



Spatial Analysis of Five Crime Statistics in Turkey

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Overview

- What is GIS?
- Crime Geography
- Why Criminologists use GIS?
- Crime Statistics in Turkey
- Methodology
- Spatial smoothing
- Spatial autocorrelation
- Results

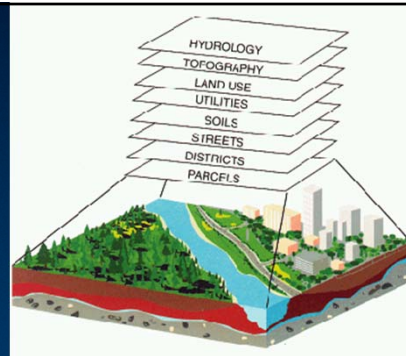
What is GIS (Geographic Information System)

Geographic → Maps

Information → Database

System → Hardware, Software, Data,
People, Plans/Programs

GIS has the ability to hold a vast amount of data that can be easily stored, shared and managed. It provides a platform for data analysis and visualization to explore relationships between data, and it can easily provide graphical or non graphical outputs.



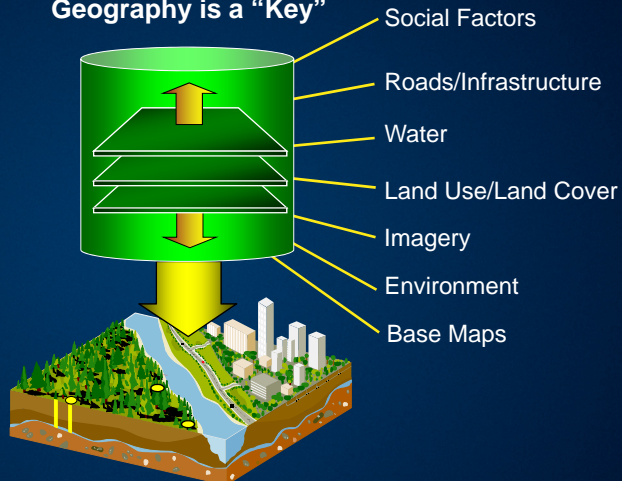
What GIS Can Do?

GIS Integrates...

GIS Concepts

- Georeferencing
- Digital Processing
- Map Overlay
- Spatial Analysis
- Visualization

Geography is a "Key"



... Disciplines, Organizations, and Activities

Who Uses GIS

- Archaeology
- Agriculture
- Banking
- Defense and Intelligence
- Education
- Electric and Gas
- Engineering
- Fire/EMS/Disaster/Homeland Security
- Forestry
- Government (Federal, State, County, Local)
- Health and Human Services
- Insurance
- Landscape Architecture
- Law Enforcement and Criminal Justice
- Marketing
- Media
- Logistics
- Libraries and Museums
- Location Services
- Marine, Coast and Oceans
- Mining and Earth Sciences
- Natural Resources
- Petroleum
- Real Estate
- Retail Business
- Telecommunications
- Transportation
- Universities
- Water and Wastewater
- Weather



Criminology - Geography

- Criminology is the scientific discipline that studies the phenomena of crime and delinquency. Criminology has links to other sciences like biology, sociology, psychology, policing and geography.
- Geography has a major influence on crime. The features and characteristics of cityscapes and rural landscapes can make it easier or more difficult for crime to occur. The placement of alleys, buildings and open spaces, for example, affects the likelihood that a criminal will strike.



Criminology - Mapping

- Computerized crime maps became more commonplace with the introduction of Geographic Information Systems (GIS).
- Analysts map where crime occurs, combine the resulting visual display with other geographic data (such as location of schools, parks and industrial complexes), analyze and investigate the causes of crime, and develop responses.
- Recent advances in statistical analysis make it possible to add more geographic and social dimensions to the analysis.

7



What is Crime Analysis, anyway?

A systematic GIS process of collecting, categorizing, analyzing, and disseminating timely, accurate, and useful information that describes crime patterns, crime trends, and potential suspects.



Why criminologists use GIS ?

- Identify patterns and problems
 - Identify hot spots
 - Use as a visual aid
 - Shows relationship between geography & other factors
 - Look at direction of movement
 - Query data
 - Track changes in crime
 - Make maps for police deployment
- ...And many other reasons

Aim of the study

- Regional variations in crimes in Turkey have also received no attention so far, although Turkey has large regional differences in socio-economic development.
- Turkey, a rapidly developing country, is a junction point between Asia and Europe in terms of its social demographic and economic structure.
- However, there is not a research on geographical distribution of crimes by using GIS and spatial analysis. This study **aims to** examine the regional disparities hidden behind national statistics on some crime statistics in Turkey by using GIS and spatial analyses.

DATA

Crime

- The crime data on convicts, which are compiled from “The Statistical Form Related to Convicts Received into Prison” by mail in each month, obtained from Turkish Statistical Institute by making payment.
 - These statistical forms have been filled in by authorized person of prison according to official records of convicts and declaration of convicts

11

Data

Demographic and Lifestyle

- Census Data of 2000 year:
 - Counts of the population
 - Descriptive information about individuals
 - Age, Race, Gender, Income groupings
 - mid-year population forecasts
 - Households
 - Type and age of housing
 - Rural or urban

obtained from Turkish Statistical Institute FREE



12

Methodology

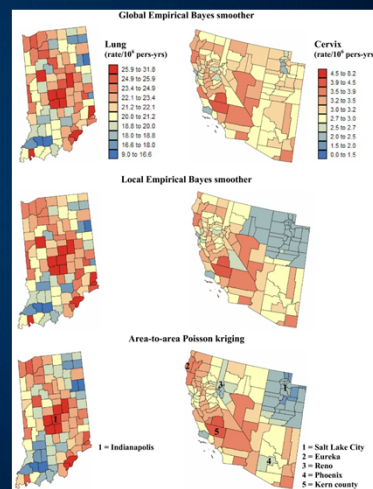
- Using the midyear population and the number of crimes, crime rates were calculated for the 1997-2007 period for 5 types of crime by provinces.



13

To compare Crime statistics Spatial Smoothing

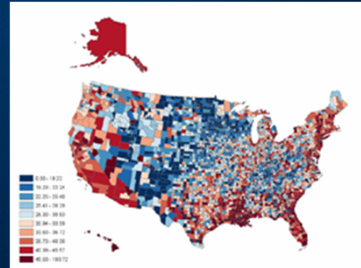
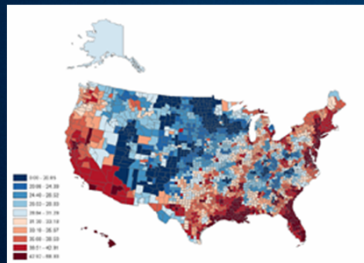
- While we work with aggregated data if the population or the number of cases is relatively small, rate estimates may not be precise.
- In order to overcome this problem, smoothing methods are usually employed.



14

Smoothed Maps

- **Excess Risk:** Expected risk based on product of raw rate and average overall risk of all observations
- **Empirical Bayes (EBS):** Overall mean of the underlying risk distribution of all observations
- **Spatial Rate:** Neighbors, as defined in spatial weights matrix
- **Spatial Empirical Bayes:** Same as EBS but strength not borrowed from all observations, only regional subset



Spatial Dependence

In order to explore spatial dependence, showing how the crime rates were correlated in the country, Global spatial autocorrelation methods were used.

Some Indices of Spatial Autocorrelation

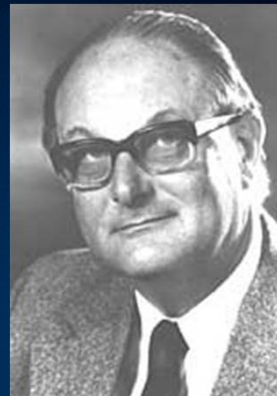
- Moran's I
- Geary's C
- Getis Ord General G
- Join Count Analysis
- Ripley's K -function
- Cuzick & Edwards' method
- Besag and Newell's method

The most often encountered indexes are the Moran's I and Geary's C

17

Global Moran's I Method

- This method was developed by Australian statistician Pat Moran in 1950.
- Moran's I is one of the most known methods within spatial autocorrelation methods.
- Throughout the area it explores whether there exists clustering.



18

Moran's I

$$I = \frac{N \sum_i \sum_j W_{i,j} (X_i - \bar{X})(X_j - \bar{X})}{(\sum_i \sum_j W_{i,j}) \sum_i (X_i - \bar{X})^2}$$

Where N is the number of cases

X_i is the variable value at a particular location

X_j is the variable value at another location

\bar{X} is the mean of the variable

W_{ij} is a weight applied to the comparison between location i and location j

19

Geary's C

- Similar to Moran's I (Geary, 1954)

Interaction is not the cross-product of the deviations from the mean, but the deviations in intensities of each observation location with one another

$$C = \frac{[(N-1) \sum_i \sum_j W_{ij} (X_i - X_j)^2]}{2(\sum_i \sum_j W_{ij} (X_i - \bar{X})^2)}$$



20

General G(d) Method



Moran's I and Geary's C methods indicate clustering of high or low values. But these methods can not distinguish between these situations. So..

- The G statistics were developed by Getis and Ord in 1992.
- In many commercial, it is under the name of high/low clustering.
- This method uses in geographical area for detecting the high values or low values clustering.

21

Global/Local

- Global statistics provides only a limited set of spatial association measurements.
- All measures discussed so far are global
 - they apply to the entire study region.
 - However, autocorrelation may exist in some parts of the region but not in others, or is even positive in some areas and negative in others
- It is possible to calculate a local version of Moran's I , Geary's C , and the General G statistic for each unit in the data

22

Local Moran's I Method



- Moran's I is most commonly used for this purpose, and the localized version is often referred to as Anselin's LISA. (1995)

LISA is a direct extension of the Moran Scatter plot which is often viewed in conjunction with LISA maps.

23

Getis-Ord G_i^* Method



- It was developed by Getis and Ord in 1995.
- So it is named as Hot Spot and Cold Spot Analysis.
- A high index value indicates that high values are clustered within the study area, a low index value indicates that low values tend to cluster.

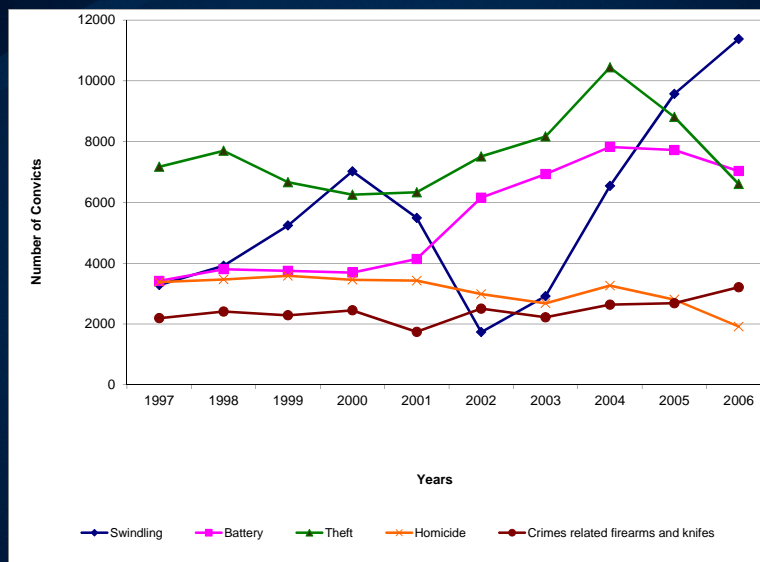
24

Study Results

- Exploratory spatial analyses and spatial cluster analyses are conducted for determination of the distribution of five crime statistics to identify the problematic provinces.
- Different methods were used for cluster analyses. Almost all methods gave the same results. The key concept is **construction of weight matrices** for methods.
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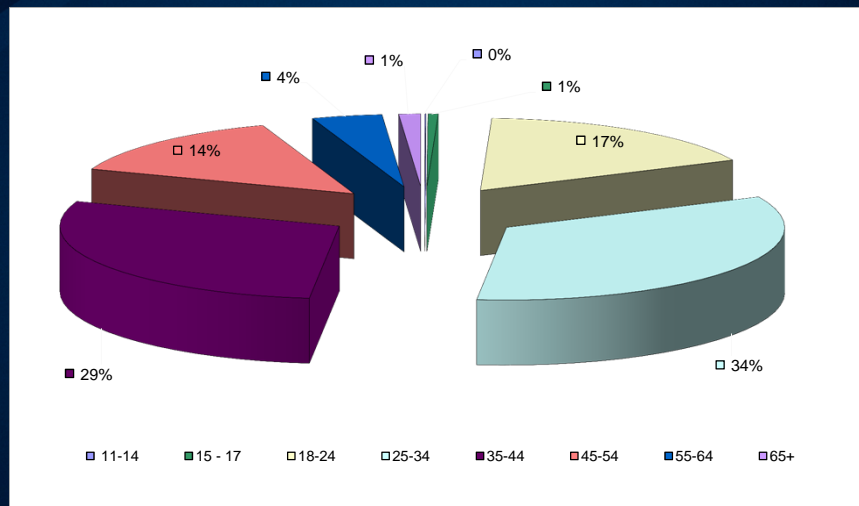
25

Crime Rates by Years



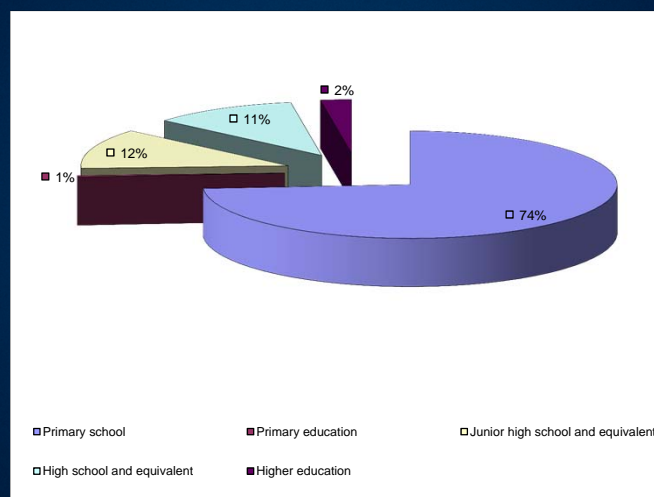
26

Demographic situation of the convicts Crimes According to the Age Groups



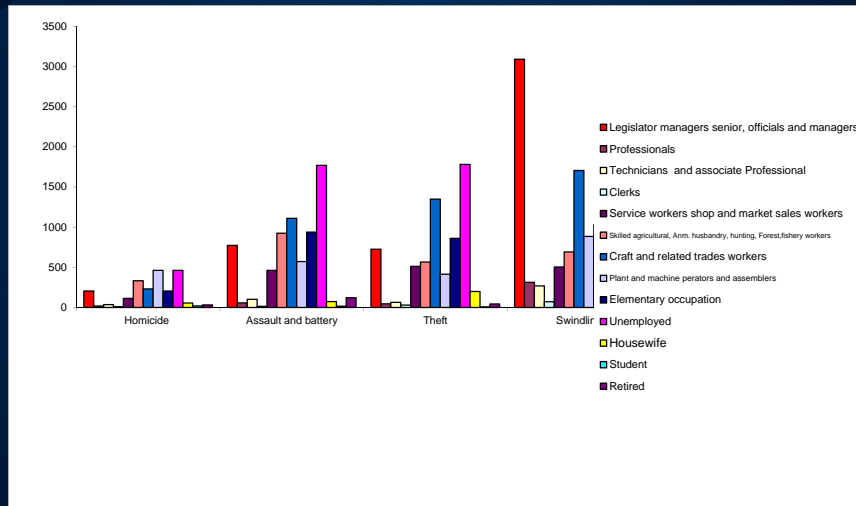
27

Demographic situation of the convicts Crimes According to the Educational Status



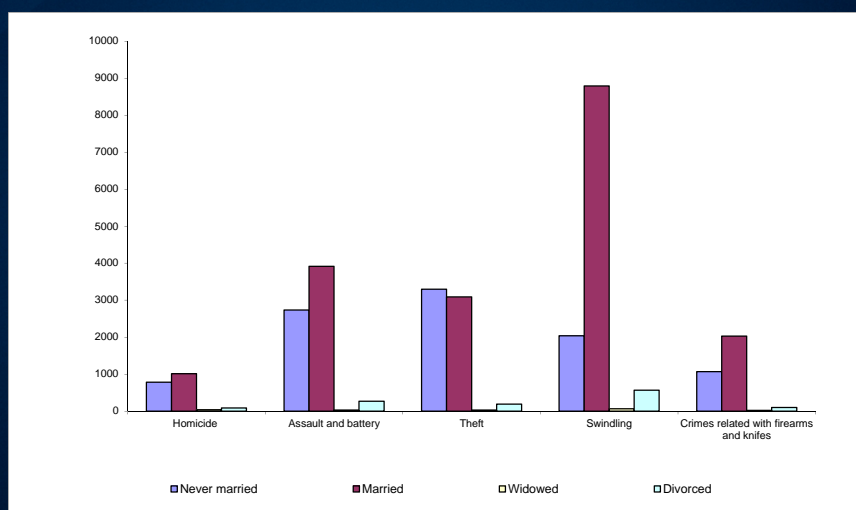
28

Demographic situation of the convicts Crimes According to the Occupational Status



29

Demographic situation of the convicts Crimes According to the Marital Status



30

Crimes related with firearms and knives



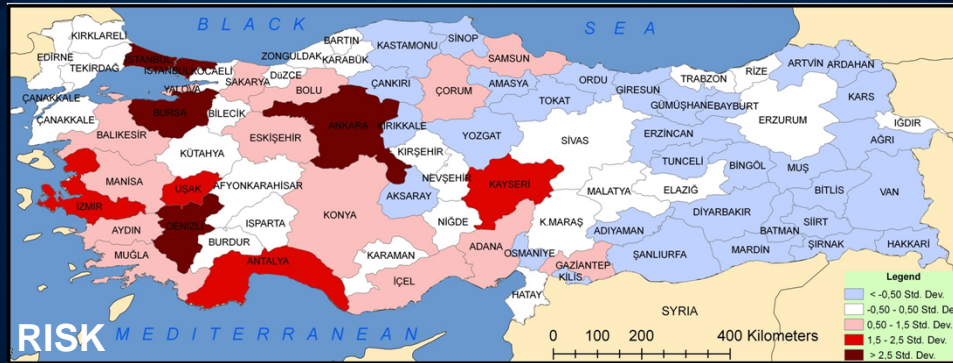
31

Homicides



32

Swindling



33

Theft



34

Assault and Battery



Clusters



CONCLUSIONS

This study is the beginning of a big study. It is important because of the showing the problematic areas to examine in detail.

Geographic coordinates provide basis for these analyses. Therefore their collection is very important.

Density mapping, proximity and demographic analysis are important categories of scientific tools for research on crime. In the next step crime rates will be modelled with the development indices of provinces.

CONCLUSIONS

- As a result, it is very important the use of such GIS aided spatial analyses as a component in the crime description and risk assessment of crimes to implement specific and geographically appropriate risk-reduction programs.

38

THANKS....

