DYNAMIC ENVIRONMENTAL FORECASTING MODEL IN GIS,
BEYKOZ AND SARIYER CASE STUDIES

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The Aim of this paper is to analyse urban spread and deforestation in Istanbul Metropolitan Area. Black Sea forests in northern part of Istanbul Metropolitan Area, Beykoz District, is selected as the case study area. Data related with a time interval of ten years as of 1985, 1995, 2005 are gathered via sattelite images and vector maps. The data of 2012 are also interpreted in order to update the situation.
Aim of the Study 2

- Forest lands around Istanbul Metropolitan Area are under constant threat of urbanization.
- However, the rate and speed of this threat is not stable and always are subject to external effects such as changes in legislation, urban plans, land values, and some large scale urban projects etc.
• Istanbul is located in northwestern Turkey within the Marmara Region.

• The Bosphorus, which connects the Sea of Marmara to the Black Sea, divides the city into two parts between Europe and Asia. The city is further divided by the Golden Horn, a natural harbor bounding the peninsula where the former Byzantium and Constantinople were founded.

• Istanbul metropolitan province (municipality) had a population of 13.26 million as of December, 2010, which makes 18% of Turkey's population and İstanbul is the 3rd largest metropolitan area in Europe after London and Moscow.

• The total area of Istanbul province is 5,343 square kilometers (2,063 sq mi).
In the 2012 year which lost the attribute of the forest land issued by the low sold out by government.

This area removed from the forest.

Lost the attribute of the forest land is 14.436 ha.
Environmental Concern

The forests in north of Istanbul are under big pressure with rapid and uncontrolled urbanization.
Transformations and Expansion

Urban sprawl

Forest

Urban sprawl

Urban expansion are stretching toward the hill around the Bosphorus and the forest regions on the Black Sea.
The Metropolitan Istanbul; 1950, is the major turning point of rapid urbanization and beginning of the mass scale urban transformation.
The building of Bosphorus Bridge: 1971.

Analysis

- Development of the built up area
- Transformation of Forest
Metropolitan Area of Istanbul

Development of built up area
Deforestation between 1985-1995

Legend
- District Boundary
- Land Use
  - Water
  - Other
  - Forest Areas
- Mis Use of Deforestrated Areas
  - Barren
  - Urban
  - Military
  - Industry
  - Agriculture
Deforestation between 1995-2005

Legend
- District Boundary

Land Use
- Water
- Other
- Forest Areas

Mis Use of Deforestrated Areas
- Barren
- Urban
- Military
- Industry
- Agriculture
Deforestation between 2005-2012

Legend
- District Boundary

Land Use
- Water
- Other
- Forest Areas

Mis Use of Deforestrated Areas
- Barren
- Urban
- Military
- Industry
- Agriculture
Deforestation between 1985-2012
Model

Forecasting future trends of urban land use change; Logistic Regression
Using Logistic Regression to explore urban dynamics

• Traditional statistical analysis techniques such as multiple regression and logistic regression are still widely used in pattern modeling. Over the last decade the logistic regression model has become in many fields the standard method of analysis.

• The technique have been used effectively in seeking some determining variables for the occurrence of certain spatial phenomena such as urban development.
The general form of logistic regression

\[ y = a + b_1 x_1 + b_2 x_2 + \cdots + b_m x_m \]
\[ y = \log_e \left( \frac{P}{1 - P} \right) = \text{logit}(P) \]
\[ P = \frac{e^{a+bX}}{1+e^{a+bX}} \]

\( x_1, x_2, x_3, \ldots, x_m \) are explanatory variables (independent), \( y \) a linear combination function of the explanatory variables representing a linear relationship.

The parameter \( b_1, b_2, \ldots, b_m \) are the regression coefficients to be estimated.

The \( P \) means the probability of occurrence of a new unit.

In Logistic regression dependent variable could be binary or categorical.

The independent variables of logistic regression could be a mixture of continuous and categorical variables.
Study area divided into 50m x 50m cells and all variables are created via the spatial analyst module in ArcView 9.2 based on 50m 50m cell size.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variables</td>
<td>Binary variable</td>
</tr>
<tr>
<td>Yapılaşma var</td>
<td>1 Built-up area</td>
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<tr>
<td>Yapılaşma yok</td>
<td>0 not</td>
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<tr>
<td><strong>Independent variables</strong></td>
<td></td>
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<tr>
<td><strong>Proximity factors</strong></td>
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<tr>
<td>merkez</td>
<td>Continuous variable, distance to major centers.</td>
</tr>
<tr>
<td>mia</td>
<td>Continuous variable, distance to CBD.</td>
</tr>
<tr>
<td>ikimerk</td>
<td>Continuous variable, distance to minor centers.</td>
</tr>
<tr>
<td>sanayi</td>
<td>Continuous variable, distance to industrial centers.</td>
</tr>
<tr>
<td>anayol</td>
<td>Continuous variable, distance to major roads.</td>
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<tr>
<td>otoyolo</td>
<td>Continuous variable, distance to highways.</td>
</tr>
<tr>
<td>koyyol</td>
<td>Continuous variable, distance to minor roads.</td>
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<tr>
<td>otobus</td>
<td>Continuous variable, distance to bus stops.</td>
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<tr>
<td>trenist</td>
<td>Continuous variable, distance to railway stations.</td>
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<tr>
<td>trenhat</td>
<td>Continuous variable, distance to railway Lines.</td>
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<tr>
<td>iskele</td>
<td>Continuous variable, distance to port side of a ships</td>
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<tr>
<td>arazi</td>
<td>Land use.</td>
</tr>
<tr>
<td>deniz</td>
<td>Continuous variable, distance to water body.</td>
</tr>
<tr>
<td><strong>Social factors</strong></td>
<td></td>
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<tr>
<td>yogunluk</td>
<td>Population Density</td>
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<tr>
<td><strong>Physical factors</strong></td>
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<td>egim</td>
<td>Slop</td>
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<td><strong>Governmental factors</strong></td>
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<tr>
<td>plan</td>
<td>Master Plan</td>
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<tr>
<td>Ea Easting coordinate (m)</td>
<td>Continuous</td>
</tr>
<tr>
<td>Na Northing coordinate (m)</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
1. Proximity Factors
The distance of Village Road of each cell, 2005
The distance of industrial area of each cell, 2005
Result of Logistic Regression Model

- Slope, major road network, city center, water body, and rail line network show a ranked order from high to low value affecting the probability of land development in 1985.

- Density of population shows statistically significant positive impacts on probability of development which means high population density creates new development around.

- Industrial area doesn’t have a specific effect on the development.
  - Industrial area began to significantly affect the probability of land development in 1995.

- Minor city center, water body, rail line network, and ports show a ranked order from high to low value in negatively affecting the probability of land development in 1995.

- Slope, master plan, and population show a ranked order from high to low value affecting the probability of land development in 2005.