An Investigation of Coastal Zone Change on the Zonguldak Hard Coal Basin Depending on Developing Industry since over a Century

Hakan S. Kutoglu, **Kurtulus S. Gormus**, **Murat Oruc**, **Sayim Ongel and Simsek Safak, Turkey**

Keywords: Coastal zone change, topographical map, satellite image, history.

SUMMARY

In this study, the coastal zone change around the Zonguldak hard coal basin of Turkey are investigated based on a French map produced a century ago and actual satellite images. The results obtained shows that the coastal zone around the Kozlu region dramatically changed in time. This map coming from the history not only answers our questions but also bridges our French and Turkish cultures.

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1. INTRODUCTION

Zonguldak located on the western coast of Black Sea is the first province of Republic of Turkey. Urbanization in this young city first started in the last term of the Ottoman Empire with the hard coal mining starting in 1848. In that term, the Ottoman Empire assigned the mining rights in the basin to French companies. Republic of Turkey established in 1923 nationalized the coal mines, and assigned the rights to Eregli Coal Enterprise whose today's name is Turkish Hard Coal Enterprise (Tamzok, 2008; Quataert, 2009).

Zonguldak has a steep topography covered dense forests, and unsuitable for settlement. Mining facilities were therefore planted near the coast lines, and mine wastes were charged into sea for gaining area. This process carried on until the 1990's. Mine wastes are now stored inland areas, but other excavations are still utilized for filling the sea.

As a result, the coast line of Zonguldak progressively changed in time. Today, there are plenty of structures on these areas. Whereas the zoning law of Turkey restricts structuring in coastlines. This fact has been caused law cases between citizens and government. The main problem in these cases is that the historical coast line is a controversial issue.

Fortunately, a topographical map produced by French at the beginning of the 1900's was discovered in the archives. This map which is a masterpiece of surveying was interpreted with the Ikonos image of the region acquired in 2008. Then, the historical coast line and amount of the filling areas were determined. Consequently, this historical map coming out from time tunnel was not only ended controversy but also bridged the French and Turkish cultures.

2. DATA USED

Fig. 1 shows the historical topographical map of Zonguldak hardcoal basin. The scale of the map is 1:10000. The topography of the basin is represented by the height contours per 10 meters in the map. In addition, it illustrates the seaport, industrial facilities and some other buildings used in 1900s. This map was scanned in resolution of 150 dpi, and stored in 24 bit TIFF format for investigating the coastal zone change.

The other data used for the investigation are the Quickbird and Ikonos satellite images acquired in 2004 and 2008, respectively. Ground sampling intervals of the images are 0.60 m for Quickbird and 1 m for Ikonos panchromatic.

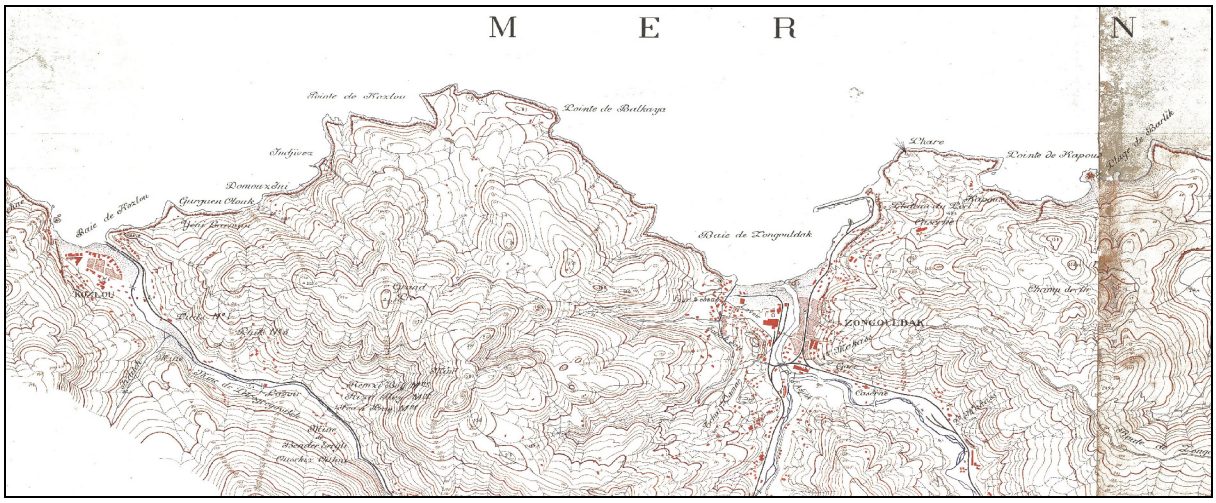
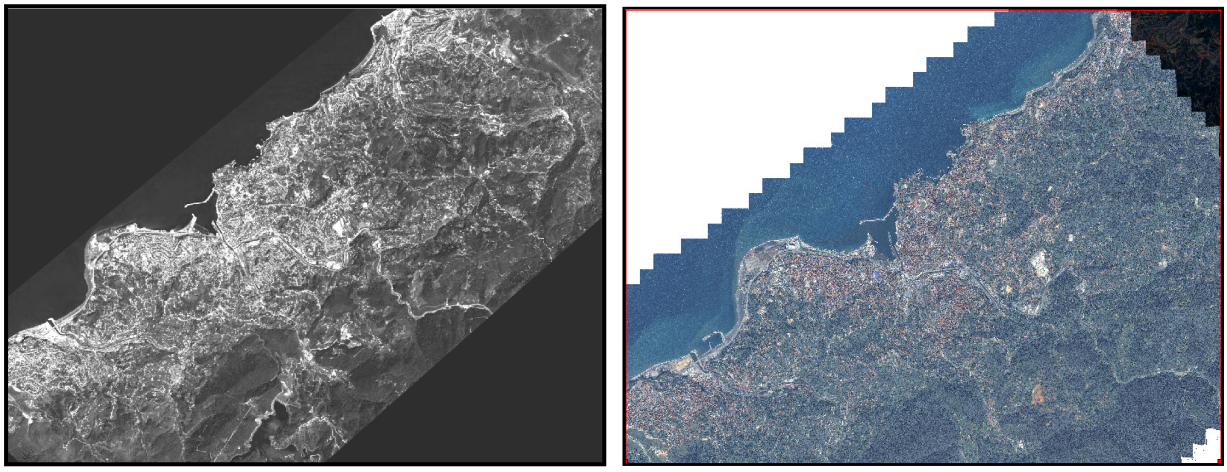


Figure 1. Historical topographical map of Zonguldak hard coal basin produced by French.



(a) (b)

Figure 2. (a) Quicbird image acquired in 2004. (b) Ikonos image acquired in 2008

3. DATA PROCESS

The 2004 Quickbird and 2008 Ikonos images were geometrically corrected using 59 Ground Contol Points (GCPs) observed by RTK GPS technique (Fig. 3). The horizontal precisions of the GPS-obtained coordinates varied from ± 6 cm to ± 50 cm, and the geometric correction resulted in precision of < 1 pixel. The satellite images were related into ITRF which is the conventional terrestrial reference system (Topan et al., 2007).

To match the historic map with the satellite image, a coordinate transformation has to be applied for the map. For that purpose, there is a need common details existing not only in the satellite data but also in the historic map. By a diligent endeavor, eighteen historic facility and building having still been standing on the ground were found out in the basin (Fig. 4). Using the coordinates of these details, the map was transformed into the same coordinate system as the satellite images by an affine transformation with the precision of 38.14 m.

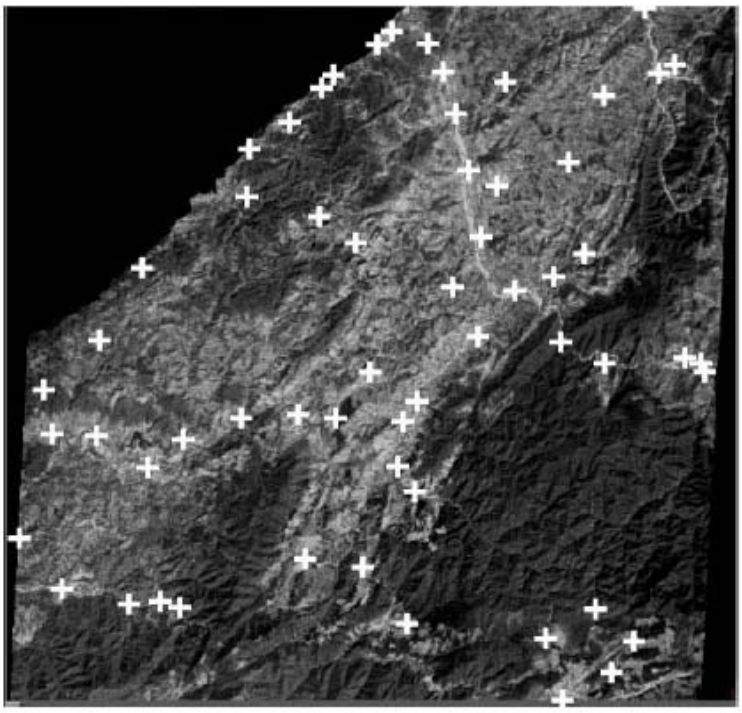


Figure 3. Ground control points over the study area.

Figure 4. Some historic buildings standing on the ground (Akcin et al., 2009).

4. COASTAL ZONE CHANGE

The transformed historical map and the geometrically corrected satellite images were combined in the CAD environment using NetCAD 5.1 software, and temporal coastlines were vectorized from the raster data.

Fig. 5 shows the comparison of the 1900s coastline with the one from 2004 Quickbird. There, the red line shows the coastline in 2004 while the blue one in 1900s. As seen from the figure, a remarkable changes occurred in the coastline around the Kozlu region durin a century. There are fills in the sea varying from 20 m 450 m. Another significant change is seen in the city centre. This change caused by seaport construction composes of 0.12 km^2 fill and 0.025 km^2 land loss. The total changes are 0.83 km^2 fill and 0.14 km^2 loss.

Figure 5. Coastline change between 1900-2004

Şekil 6: 1900-2008 Mesafe Karşılaştırması

After 2004, the only significant is caused by the seaport built in the Kozlu region. The amount of the changes are 0.03 km^2 fill and 0.01 km^2 loss.

5. CONCLUSION

The analyses in this study show that the coastline in the Zonguldak hard coal basin dramatically changed in the last century especially around the Kozlu region. Table 1 summarizes the amount of the changes.

Table 1. Temporal change in the coastal area

Years	Fill (km^2)	Loss (km^2)
1900-2004	0.83	0.14
1900-2008	0.87	0.15

Those areas gained from the sea are restricted for structuring. However, there was a lack of a scientific proof exposing the coastline in the past. Fortunately, we have the French map coming from the past. This map not only answers our questions but also bridges our French and Turkish cultures.

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BIOGRAPHICAL NOTES

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