3D SHORELINE EXTRACTION USING ORTHOPHOTO AND LIDAR DATA

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ABSTRACT: Shorelines are complex ecosystems and vital socio-economic environments. They may change rapidly due to both natural and human-induced effects. Determination of movements along the shoreline and monitoring of the changes are indispensable for many purposes such as coastline management, agriculture, decision support systems etc. Thus, rapid, up-to-date and accurate information are required to monitor the shorelines. In this study, the Kestel Dam Lake has been selected for evaluation and testing of the methods which will be used for the research project, about shoreline extraction with use of UAV-Based LIDAR data in the region of Terkos-Istanbul, which supported by TUBITAK (The Scientific and Technological Research Council of Turkey) with project nr. 115Y718. Kestel Dam is located on the river of Kestel that is constructed for the irrigation purposes, built between 1983 and1988. Irrigation capacity of dam is about 4077 ha of agricultural areas. The used dataset is LIDAR data which is provided by HGK (Turkish General Command of Mapping). In this study, two different methods are applied with use of LIDAR data, acquired in 2013. One method is mean-shift segmentation and the other is Particle Swarm Optimization Analysis (PSO)**.** The results are both compared with manually created reference vector dataset which is created using orthoimage dataset. The results shows that the developed methods have potential to give success in the research project which will be performed in the region of Terkos which is the study area of the project.

1. INTRODUCTION

Coastal areas change rapidly due to both natural period and human effect. Since 1980s, tourism establishment, industrial areas and culture fishing activities which has so close to coastal areas, brought with uncontrolled and unplanned urbanization to the coastal area. Coastal areas are under the thread of many human activities. These are port and jetty constructions that are result of wrong decisions, filling the shorelines to create fields for urbanization, excavations for regulation, highway constructions and many more.

The most of conditions of shorelines where have interactions between atmosphere, hydrosphere and the Earth, are affected by seasonal changes or climate changes, therefore the changes along the shorelines have to be detected. The remote sensing technologies are useful for these purposes (Kabdasli, et al., 1997). The changes along the shorelines have been become a research topic for decades (Dornbusch et al., 2006; Marques, 2006; Pierre and Lahousse, 2006; Benumof and Griggs, 1999)

In this study, two methods are applied to extract the shoreline of the Lake Kestel. One is mean-shift based segmentation, and the other is Particle Swarm Optimization Analysis (PSO).

2. USED DATA & STUDY AREA

The used dataset in the study is LIDAR point cloud, acquired from 1200m height above from the ground. Kestel Dam Lake has been selected for evaluation and testing of the methods which will be used for the research project, about shoreline extraction with use of UAV-Based LIDAR data in the region of Terkos-Istanbul, which supported by TUBITAK (The Scientific and Technological Research Council of Turkey) with project nr. 115Y718. The ortho image was used to create the reference vector dataset for quality assessment purpose.

3. APPLIED METHODOLOGY

The intensity values of LIDAR point cloud data are converted to the raster form, and the holes in the data, are filled with the elevation values. The derived image has about 3 m resolution.

Two different methods are applied on this raster data set to extract the shoreline, one is mean-shift segmentation and the other is Particle Swarm Optimization Analysis (PSO).

3.1. Mean Shift Segmentation

Mean-shift method was firstly mentioned by Fukunaga and Hostetler (1975) and widely applied by various studies by different studies. The mean idea is the method is the dividing the image into the segments which have strong correlation. The method uses a search window which is assumed with having radius as kernel.

This kernel is shifted to the centroid or the mean of the pixels within the area until convergence. Monteverdi 1.24 open source freeware is used for the processes. The used parameters are Spatial radius: 11, Spectral value: 30, Min. Region Size: 1000. In this study, mean-shift segmentation is applied on the intensity values of LIDAR dataset. The results is shown in the Figure 1.

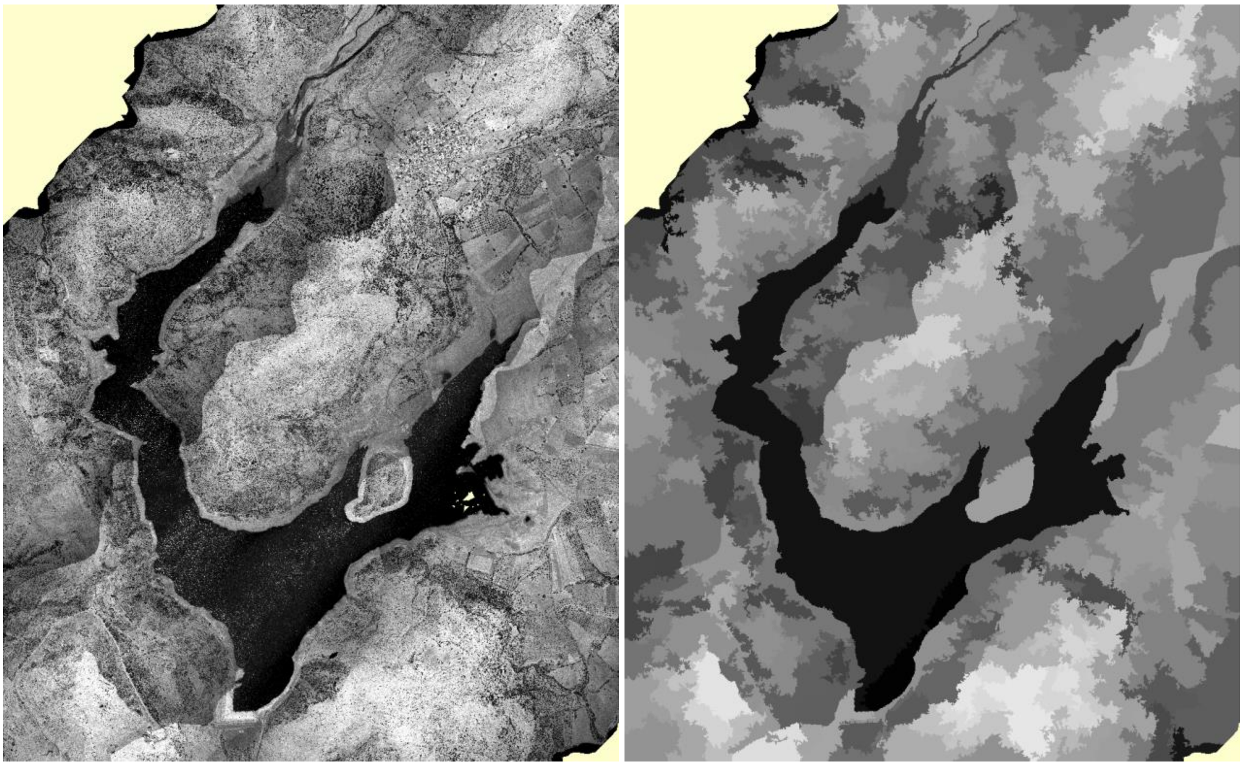

Figure 1. LIDAR intensity image (left), the segmentation result (black) from mean-shift method (right)

3.2. Particle Swarm Optimization Analysis (PSO)

The second method applied is Particle Swarm Optimization Analysis. It is developed by to Kennedy, Shi and Eberhart (1978) and the segments the image with consideration of the candidates' quality. Each candidate is moved and the position and velocity of the candidates are measured. In the algorithm, the best candidate position gives the best score for the quality.Here, again intensity based LIDAR image is used and the results are shown in the Figure 2.

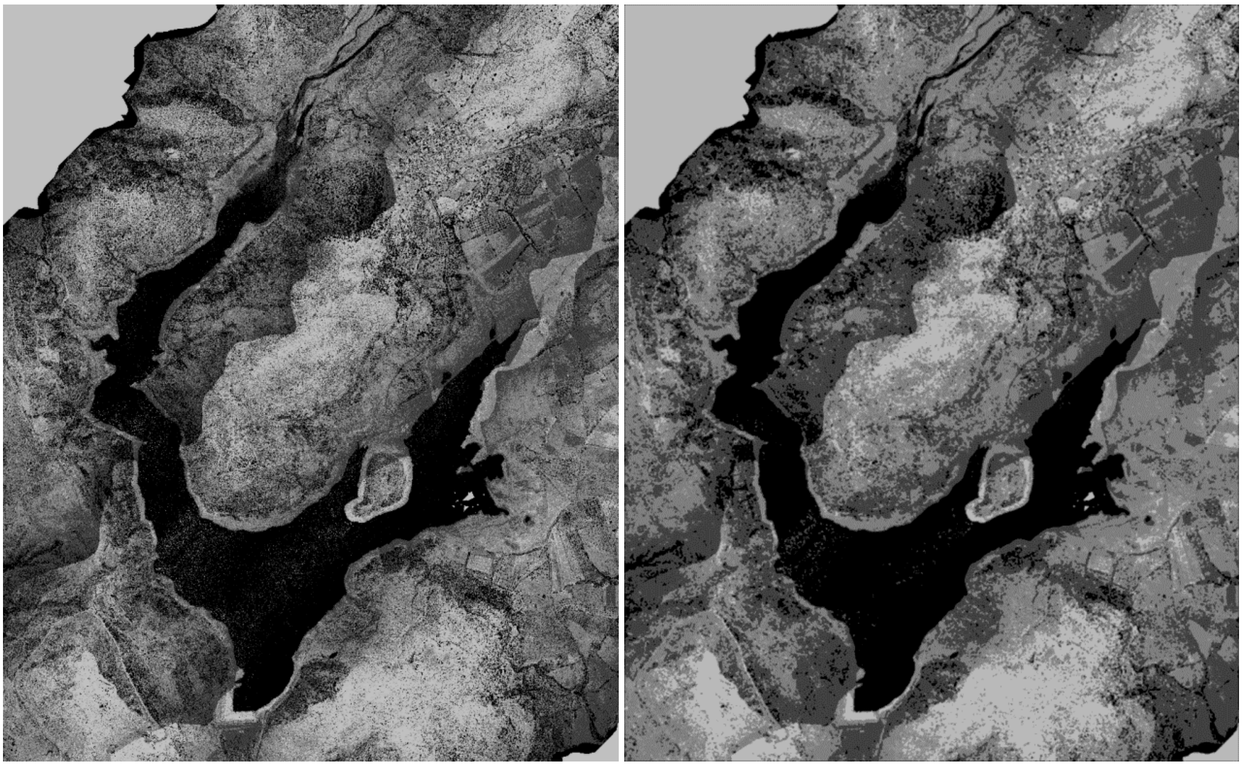

Figure 2. LIDAR density image (left), the segmentation result (black) from mean-shift method (right)

4. QUALITY ASSESSMENT

The results are evaluated with the manually created shoreline which is derived from the used orthoimage data. The assessment is performed with two different results from two different approaches. The quality values are calculated using the distances to the reference vector shoreline. Firstly, the each result is converted to the dense points along the shoreline in each 3 meters which is the resolution of the derived images those used in the extraction of the shoreline. Then, the perpendicular distance between each point to the reference shoreline is calculated. The statistics; mean, median and standard deviation are calculated for the all points along the results. The distance graphs are shown in Figures 3 and 4 and obtained are presented in Table 1.

a

b

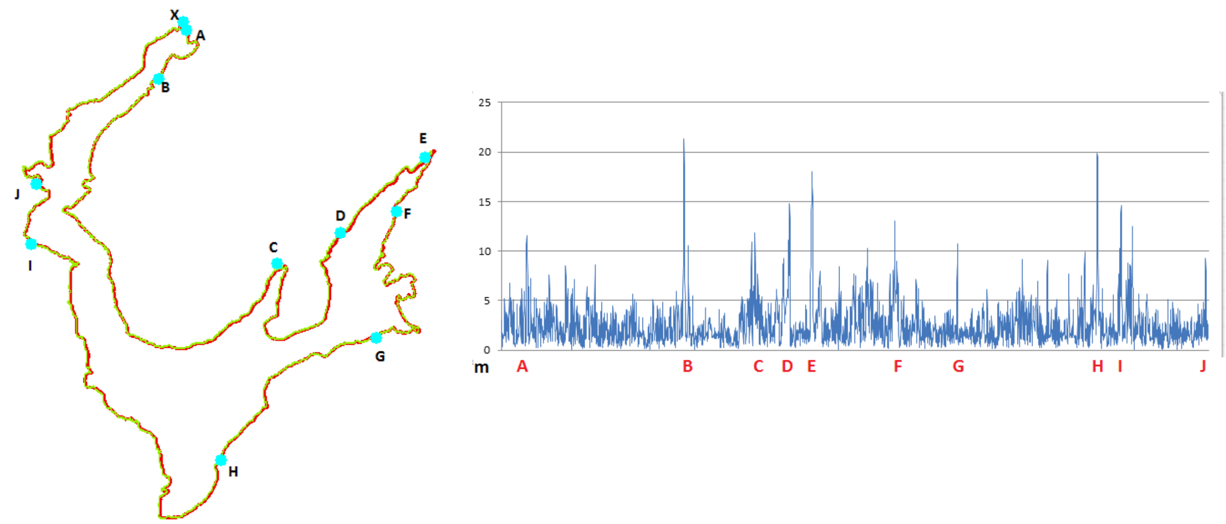

Figure 3. a.Shoreline result from mean-shift method(green), reference vector (red). b.The perpendicular distances between points along the shoreline and the reference vector. The locations shown in the graph b.

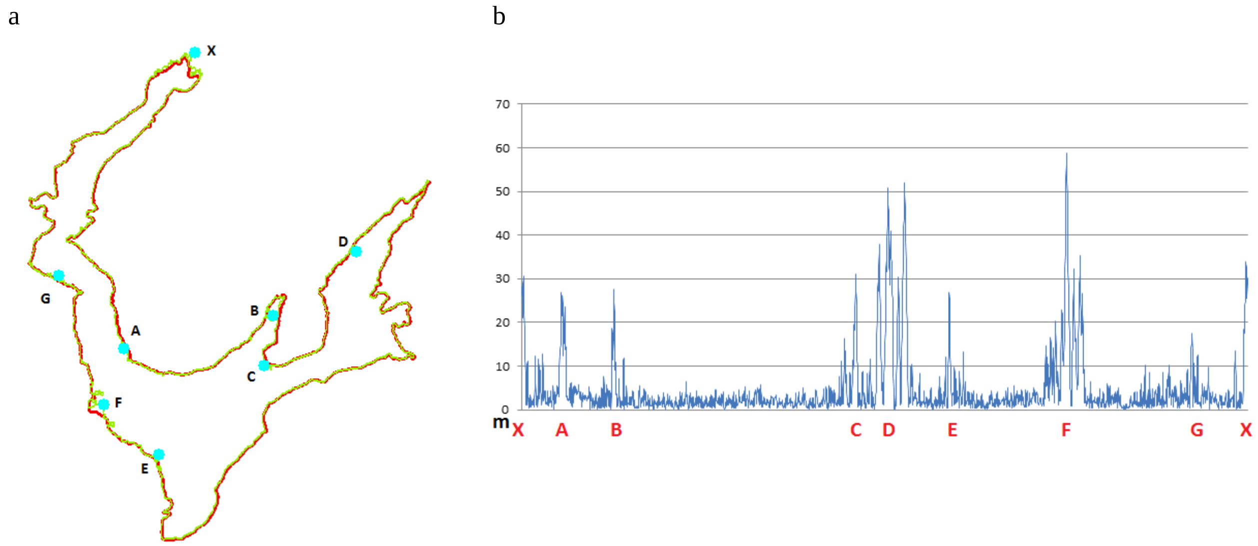

Figure 4. a) Shoreline result from POS method (green), reference vector (red). b) The perpendicular distances between points along the shoreline and the reference vector. The locations shown in the graph b.

Figures 3 and 4 displays both reference vector dataset and the extraction results. The perpendicular distances between points created along the shoreline results and the reference vector data are also shown in the right sides. Some locations are marked on the graphs for better understanding of the quality assessment results.

Table 1 Quality values for two applied methods

	Mean-Shift	PSO
Mean	2.55	4.69
Median	1.97	2.23
Standard Deviation	2.11	7.34

Regarding the mean-shift method, the mean, median and standard deviations show that the difference between reference vector dataset rely under 3 m which is the resolution of the derived images to be used in extraction. Some locations reach up to 20 m. The results from the second method is worse than the first method, but also promising with mean value of 4.69 m, median is below 3 m and the standard deviation is about 7 m. There are some parts have a significance differences with reference dataset such as D, E and F, which they affect the quality values negatively.

5. CONCLUSIONS

In this study, two different methods are used to extract the shorelines from LIDAR and orthoimages. The selected methods have significant capability for extraction and the assessment shows us both LIDAR and orthoimage datasets are promising to derive the shorelines automatically. The mean-shift method have only one pixel difference between the reference vector data, while the second method has about 1.5 pixel in the mean value.

The results show that the extraction from LIDAR has big potential using the mean-shift method with intensity image of the data, which will be implemented in the TUBITAK project. In this study, the Kestel Dam Lake has been selected for evaluation and testing of the methods which will be used for the research project, about shoreline extraction with use of UAV-Based LIDAR data in the region of Terkos - Istanbul, which supported by TUBITAK (The Scientific and Technological Research Council of Turkey) with project nr. 115Y718. The results shows that the developed methods have potential to give success in the research project which will be performed in the region of Terkos.

In the future work, the fusion of datasets and the other data sources such as SAR, can be integrated for elimination of the bulk errors especially in the areas which has low separability between land and water surface where both LIDAR have poor performance.

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