

## Using GIS to Produce Cancer Incidence Maps: A Case Study of Trabzon, Turkey



**Ebru Colak, MScE**

Karadeniz Technical University Department of Geodesy and Photogrammetry Engineering, GISLab  
61080 Trabzon-Turkey  
Phone. +90-462-3773654  
Fax: +90-462-3280918  
Email: [ecolak@ktu.edu.tr](mailto:ecolak@ktu.edu.tr)



**Tahsin Yomralioglu, PhD**

Karadeniz Technical University  
Department of Geodesy and Photogrammetry Engineering, GISLab  
61080 Trabzon-Turkey  
Phone. +90-462-3773654  
Fax: +90-462-3280918  
Email: [tahsin@ktu.edu.tr](mailto:tahsin@ktu.edu.tr)  
Web: [www.qislab.ktu.edu.tr](http://www.qislab.ktu.edu.tr)

### Abstract

Forming a cancer control program and putting strategic action plans into practice became an important matter for the health industry. Especially in cancer cases, the correlation of variations in different societies and environmental factors should be examined spatially with reliable data. To achieve this, cancer occurrence density maps have to be created. In this study, a database was built with the ability of GIS to examine the distribution of cancer cases, and maps relating to cancer events in allocation units were created. The Trabzon province of Turkey has been used as a case study. Cancer cases data registered in 2004 by the Cancer Struggle Department of Health Directorate of Trabzon of Turkey were used. Using ArcGIS software, the distribution of cancer cases was presented on cancer maps including allocation units and incidence values, which were calculated for each town-based region. According to the World Health Organization standards cancer rates were determined and examined by the spatial analysis power of GIS.

### 1. Introduction

Cancer is one of the most important health phenomena of today. Its high mortality rate, the disabilities it leaves behind and the high costs of medication are the causes of heavy losses in terms of both national economy and labor. In Turkey, for example, cancer is the second mortal disease leading to deaths (Özet, 2005). In the country, 100-150 thousand cancer cases are observed, and prevalence of cancer is increasing 6% rate in every year. It must take a measures against cancer, otherwise, 5 million people will be cancer in the future 20 years and 3,5 million of these people will lose their life (Tuncer, 2005).

Precaution policy against cancer is tried to form in Turkey. Firstly, available dimension of cancer is required to reveal. Therefore, cancer statistics is tried to obtain reliably. In order for the Cancer Control Programme (CCP) which is prepared to cancer by World Health Organization (WHO) to be implemented in Turkey, the frequency of the cancer disease, the number of patients and the cancer types should be known (URL-1). In order to develop control strategies for cancer, firstly, there is need for descriptive statistics defining dimension of the disease (Sengelen, 2002).

In 1992, "Turkish Cancer Record and Incidence" project was started to make cancer statistics and control programs available. For this purpose, Cancer Record Centers (CRC) were founded in 11 provinces of Turkey and the cancer cases was started to be recorded in the country. One of these centers is located in the Trabzon province. The cancer cases in the Eastern Black Sea Region are recorded by Trabzon Cancer

This study is a pilot application regarding the cancer maps which are guiding base maps in order for the cancer control program to be prepared. It will be tested in view of reaching effective results in the usage of cancer maps for nationwide cancer controls. When cancer maps are produced, there will be opportunities for determining the regions with a considerable density and studying the factors triggering the cancer cases in these regions (Colak, E., 2005).

Trabzon province of Turkey is selected as a study area. In this study, firstly, a database using Geographical Information Systems (GIS) set up and then the statistical maps displaying cancer density of settlement areas were displayed. In constitution of statistical cancer maps, the cancer cases data recorded in the Cancer Struggle Department of Health Directorate of Trabzon for the year 2004 was used. The cancer cases and related information were displayed on the maps by GIS techniques to make cancer data in spatial meaning. Therefore, distribution of the cancer cases could have been investigated in spatial base.

## 2. Aim of Study

- To be determined cancer density areas and to be guiding component for geographical analysis research to factors causing cancer on these areas.
- To be determined relationship between cancer types and environmental threat areas.
- To be formed guiding based maps for implementation of Cancer Control Programme.
- To be supplied necessary information for epidemiological study
- To be tested an application methodology on Health GIS works.

## 3. Material and Methods

### Study Area

The study area is Trabzon where located in the North Eastern part of Turkey and having coast to the Black Sea (Figure 1). The province has 17 towns and 537 villages with 4 664 square km. Its population in 2000 is recorded as 975 137, and according to the data of 2000; the population density of Trabzon is 209. The annual rate of increase in population in 1990- 2000 is nearly 20.3% (DIE, 2002).



Figure 1: The location of Trabzon Province in Turkey

### Providing Cancer Data and Based Maps

Cancer statistics concerning Trabzon province are provided from the Cancer Struggle Department of Health Directorate of Trabzon Province of Turkey. The cancer cases data recorded for the year 2004 was used. During 2004 year, the center has recorded 1939 cancer cases for the Eastern Black Sea Region. Out of these dataset, 1216 cases occurred within the administrative boundaries of Trabzon province were selected for this study. However, as a result of the data quality analysis of these cases, some records of cancer cases lacking adequate address information were excluded. After this elimination, a total of 1150 cancer cases were used in the production of cancer maps.

Administrative unit map of Trabzon was used as the base map for the application to cancer cases is demonstrated on it. In this base map, there are graphical information representing the boundaries and the centers of administrative units. The data in the map includes boundaries of counties and villages, and their centers including their populations. The base map was transferred into topological data structure using ArcGIS 9.x software and the data was stored in the shape (.shp) files. This dataset comprises of two data layers, one is administrative boundaries in polygons and the other is administrative centers in points.

## 4. Creating GIS-based Cancer Density Maps

The cancer cases applicable for the study have been determined and the data have been arranged in a database in the Microsoft Office Excel program. Afterwards, the data that form the cancer database have been changed into 'dbase' format to be used in the ArcGIS software. ArcGIS software was used in transferring the cancer data into the base map. In this process, the previously arranged graphical data of administrative boundaries of Trabzon province together with district boundaries in the city centre of Trabzon were used as the base graphical data. Each case was marked on the map with a point with the guidance of

its address information, generating a new cancer distribution layer (Colak, H.E.,2005).

With the production of distribution map of cancer cases for Trabzon province, geographical distributions of cancer cases within Trabzon province for the year 2004 were able to be observed. However, in order to be able to perform some statistical analysis and comparisons, calculation of cancer incidence values for each administrative unit was needed. A cancer incidence rate is the number of new cancers of a specific type occurring in a specified population during a year, usually expressed as the number of cancers per 100,000 populations at risk (URL-3). For this purpose, the number of cases for each administrative unit was determined. With using case numbers and census data of the year 2000, incidence values for each unit was calculated as in the equation below. In this equation the coefficient “k” is 100.000.

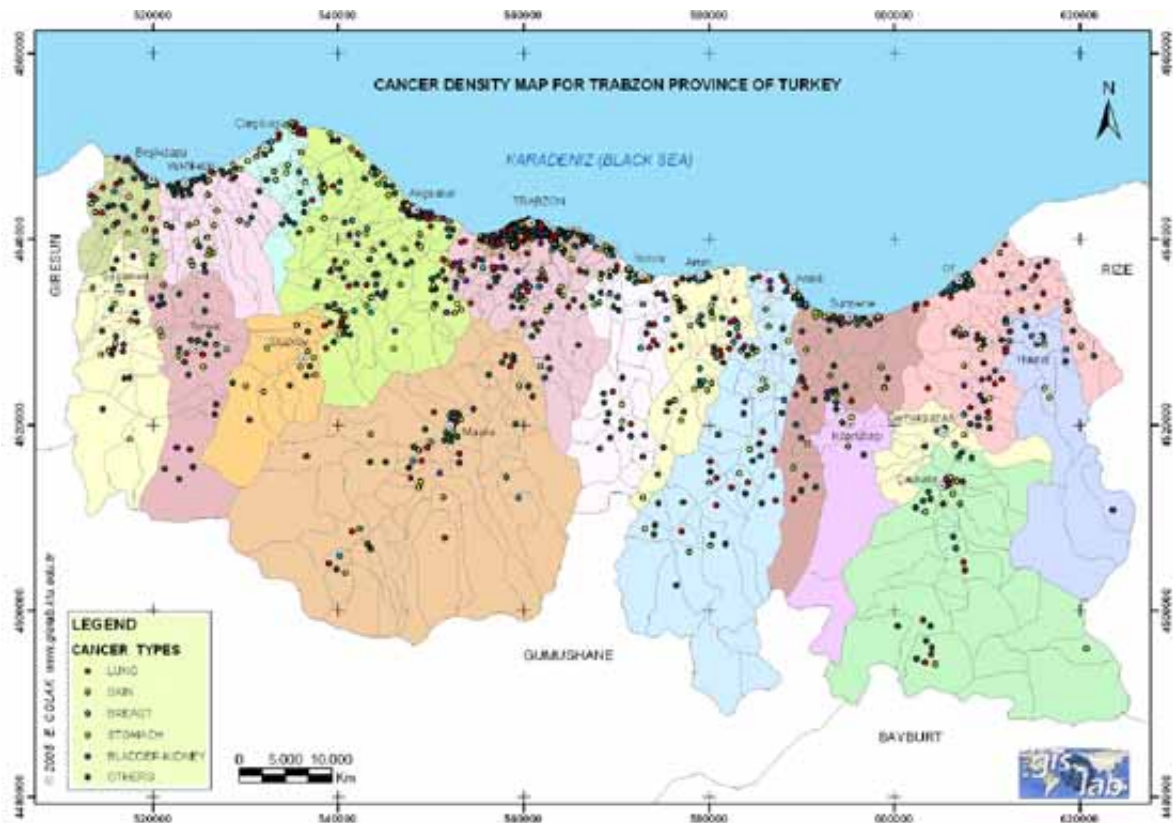
$$\text{Incidence rate} = (\text{Number of New Cancer Cases} / \text{Population}) \times k [k=100.000]$$

### Statistical Maps for Geographical Analysis

Cancer density of study area is determined and distribution of cancer cases is observed visually is required for geographical analysis. This research can be realized with statistical map regarding cancer cases. Statistical map presentations are required to examine the distribution of cancer data geographically. ESRI ArcGIS 9.x software was used at map production phase. Cancer cases were pointed with point symbol on the map. The geographic distribution of each case can be seen with point symbol on Density Map of Cancer Cases in Trabzon Province (Figure 2). Also, the distribution of cancer cases in view of cancer types can be seen on this produced map. In addition to this, the prevalence of cancer cases based on villages for each county was presented visually.

In the study, the incidence values have been used for statistical examination as the comparison criteria. Calculated incidence values present cancer prevalence in allocation areas. The maps presenting cancer prevalence in Trabzon was produced for province and city center separately. Cancer Density Map of Trabzon Province was formed for each allocation unit as to calculate incidence values (Figure 3).

According to WHO, it is expected that 150-300 people are taken cancer illness for 100.000 population (URL-4). In the produced map, allocation units having incidence value higher than 300 were determined as risky districts in view of cancer density. These figure outs were presented on the map. In the allocation units having incidence value between 150 and 300 have expected results in view of cancer density, according to world standards.



**Figure 2: Distribution of Cancer Cases in Trabzon Province of Turkey**

Based on the aspect map of Trabzon, skin cancer cases were also examined. Existing skin cancer cases were determined and distribution of these was presented on the map with point symbol. The reason for skin cancer cases is indicated to be exposed sunlight too much (Bingöl, 1978). In this way, the aspect map was



used as base map to present skin cancer cases. An aspect map shows solar orientations of slopes with different orientations and districts affected by sunlight so much can be seen on this map. Relation between skin cancer cases and districts affected by sunlight so much can be examined on this map (Figure 4).

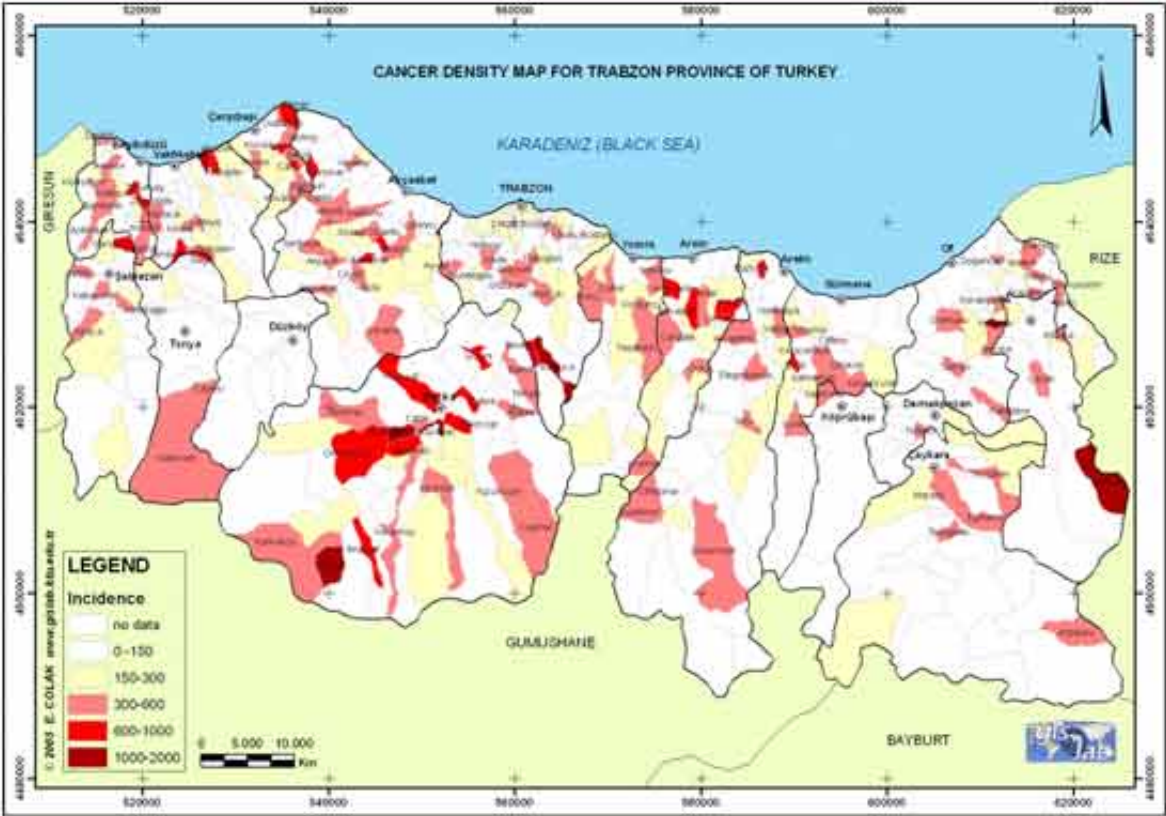


Figure 3: Cancer Incidences Map of Trabzon, Turkey.

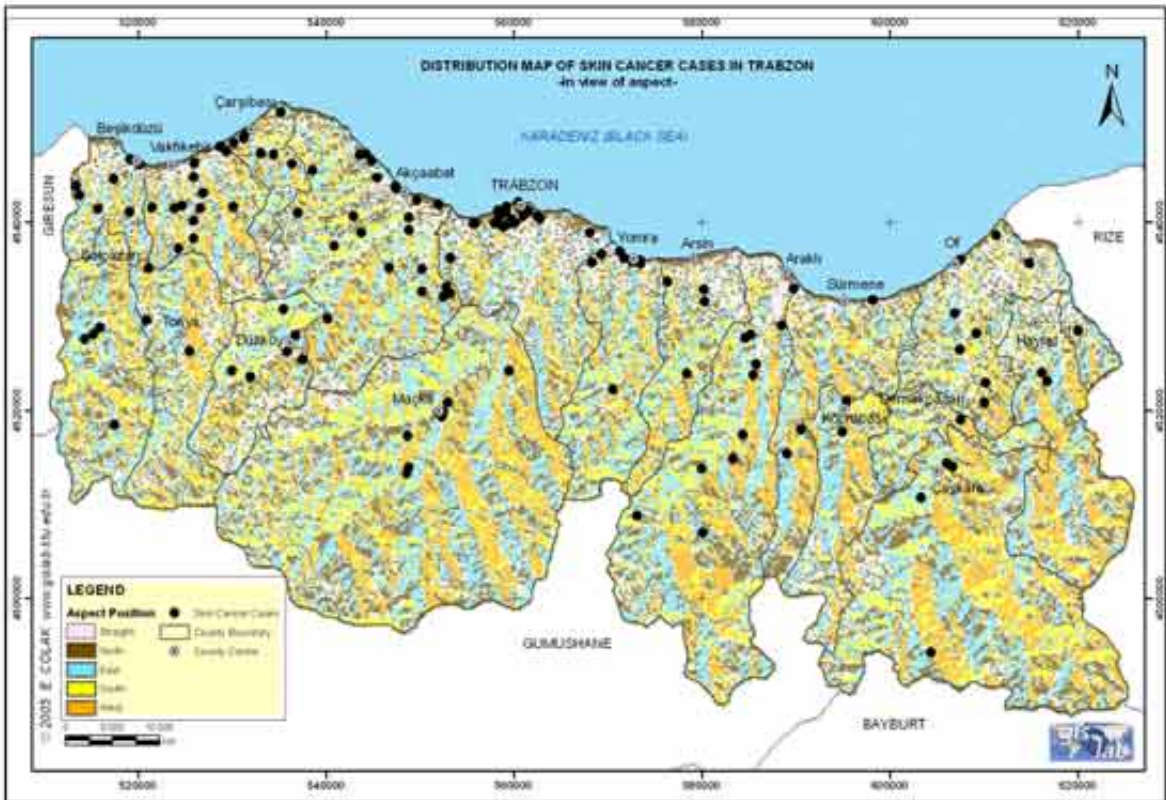


Figure 4: Skin Cancer Cases overlaid on Aspect layer in Trabzon province

In addition, when cancer cases data are available on city center as a district based, cancer incidence values can also be calculated and related maps also produced for a more focused areas. An example applied for the city center of Trabzon. In Figure 5, calculated cancer incidence values are shown for Trabzon city centre. For the city center it was figured out that incidence value is 143 which can be acceptable incidence values in accordance to the WHO standards.

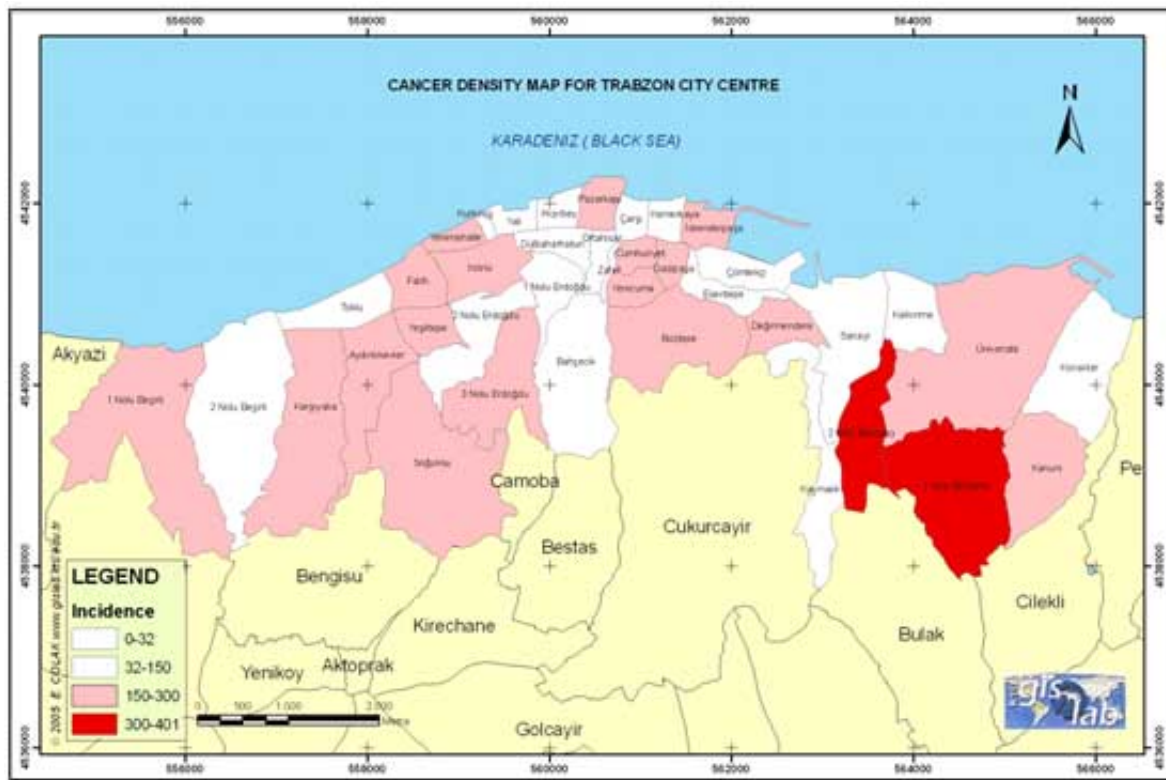


Figure 5: Cancer Density Map for Trabzon City Centre in district bases.

## 5. Conclusions

- When the prevalence of cancer cases with point symbol is examined, it is determined that cancer risky regions have more population density than other regions. It can be perceived on the map that allocations areas in coastal regions, across valley, and city center have more cancer cases.
- It was determined that totally 138 allocation units out of 596 in Trabzon exceeded the expected number of cancer cases in 100.000 population. 23% of all allocation units exceeded the value accepted as top limit, 300 incidences.
- The incidence value in Trabzon province was calculated about 118. This value is under expected cancer risk that is accepted between 150-300 regards 100.000 populations.
- When the distributions of cancer are observed in terms of their types, the first most frequently occurring cancer types observed are lung (19%), skin (12%), breast (10%), stomach (9%) and urinary bladder cancer.
- This study can be considered as a pilot application for presenting the distribution of cancer densities on the maps, producing control programs against cancer, and examining environmental factors causing cancer spatially.
- This study proved that cancer data should be collected regularly and quite a few researches about biostatistics and epidemiology can be made. It is firstly emphasized that existing cancer cases in Turkey can be recorded completely.

As a final conclusion, the ability of GIS for comprehensive cancer control, however, comes from the flexibility and extensibility of the digital environment. A GIS-based map has the potential to the capability of classical data to prompt insight about spatial distributions and relationships with the ability of the digital environment to support exploratory analysis, statistical and computational testing of hypotheses, policy decision making, and dissemination of information in a variety of forms. Such products can be integrated to new data continuously and produce new outputs to meet particular cancer researches. It will also provide a framework for extending the GIS functionality over time.

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