


Figure: Martinez-Grana, A. M., Goy, J, Cimarra, L.,



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The GoogleEarth® service is the most well-known and used internet service that provides free-of-charge access to the global collection of georeferenced satellite imagery. GE now hosts high-resolution (0.5 meter) imagery allows human observers to readily discriminate between major natural land cover classes and to discern components of the human built environment, including; individual houses, industrial facilities and roads.



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In Turkey there is no official harvest planning and logging planning in universal sense. The maintenance and regeneration works of forest is carried out according to silviculture plans located in the forest management plans.

There is not any operational plan for the cutting work. In these planning that is required to enter at forest operations in the future the usage of the extraction distances, which can be measured easily, has represent ability of the forest land surface features and can be increased success of plans, are very important.





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What we do?

The aim of this study is evaluating of the usage of google earth 3D virtual globe data for determining of timber extraction distance will be used at logging planning.



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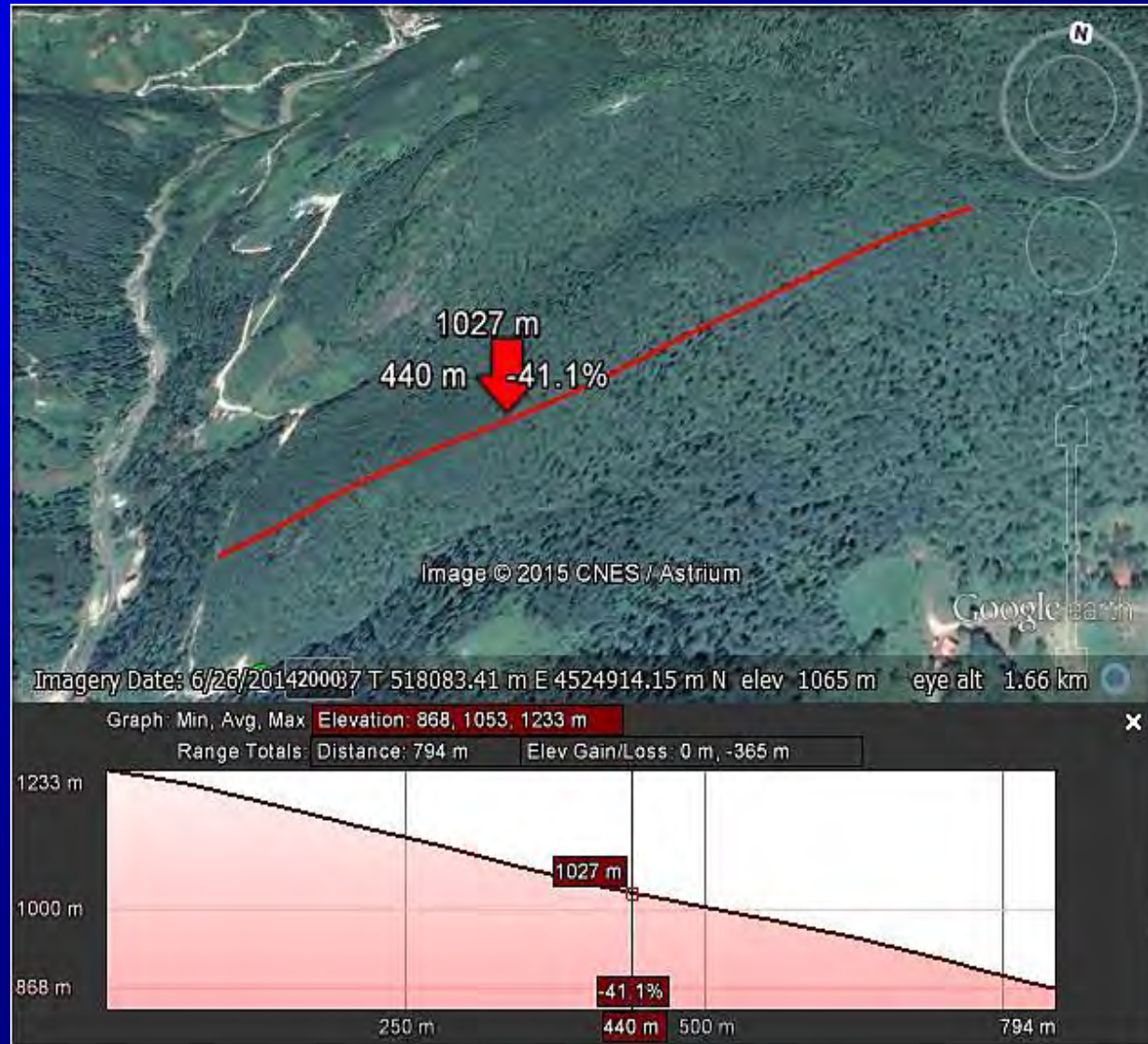


Figure 1 Sample plots locations at Netcad®GIS7 software used GE images



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3D Maximum Extraction Distance (MED) and Average Terrain Slope (ATS) were measured at the determined sample plots considering the closest forest roads. Firstly the extraction route were determined and designated using of the GE add-road module for measurement. After that, MED and ATS values captured by using show elevation profile module of GE of the designated extraction route and the values were recorded.





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Planner map distances (PMD) used at traditional logging plans were calculated by using of 3D MED and ATS values with trigonometric transformations.

In the last part of this study, extraction distance which was used for cost calculation of Turkey General Directorate of Forestry and 3D MED obtained from GE were compared with each other.

For this purpose, cutting compartments located at Eastern Black Sea region between 2010 and 2012 was determined and was sampled by examining of the official logging site records. The total number of the cutting area is 1089 at Eastern Black Sea Region. Trabzon RFH has 341 compartment, Giresun RFH has 324 compartment and Artvin RFH has 424 compartment.





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The following formula was used to determine the minimum number of samples.

$$n = \frac{N \cdot t^2 \cdot p \cdot q}{d^2 \cdot (N - 1) + t^2 \cdot p \cdot q}$$

In the equation:

N= EBSR cutting area number

n= sampling number

p= the possible presence percentage of a measured feature in the main body (this ratio has been approved as 50%)

q= 1-p

t= theoretical values in the table t at a certain degree of freedom and detected in 5% error level

d= desired \pm deviation





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The minimum sample number was calculated 285 with 95% confidence level at EBSR. 120 logging area files at Artvin RFH, 91 logging area files at Giresun RFH and 91 logging area files at Trabzon RFH was accepted as selected sample by taking into account of weighted average. The selection of the logging files was random.

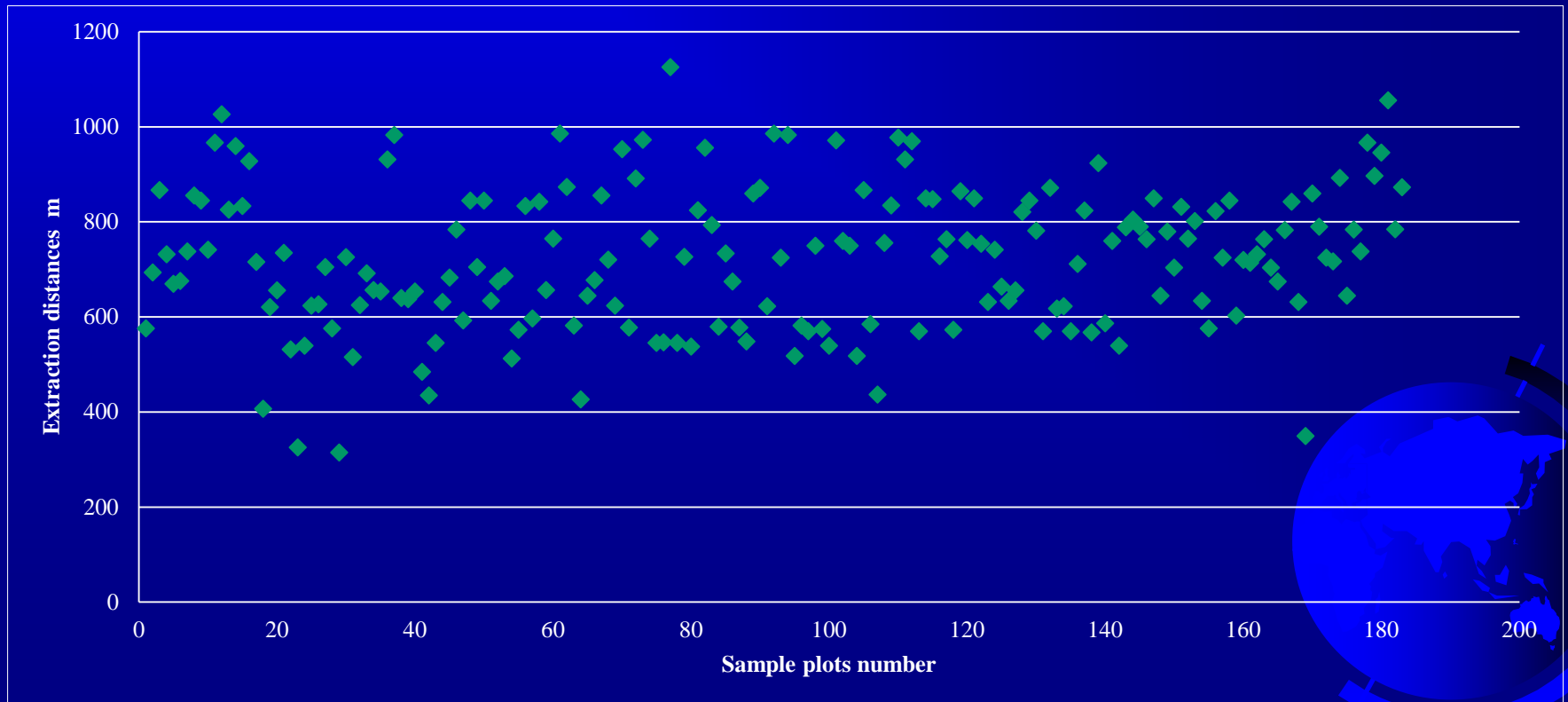




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Results and Discussions

The 3D MED measurement was made at 183 samples plot in the study area. MED has been found to vary from 315 m to 1126 m according to the results of measurements (Figure 3).





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Table 1 Measured and calculated extraction distances and slope gradient derivate form GE Virtual Globe

RFH	Sample Plot Total Number	ATS, %	3D MED, m	2D MED, m	Difference ratio, %
Artvin	43	76	686	547	20.3
Giresun	56	72	718	582	18.9
Trabzon	84	75	747	598	19.9
Avegare		74.2	716,8	575,7	19.7



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B.C. Ministry of Forests had defined terrain stability classes (B.C. Ministry of Forests 1999). Region forest lands can be classified as 5th class ($> 70\%$) very steeply sloping land.

Because of the very steeply sloping of the region's forested area, work here requires to be done more careful. The effect of the terrain slope constitutes 19.7% differences between actual terrain distances and measured from planar maps. So, the plan distance located between two points on the map is shorter 19.7% than the actual terrain slope distance.





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MED was determined 602 m in Artvin RFH, 616 m in Giresun RFH and 572 m in Trabzon RFH according to the data derived from number of 302 logging files that prepared for calculation of extraction costs by GDF.

Average extraction distance obtained from logging site records is 597 m. This value more than 2D planer map distance, but less than 16.7% from 3D virtual globe extraction distance. These values demonstrate the shortcoming of the harvesting systems, which are being implemented in Turkey.





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Conclusions

GE receives increasing interest every day from the environmental sciences all over the world and has been used in scientific studies with offered open source spatial data. In this study, GE 3D virtual globe and Netcad®GIS7 software were used and these software was found as capable to estimate the extraction distance.

According to the study results, the GE 3D MED was found as 716.8 m, 2D plan map MED as 575.7 m and GDF's MED used for the calculation of logging costs as 597 m at EBSR. 2D PMMED is shorter 19.7%, the rate cannot be neglected, than 3D MED for the logging planning. Beside this, AEM value, which was obtained from GDF's cutting operation that was not based on any foreground, was also found 16.7% shorter than its terrain distance.





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3D distances which can be easily measured, specified terrain features and has qualifications for improving the success of the plans should be preferred as a decision making data at the operational scale logging planning based on harvest plans.

Turkey GDF is not being used the harvest or logging plans at a conventional scale. Having very steep terrain classes according to the land capability class of EBSR forests, that contains a significant portion of the forests in Turkey, shows absolute need of preparing of the logging planning.





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THANK YOU FOR YOUR ATTENTION

