Implementation of GIS for Landforms of Southern Marmara

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Landforms

- Landform term as used to denote a portion of the earth that unites the qualities of homogeneous and continuous relief due to the action of common geological and geomorphological processes
- Landforms are natural features such as mountains, hills, lakes, plains, valleys, terraces, stream fans, etc

Landforms

http://rst.gsfc.nasa.gov/Sect2/landforms.jpg

Landforms & GIS

- Generally in classical GIS
  - Mountain, hill and plain features are represented by points
  - Valleys, terraces, fans haven't been represented
- Hillside effects and the other perspective views are mostly being represented by the contour lines, TIN or DEM

Geomorphometry

- Subdiscipline of geomorphology
- Its object the quantitative and qualitative description and measurement of landform and is based, principally, on the analysis of variations in elevation as a function of distance
- A basic principal underlying geomorphometrics is that there exists a relationship between relief form and the numerical parameters used to describe it, as well as to the processes related to its genesis and evolution

Geomorphometry & Landforms

- Derivation of landform units can be carried using various approaches
  - classification of morphometric parameters
  - filter techniques
  - cluster analysis, and multivariate statistics
- Morphometric studies usually begin with the extraction of basic components of relief
  - elevation, slope, and aspect
- A more complete description of the landform may be achieved by using spatial derivatives of these initial descriptors
  - the topographic wetness
  - stream power index
  - aggradation and degradation index
- Currently, geomorphology frequently relies on DEM as the information base from which both the basic components and indicators are extracted

Determination of the landforms

- Automatic or semiautomatic algorithms and results
  - Weiss 2001; Dehn et al 2001; Shary et al 2002; Burrough et al 2000; Schmidt et al 2004; Bolongaro-Crevenna et al 2005; Jordan et al 2005; Drăguț et al 2006; Prima et al 2006; Iwahashi et al 2007; Deng et al 2007; Klingseisen et al 2007; Arrella et al 2007; Minár et al 2008 ....

And the research

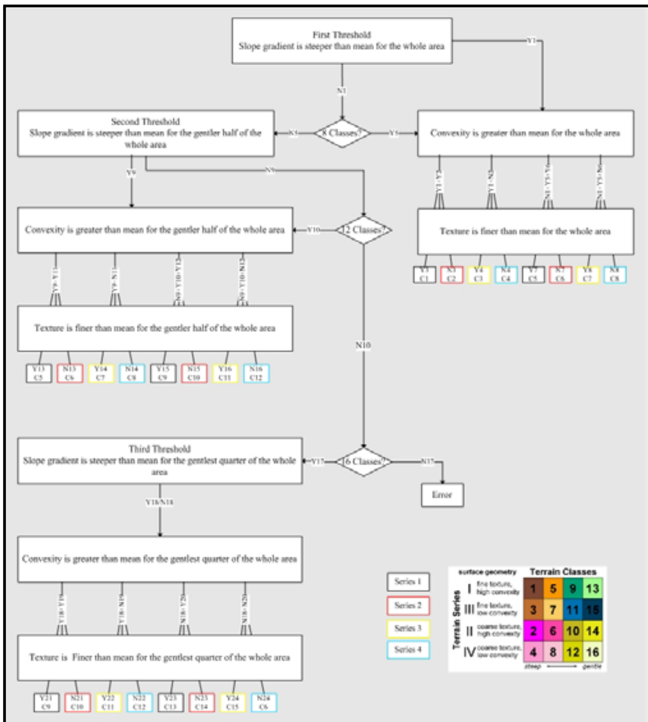
- it is aimed to examine and present the results of the model application, which was developed by Iwahashi and Pike (2007), for landforms located at Southern Marmara
- This region is selected for this study, since Southern Marmara is being threatening by disasters caused by tectonic reasons of NAF’s southern branch

Method

- An iterative procedure that implements the classification of continuous topography was developed by Iwahashi and Pike (2007)
- Three taxonomic criteria
  - slope gradient
  - local convexity
  - surface texture

- The surface curvature (local convexity) is measured by using the 3×3 Laplacian filter, an image processing operation that is used for edge enhancement and approximation of the second derivative of elevation
  - positive values in convex-upward areas
  - negative values in concave areas
  - zero on planar slopes
- Local convexity at each grid cell was calculated as the percentage of the convex-upward cells within a constant radius of ten cells

- Terrain texture (frequency of ridges and valleys or roughness), the measure is to emphasize its fine-versus coarse expression of topographic spacing, or grain
- Texture is calculated by extracting grid cells that outlines the distribution of valleys and ridges in the DEM. These cells are identified from differences between the original DEM and a second DEM derived by passing the original through the median filter; the filter is a nonlinear image-processing operation that removes high-frequency spatial “noise” from a digital scene by replacing original values with a value of central tendency, here the median, computed for each 3×3 neighborhood.
- Terrain texture at each grid cell was calculated as the number of pits and peaks within a radius of ten cells



The AML routine was converted to ArcGIS 9.2 Model Builder application for the study

AML Programı

```
AML program for automated classification of topography
/* by Junko IWAHASHI, Geographical Survey Institute of Japan
/*    October, 2005
/* usage
/*  Arc: &r ACT.aml
/* data needed:
/*      dem: DEM image (Arc/INFO GRID format); NODATA area must be defined
/*           for waterbodies
/*      laplacian: kernel file (ASCII text) for 3*3 laplacian filter
/*      classnumber: ASCII number (8, 12 or 16)

&setvar dem := [response 'Enter a grid to be classify']
  &if ^ [exists [dem100m] -GRID] &then
    &return &inform Grid does not exist.
&setvar classmap := [response 'Enter an output grid']
  &if [exists %classmap% -GRID] &then
    &return &inform Grid already exists.
&setvar laplacian := [response 'Enter a laplacian 3*3 kernel']
  &if ^ [exists C:\proje\pike\laplacian.ker -file] &then
    &return &inform File does not exist.
&setvar classnumber := [response 'Enter number of classified categories 8,12 or 16']
 &if %classnumber% = 8 or %classnumber% = 12 or %classnumber% = 16 &then
  &do

   &type [dem100m] will be classified into %classnumber% categories ...

   GRID


   /*making slope image
   simg = slope ([dem100m],degree)

   /* making convex area image
   img1 = con ( focalmean ([dem100m],weight,C:\proje\pike\laplacian.ker) > 0, 1, 0)
   convex = focalmean (img1,circle,10)
   kill img1 all

   /* making pits and peaks distribution image
   img2 = focalmedian ([dem100m])
   img3 = float ( con ( ([dem100m] - img2) > 0,1,0) + con ( (img2 - [dem100m]) > 0,1,0) )
   kill img2 all
..............................................
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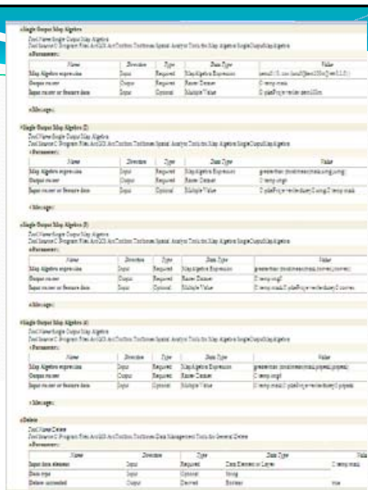
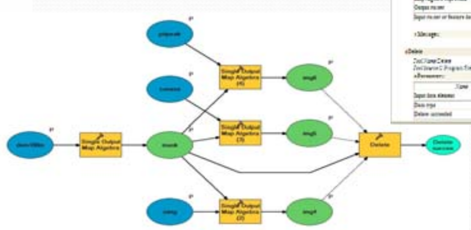
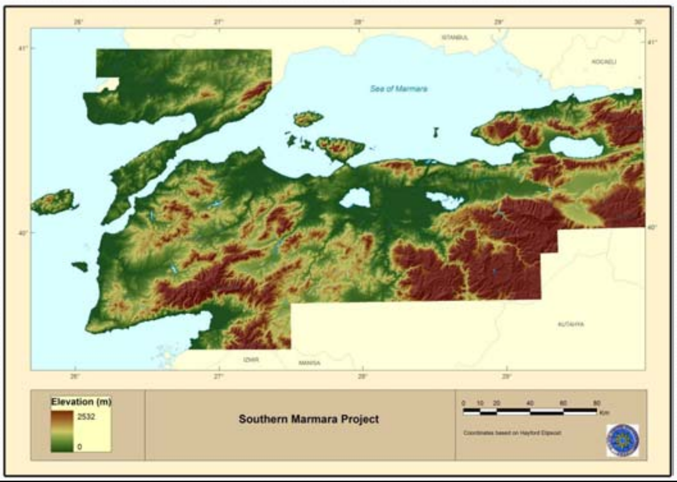


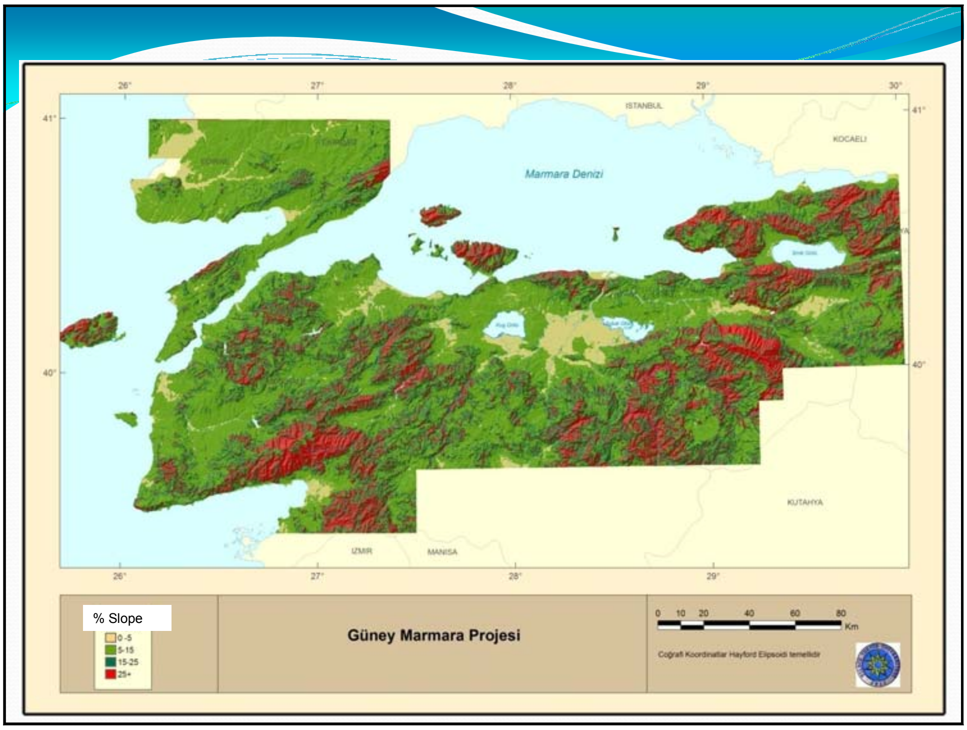


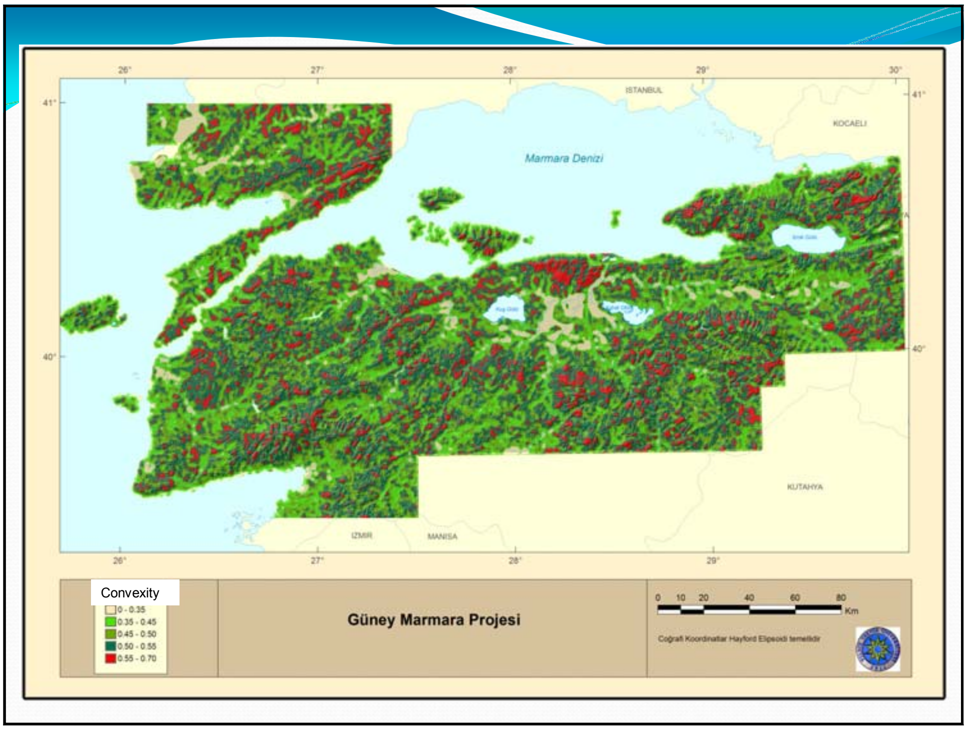
Study Area

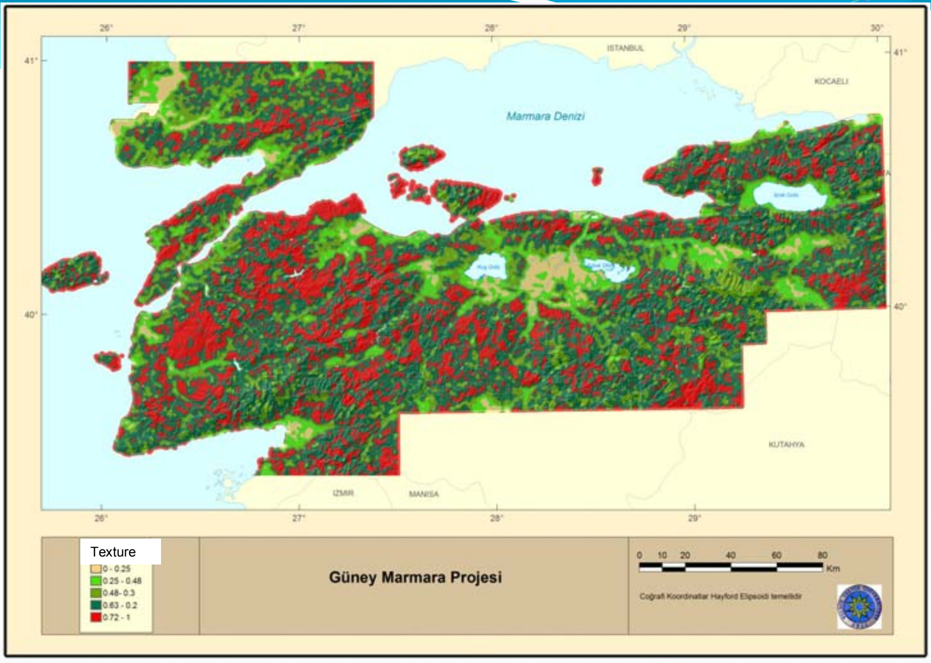
- Southern terrestrial zone of Sea of Marmara
- This zone is covered by shoreline between the Biga Peninsula and the Dardanelles coastal area
- Northern boundary constitutes southern shore of Sea of Marmara, and southern boundary consolidates the line along Bilecik and Edremit Bay
- Since the area, with approximately 29.500 km^2, is quite active from the seismic point of view, morphological units are mostly being constituted under control of tectonics. However, active tectonics of the zone is being controlled by NAFZ

- DEM with 100 meters grid size is derived from the contour lines with the conversion tools of ArcGIS 9.2
- The contour data used in the project were obtained from General Command of Mapping



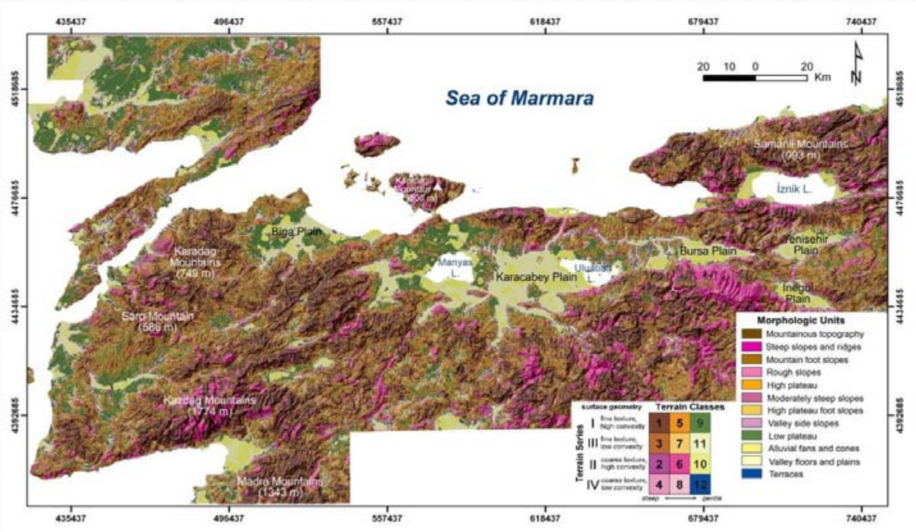

ISTANBUL
KOCAELI
Marmara Denizi
KUTAHYA
IZMIR
MANISA
% Slope
0 -5
5-15
15-25
25+
Güney Marmara Projesi
0 10 20 40 60 80
Km
Coğrafi Koordinatlar Hayford Elipsoidi temellidir


ISTANBUL
KOCAELI
Marmara Denizi
KUTAHYA
IZMIR
MANISA
Convexity
0 - 0.35
0.35 - 0.45
0.45 - 0.50
0.50 - 0.55
0.55 - 0.70
Güney Marmara Projesi
0 10 20 40 60 80
Km
Coğrafi Koordinatlar Hayford Elipsoidi temellidir



- Both of the results of 12 and 16 classes classifications are evaluated together, and morphological unit boundaries are described for 12 classes
- Eventually, three macro morphological element, six distinctive hillside zones and alluvial fan and cone are automatically assigned to derived

Classified Landforms



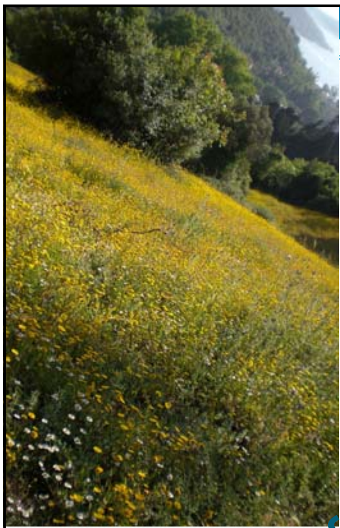
- The results of the method were significant for the study area
- According to the inference of the evaluation of the zone, there are both large and small shore plains at the north and south; and there are hilly, plateau areas and mountainous areas are located behind the shore plains. It is also revealed that there are also inter mountain plains as well as the macro morphological units

Conclusions

- Boundaries of landforms such as mountain, hill, valley and plain haven't been stored as polygonal or line type vector features in GIS based on topographic maps, in generally. Impressions for hillsides and the others are viewed by the contours or TIN. DEMs are also be used for giving landform impression on the screen
- This study proves that the landforms can be described in raster formats; consequently, they can be also converted to vector data formats in geodatabases when necessary

Conclusions

- The model which was developed by Iwahashi and Pike (2007) is implemented for the classification of landform in Southern Marmara instance by using DEM with 100m grid
- In this respect three different classification methods are applied, and result maps are prepared for the relevant classification system. The landforms are created in raster format via GIS tools, and results of this model are found very significant when compared to the reality



Thanks for your attention