ISTANBUL TECHNICAL UNIVERSITY ★ FACULITY OF CIVIL ENGINEERING

PRODUCTION OF NOMINAL BASED REAL ESTATE VALUATION MAP OF CANAL ISTANBUL AND ITS SURROUNDINGS

Bachelor Thesis

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JUNE, 2022

FOREWORD

I hope that this study, which emerged as a result of intense and devoted work, will contribute to real estate valuation activities.

I would like to express my gratitude to my esteemed teacher, advisor Prof. Dr. Tahsin YOMRALIOĞLU, who guided me, shared his knowledge and experience and supported me throughout my studies. I would like to thank my research assistant Muhammed Oğuzhan METE for his help and support during the thesis work.

I would like to thank my dear mother, father and siblings for their support and prayers during this thesis work, as in every phase of my life.

June 2022

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ABBREVIATIONS

ASTER : The Advanced Spaceborne Thermal Emission Radiometer
BWM : Best Worst Method
DEM : Digital Elevation Model
GIS : Geographical Informatıon System
MCDM : Multi Criteria Decision Making
OSM : Open Street Map
USGS : United States Geological Survey

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KANAL İSTANBUL VE ÇEVRESİNİN NOMİNAL YÖNTEM İLE TAŞINMAZ DEĞER HARİTASININ ÜRETİMİ

ÖZET

Taşınmaz değerleme, belli bir dönemde yasal prosedürler de dikkate alınarak ve piyasa koşulları değerlendirilerek objektif olarak taşınmazın, taşınmaza bağlı hak ve faydanın değerinin tespit edilmesi işlemidir. Taşınmaz değerlemesi yapılırken gayrimenkulün belli bir tarihteki imar durumu, konumu, zemin ve inşaat yapısı, elde edilen gelir, ulaşım imkânı, altyapı durumu, parselin şekli gibi değerini etkileyen bütün unsurların dikkate alınması gerekir. Taşınmaz değerlemesi için bir çok yöntem bulunmaktadır. Son zamanlarda klasik yöntemlerden ziyade modern/stokastik yöntemler tercih edilmektedir. Stokastik yöntemler olarak yapay sinir ağları, hedonik, bulanık mantık, çoklu regresyon, nominal yöntem gibi çeşitli yöntemler kullanılmaktadır. Taşınmaz mal değerlemesinde değerleme sonucu kişiden kişiye değişebilmektedir ve geniş alanlarda uygulaması zor ve zaman alan bir işlemdir. Bu sebepten alternatif yöntemlere ihtiyaç duyulmaktadır. Geniş alanlarda yapılacak olan toplu taşınmaz mal değerlemeleri için bilimsel bir yaklaşıma sahip, nesnel değerlendirme imkanı sunan ve uygulama açısından pratik bir yaklaşım olan nominal değerleme yöntemi tercih edilmiştir. Nominal değerleme yaklaşımı ile Kanal İstanbul projesi öncesi için ve proje sonrasında oluşacak değer değişiminin saptanması amaçlanmıştır. Bu amaçta İstanbul ili Avrupa bölgesi için iki adet nominal değer haritası oluşturulması amaçlanmıştır. Çalışma alanı için kriterler belirlenmiş ve yakınlık, görünürlük ve yüzey analizi gibi analizler gerçekleştirilmiştir. Bu analizler önem derecelerine göre ağırlıklandırılmıştır. Görünürlük analizleri kapsamında boğaz, göl, deniz manzarasına sahip bölgeler belirlenmiş ve kanal projesi sonrasında oluşacak kanal manzarası için bölgeler tespit edilmiştir. Eğim, bakı analizleri ve hastane, metro istasyonları, itfaiye gibi alanlara yakınlık analizleri gerçekleştirilmiştir. Kanal projesi öncesi ve sonrası için üretilecek nominal değer haritalarında kullanılan analizlerde aynı kriterler kullanılmıştır. Analizler önem derecelerine göre ağırlıklandırılmıştır, kanal öncesi ve kanal sonrası için nominal değer haritası üretilmiştir. Elde edilen nominal değerler karşılaştırıldı ve nominal değer değişim alanları tespit edilmiştir. Kanal güzergahında bulunan parseller için ortalama nominal değerler hesaplanmıştır ve nominal değer değişimi saptanmıştır. Kanal İstanbul projesinin uygulanması sonrasında oluşan durumda değerlerin Sazlıdere Barajı çevresi ve kanal güzergahı boyunca belli oranda arttığı görülmüştür.

PRODUCTION OF NOMINAL BASED REAL ESTATE VALUATION MAP OF CANAL ISTANBUL AND ITS SURROUNDINGS

SUMMARY

Real estate appraisal is the process of determining the value of the real estate, the rights and benefits attached to the real estate, objectively, by taking into account the legal procedures and evaluating the market conditions in a certain period. All factors affecting the value of the real estate such as the zoning status of the real estate at a certain date, location, ground and construction structure, income obtained, transportation facility, infrastructure status, and shape of the parcel should be taken into consideration while making a real estate appraisal. There are many methods for real estate valuation. Recently, modern/stochastic methods are preferred rather than classical methods. Various methods such as artificial neural networks, hedonic, fuzzy logic, multiple regression, nominal method are used as stochastic methods. In real estate valuation, the result of valuation can vary from person to person and it is a difficult and time-consuming process to apply in large areas. For this reason, alternative methods are needed. Nominal valuation method has been preferred in order to save time and reduce the difficulty of working for mass real estate valuations to be made in large areas. With the nominal valuation approach, it is aimed to determine the value change that will occur before and after the Canal Istanbul project. For this purpose, it is aimed to create two nominal value maps for the European region of Istanbul. Criteria for the study area were determined and analyzes such as proximity, visibility and surface analysis were performed. These analyzes were weighted according to their importance. Within the scope of visibility analysis, regions with views of the bosphorus, lake and sea were determined, and regions were determined for the canal view to be formed after the canal project. Slope, aspect analyzes and proximity analyzes to areas such as hospitals, metro stations, and fire departments were performed. The same criteria were used in the analyzes used in the nominal value maps to be produced before and after the canal project. Analyzes were weighted according to their importance, and nominal value maps were produced for before canal and after canal. The nominal values obtained were compared and the nominal value change areas were determined. The average nominal values were calculated for the parcels located on the canal route and the nominal value change was determined.

1. INTRODUCTION

1.1 General Information

The state of saving, using and benefiting from a movable or immovable property is called as ownership. Property is a right enshrined in the constitution as well. According to our constitution, everyone has the property rights. In terms of law, property is limited by law or other regulatory legal concepts. This right is limited by law only in the case of public interest.

The real estate (immovable) is the land itself, which is a physical asset, or the artificial structures built on this land. Immovable is a tangible asset that can be seen and touched. Valuation is the independent and impartial determination of the probable value of an asset or real estate, real estate project or the rights and benefits attached to a real estate at a certain date. The difference between value and price is; value is an intangible measure that expresses the value of a good, while price is a concrete measure of the money equivalent of a good in the market (SPK, 2006).

Human beings need immovable property to meet their needs. These immovable properties cause property rights in people. As a requirement of these rights, it can used this immovable for both trade and benefit. Therefore, these immovable properties have a value. The determination of this value is explained with the concept of real estate valuation.

People can sell their lands, lands and immovable properties such as residences for commercial income or buy them for investment and use. Thus, it can be earned income with immovable property. For this reason, immovable property has a value. Determination of this value is called as immovable valuation. This valuation work is carried out by impartial valuation specialists, institutions or organizations. For the appraisal, the characteristics, benefits, positive features and negative features of the immovable property are taken into account. Real estate valuation is to determine a part or all of a real estate in terms of quantity and quality.

When real estate valuation in Turkey is examined, it is noticed that this system does not have a common valuation system. The valuation process is carried out subjectively and may vary from person to person. When different institutions and organizations do

the valuation, different results may emerge. This situation eliminates an objective real estate valuation. For this reason, real estate valuation should be established in a common system and real estate value maps should be produced by avoiding subjectivity.

Zoning projects, urban transformation, expropriation, property taxes, purchase and sale etc. real estate valuation is important. Real estate tax application in Turkey is carried out by the municipalities. The municipality applies the same fair value for all residences on a street. But the residences on this street do not have the same features and benefits. Even the characteristics of each flat in a building are different from each other. For this reason, it is not appropriate to subject all the houses on the street to the same current value. Undoubtedly, thanks to the value maps that will be produced in this context, the value differences of even the parcels on the same street will be easily seen with respect to each other (Doldur, Alkan 2021).

For immovable valuation, the immovable value can be determined classically by methods such as precedent, income, cost and mixed. As modern methods, artificial neural networks, hedonic, fuzzy logic, multiple regression, nominal method are used.

With the Nominal Valuation method, the value is determined by grading the real estate with all its features, depending on the characteristics of the real estate. The working area for nominal valuation can be parcels. The size determined as a unit area can be in the form of pixels/grid. With the help of Geographical Information System (GIS), nominal based (pixel) real estate value map can be produced.

GIS is a system created for collecting, storing, processing, visualizing, analyzing, querying and getting results of spatial-spatial data (Yomralioglu, 2000). In real estate valuation studies, spatial data is used extensively. For this reason, the use of GIS is very important in real estate valuation studies.

In addition, in the final report of the "Immovable Valuation and Cadastre Symposium in Land Management" organized by the Chamber of Surveying and Cadastre Engineers (CSCE) and the General Directorate of Land Registry and Cadastre (GDLRC) in 2012, it was stated that GIS supported approaches were preferred in real estate valuation studies and "Immovable Valuation Information System" is recommended.

In combination with the nominal valuation method and GIS, it offers an effective way of processing, visualizing and analyzing data. In nominal-based valuation, the

immovables that are taken as a precedent are scored according to the factors affecting the value of the immovable. A weighted average value calculation is made for each real estate. The property is evaluated with all its features. The subject of the appraisal can be real estate, parcel or pixels of a certain size.

Within the scope of the study, it was decided to create a nominal-based value map of the route determined for the Istanbul province, "Canal Istanbul" project. For this study, proximity, visibility and surface analyzes were performed using the QGIS program. Effective factors for the study area was determined and their weights will be calculated. The "Best Worst Method" was used to calculate the weights. The whole process was automated and a value map was created.

1.2 Description of the Problem

Many features such as environmental, technical and spatial features are taken into account for the real estate valuation. These are called factors. The evaluation and analysis of these factors can be done by appraisers, institutions and organizations. It is seen that different results can be obtained for the same real estate. Because there is no objective evaluation criterion in the evaluation of these factors. Different institutions and different people can achieve different results.

Immovable properties play a very important role in human life. In this market, real estate agents, customers, sellers, companies, investors earn income with immovable properties. Legal problems arise due to different valuations obtained for the same immovable property. In this case, citizens may face injustice. In addition, it may cause tax losses for the state. In order to eliminate these problems and to prevent people from being victims, the state should take precautions and make regulations.

In our country, real estate valuation should be done in an objective, impartial, reliable and fair manner. Valuation studies should be updatable and valuation should be made collectively for large areas. For a large project, the change and updating of the values of the immovable properties in the region should be followed. For this, it is important to benefit more from technological opportunities in real estate valuation studies and to benefit from stochastic valuation methods.

1.3 Purpose of the Study

The aim of the study is to analyze the value change on the real estate properties of the Canal Istanbul Project, which is planned to be built in our country, and to produce a nominal based real estate value map of the Canal Istanbul project route. With this study, the value changes of the lands on the canal route were analyzed and a nominal based real estate value map was created.

In this context, the goal is to create a scientific and unbiased value map. While creating this, it is to create a technological value map for the large area by using GIS based programs. For valuation, the impact of the Canal Istanbul project on the lands was examined. The effects of factors such as the public areas covered by the project, bridges, new landscape, and transportation lines on the land were taken into account.

In this way, a fast and accessible service was created for use in activities such as purchase-sale, rent, housing tax, land-land taxes, real estate values, expropriation, zoning implementation, urban transformation, and capital market. In this way, it becomes easier to reach objective, reliable and accurate market values.

1.4 Methodology

Within the scope of the study, the methodology followed to determine the values of the immovables is as follows:

- Researching the concept of real estate valuation and real estate valuation studies in Turkey,
- Research on the problems encountered in real estate valuation in Turkey,
- Research on methods for real estate valuation and how the methods are applied,
- Examining the studies of the nominal-based valuation method, one of the real estate valuation methods,
- Determination of the study area (Canal Istanbul route),
- Determining the factors that will affect the value in the study area,
- Determination of factor weights,
- Database design,

- Investigation of the details of the Canal Istanbul Project and analysis of the factors on the lands with GIS,
- Determination of pixel size for generation of raster based value map,
- Production of nominal based real estate value map,
- Analysis and comparison of found values.

1.5 Literature Review

Real estate valuation is to determine the value of a real estate by analyzing its characteristics, its relationship with the environment, its beneficial and negative aspects. The purpose of use of the real estate to be appraised is determined and the factors are determined accordingly. These factors are the location of the real estate, its view, proximity to public facilities, ease of transportation, distance to green areas, proximity to school, proximity to shopping centers. By identifying these and more factors, analyzes are performed for the valuation study.

One of the main things in valuation is the date, its value is determined on a date. Because the terms and conditions change over time, change in the current value is inevitable. Real estate valuation is carried out by valuation specialists, institutions and organizations. There is a difference in the evaluation of factors in real estate valuation. Different values can be obtained in valuation studies carried out by different persons for the same real estate. This turns into a struggle for rights among people. Thus, legal problems arise. Objective regulations and new legislation should be introduced by the state for the valuation of real estate. In addition, the appraiser must be objective, impartial, reliable and fair.

When the valuation methods are examined, the precedent, cost and income methods are insufficient for the collective valuation of the immovables. A large number of spatial data should be examined for large areas and collective valuation studies. It takes a lot of time to examine and analyze these data with these methods. For this reason, Artifical Neural Networks, Fuzzy Logic and Spatial Analysis methods are used in real estate valuation studies for large areas.

When innovative valuation methods are examined instead of traditional valuation methods, the use of GIS analyzes for real estate valuation is important for large areas.

GIS offers the opportunity to use it as a technological platform for performing spatial analyzes and displaying property information in the form of value maps. For real estate valuation, spatial data is used extensively. Therefore, the use of GIS is of great importance for real estate valuation.

In order to eliminate the problems encountered in real estate valuation and at the same time increase the use of GIS, which is of great importance for real estate valuation, a GIS supported Real Estate Valuation Information System should be established. Thus, the valuation study will be more reliable, unbiased and accurate. In the final report of the "Immovable Valuation and Cadastre Symposium in Land Management" organized by the Chamber of Mapping and Cadastre Engineers (HKMO) and the General Directorate of Land Registry and Cadastre (TKGM) in 2012, it was stated that GIS supported approaches were preferred in real estate valuation studies and that the "Real Estate Valuation Information System" was used. creation is recommended.

The use of GIS in Nominal Real Estate Valuation applications makes processes easier and more effective. Providing property owners with an easy and understandable explanation of how their properties are valued is difficult and time consuming for the appraiser. With the help of GIS it becomes easier and takes less time to perform these complex tasks.

In raster-based GIS applications, a pixel represents an area in a property valuation. The edge of this pixel can be scaled as desired. Thus, it can be arranged how many square meters each pixel corresponds to in the field. All factors affecting the value are identified and weighted. These weighted totals are distributed over the pixels. Thus, a pixel is equal to the weighted sum of all the factors that affect the value. Thanks to this method, pixel values are calculated and balanced with plots. Thus, the valuation application is made.

The use of nominal based real estate valuation gives a more accurate, fair and objective result to analyze the impact of a project to be made in a region on the real estates in the region before and after. The use of GIS in determining the real estate value and in the production of value maps allows us to obtain accurate analyzes for the projects to be made in the region. By using these value maps, it will facilitate many valuation studies such as zoning applications, urban transformation, and property tax.

Yomralioglu (1993) established the land and land arrangement system (LARES) in 1993. Yomralıoğlu and Nişancı summarized the real estate valuation studies in 2004, and they implemented the nominal real estate valuation, which is a stochastic method, with GIS, in order to evaluate the real estates collectively.

Doldur and Alkan (2021) created two different GIS based real estate value models in Avanos district of Nevşehir province in 2021. According to the first model, the nominal value was established according to the generally accepted factors. According to the second model, the factors were created by considering the characteristics of the region and the value was obtained. As a result, the value given by the factors created by considering the characteristics of the region became more meaningful.

Mete (2019) produced a GIS-based Nominal Real Estate Value map for the province of Istanbul in 2019. With this study, he obtained pixel-based nominal value with scientific criteria and worked to ensure the standardization of the real estate market. Thus, it aimed to be a resource for the realization of transactions such as purchase and sale, rent, tax, expropriation, urban transformation, and zoning applications.

2. BASIC CONCEPTS

2.1 Geographical Information System

GIS is a system in which world data is collected, stored, queried, transformed and displayed in line with a target. Databases can be created with spatial data in this system and queries can be made by using different tools together. GIS enables us to use spatial data more effectively and to obtain accurate analysis. From the analyzes made, we can think that GIS is a tool. However, it is possible to say that GIS is a system, considering that not only analysis is done with GIS, but also database management is done, and it is effective in making decisions with the data it contains in solving any problem (Mete, 2019).

Value maps are produced by using spatial data together with GIS. GIS enables the collection, storage and processing of spatial data. Spatial data is also needed to produce a value map of a real estate, and these spatial analyzes are carried out at an optimum level with GIS.

The GIS uses spatial information and can combine multiple data layers. One of the most important features of GIS is its layered structure. Data in a GIS layer can be in one of two forms, vector and raster. Entities are represented in vector form by a point, a line, or an area. Produces accurate information using geographic components of data.

GIS data; Includes photographs, details, basemaps and tables. Maps are geographic storage tools that contain layers for the area and purpose you want to work in.

Maps created using GIS can be easily managed, shared, and made available to anyone, anywhere, anytime by producing an application. Therefore, the use of GIS is an important system for accessibility and data analysis.

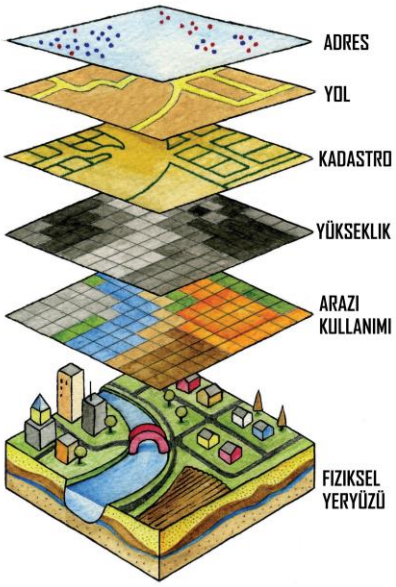

Figure 1. 1 : GIS data layers (Mete, 2019).

2.2 Real Estate Valuation

There are many definitions for real estate valuation. According to Mete and Yomralıoğlu (2019), real estate valuation is a value estimation approach encountered in many applications such as taxation, purchase-sale, leasing, expropriation and urban transformation. Time is an important factor in real estate valuation, the value of the real estate is valid for the time it is made. The properties, locational features, benefits and damages of the immovables are examined. These features are determined as factors and the value of the real estate is determined by the appraiser, person, institution or organization. The valuation results of different people or institutions for the same real estate may be different from each other. Since subjectivity is at the forefront in real estate valuation, the person who will make the valuation must be reliable, independent and impartial. At the same time, using scientific methods and giving importance to scientific methods are important for the results to be consistent.

Real estate valuation is of great importance for the state as well as individuals benefiting from real estate valuation services such as citizens, real estate institutions, banks. The state should be fair while taking the property tax from the public, and the taxes it collects should be taken in accordance with their values. Mistakes to be made in this regard can cause great harm to the state and citizens. For this, the state needs to

publish an objective legislation for the valuation of real estate and create a regulation for the valuation to get updated, fast and accurate results.

2.3 Real Estate Valuation Methods

There are many valuation methods for real estate valuation. The most effective valuation method is used according to the location and characteristics of the real estate. These methods are examined under two headings as classical methods and stochastic methods. The most widely used and known methods in classical methods are the comparison method and the cost method.

2.3.1 Classical Methods

2.3.1.1 Sales-Comparison Method

For the real estate valuation application with the sales-comparison method, the immovables that can be precedent, which have similar characteristics to the real estate to be appraised, are determined. The purpose of this method is to determine the value of the subject property by analyzing comparable sample properties. Attention is paid to the conditions that the immovables that will have similar characteristics are in the same region, the quality and the zoning data are similar. This method is generally used for land or land valuation that does not have a building on it.

2.3.1.2 Cost Method

In real estate valuation, the cost method is generally used for valuation activities in insurance transactions. The cost method is used only for immovables with structures on them. The purpose of valuation with this method is to reach the cost value on the day of the valuation. The emphasis in valuation is based on the cost of the feature. With this method, a permanent value such as the market price is not obtained. The basic process of the cost method is to subtract depreciation from the total cost by adding the entrepreneur's profit to the current cost of constructing or replacing the existing structure and adding the estimated land value to the valuation. In other words, it is obtained by subtracting the depreciating values of the real estate from the total cost value.

2.3.2 Stochastic Methods

The word stochastic consists of probability and statistics. Immovable properties have a common value character that creates a cluster in terms of quality and quantity. Due

to the complexity of the parameters affecting the value and the dependence of these parameters on various events, it is tried to reach a conclusion with statistical studies.

The numerical and proportional relationships between the purchase and sale values reflect the value trends of real estates (Mete, 2019). Examination of the value data of many real estates can be carried out using the geographical information system and statistical methods. Thanks to these innovative methods, it becomes easier to determine the real estate value in large areas. In addition, the values obtained are more scientific, accurate and objective values.

Nominal Valuation, Regression Analysis, Linearization, Hedonic Valuation, Cluster Valuation, Matrix Method, Artificial Neural Networks, Fuzzy Logic methods are known as stochastic methods.

2.3.2.1 Nominal Valuation Methods

Nominal Valuation Method (Yomralioglu, 1993) is one of the stochastic methods frequently used for collective valuation studies. Since the working area is large for the mass real estate valuation studies to be carried out in large areas, the time spent is too much. In the nominal valuation method, the factors are determined first. Factors vary depending on the location of the real estate. For example, it is not expected to use the same value factors in a region developed by tourism and in a region developed by agriculture (Doldur and Alkan, 2021).

While determining the factors, it is necessary to take into account the local characteristics of the real estate to be appraised. These factors are weighted according to their importance and a numerical value is produced for the properties. Nominal valuation, which provides calculated parametric scores of weighted criteria which affect real estate values (Yomralioglu et al., 2007).

With the nominal valuation method, it is possible to calculate the value of pixels in a parcel or smaller unit. The criterion score is obtained by multiplying the score of each criterion affecting the value with the weight coefficient. Real estate values are calculated in nominal terms as a result of adding the criteria points by performing the same procedure for all criteria and multiplying this value by the pixel or parcel area (Mete, 2019).

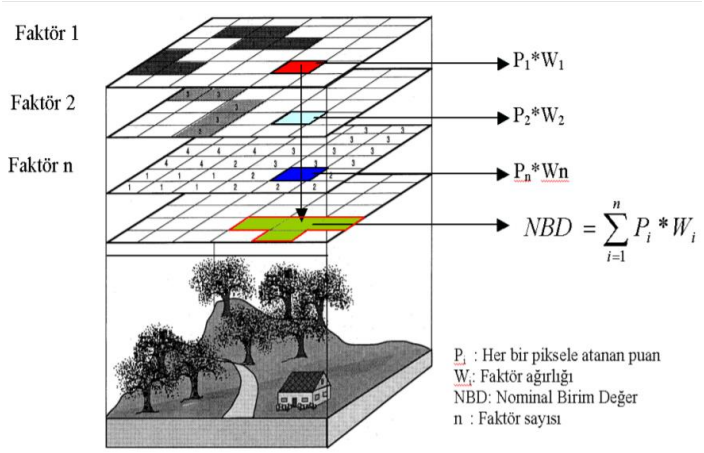

Figure 2. 1 : Pixel based nominal valuation map producing (Nişancı, 2005).

$$D_i = A_i * \sum_{j=1}^{n} (P_{ji} * W_j) \quad \textbf{(1)}$$

Di: Number of pixel i of total nominal value

Ai: Area of a pixel

Pji: Factor point

Wj: Factor weight

n: total number of factor

In order to produce a pixel-based immovable value map, the total value of each pixel is parametrically calculated with the help of formula (1) (Yomralioglu, 1993; Mete, 2019). The weight associated with the factor score is multiplied and the weighted value layer is calculated for each factor. The calculated weight value layers are summed and multiplied by the pixel areas, and the total nominal value is calculated.

3. MADE STUDIES

3.1 Study Area

The European region of Istanbul, the metropolitan city of Turkey with a population of 16 million, was chosen as the study area. Istanbul is a transcontinental city and its part in Europe is called the European Side. Istanbul is the most populated and most populated city of Turkey in terms of population. It is one of the leading cities in terms of economic, historical and socio-cultural aspects. Due to the constant immigration and the opportunities it creates, the interest in real estate is always high in Istanbul. Although the population is high, the purchase-sale and rental values of the immovables are quite high. Despite this, the real estate market is always alive. Many mega projects in Istanbul (Bosphorus bridge, connection roads, canal, etc.) frequently change the value of immovable properties. The effect of the planned Canal Istanbul project on the value of immovable properties in the European region of Istanbul has been examined objectively. In this context, a nominal real estate valuation study was carried out based on the new urbanization that will occur before and after the canal is built. In Figure (3.1), the study area for the European Region of Istanbul is shown.

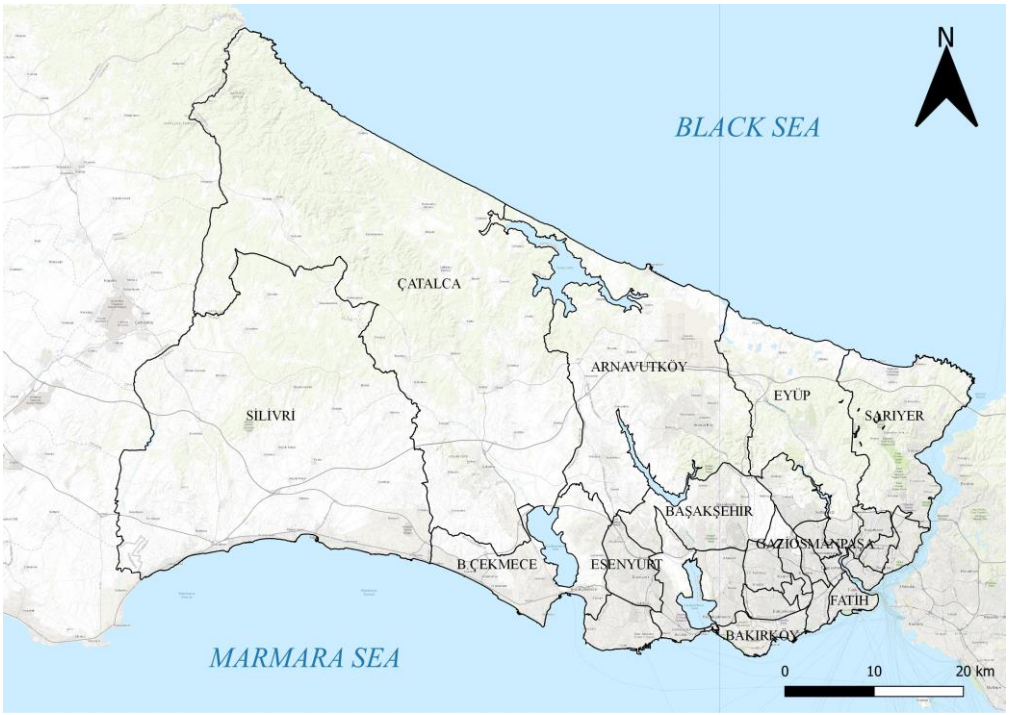

Figure 3. 1 : Istanbul province Europa region study area

3.2 Factors Affecting The Real Estate Value

There are natural, environmental, physical and legal criteria that affect the value in real estate valuation. The quality, shape, and limitations of the immovable as well as environmental criteria such as proximity to resources, location, proximity to public services, population density also affect the value. For the selection of factors, generally accepted recommendations in the literature are taken as a basis. In addition to these generally accepted factors, local conditions are also taken into account. Local factors vary according to the location of the property. For example, the sea view in a coastal city, the effect of the canal in an area with a canal view, and the effect of the forest view on the value in an area with a forest view vary.

The nominal value is a value obtained by evaluating many parameters together. For this reason, it is necessary to determine the basic parameters that can affect the value. At the beginning of these basic parameters is “position”. Analysis of spatial effects is important in the valuation study to be carried out. Position supported models should be used for the analysis of spatial effects. Another heading that affects the value is the slope and aspect of the real estate. Immovables with low slope and which can be described as flat are more preferred. In order to get the maximum efficiency from sunlight, aspect is important. The views of the property also affect the value. The fact that the view is sea, strait, forest or canal causes the value of the property to be high.

In this context, criteria affecting the real estate value in the European region of Istanbul have been determined. 19 criteria were selected for the nominal value map produced before the canal was made. 20 criteria were selected for the before-canal nominal value map, together with the canal landscape that will be formed after the canal is built. The same criteria were used for the generation of both nominal value maps, the data were updated for the new settlement formed after the canal. These criteria generally consist of factors of proximity, landscape and topography.

As proximity criteria, analyzes such as proximity to metro and metrobus stations, educational institutions, health institutions, green areas and universities were made. Slope and aspect analysis were performed as topography criteria. Sea view, Bosphorus view, lake view and canal view were examined as landscape criteria.

3.2.1 Determining The Weights of Factors

The weights of the criteria in real estate valuation vary from person to person. While the criterion affecting the value may be very important for one person, it may not be very important for another person. For this reason, it is very important that the person who will make the real estate valuation is experienced and objective.

Mete (2019) produced a GIS-based Nominal Real Estate Value map for the province of Istanbul in 2019. While determining the weights of the factors within the scope of the study, the weights calculated with the BWM (Best Worst Method) used for this GIS-based Nominal Real Estate Value map for the Istanbul in 2019 were used.

In the real estate valuation study, the effect of the criteria on the value changes. Different weight coefficients are determined according to the importance of each criterion. The higher the importance of the criterion, the higher the weight coefficient. Bosphorus view and transportation are very important criteria for the province of Istanbul. For this reason, the weight coefficients of these criteria are higher than the other criteria. The criteria affecting the value and the weighting coefficients of these criteria are shown in the Table (1.1) and Table (1.2). The distribution of the weights of the criteria affecting the immovable values is compared in Figure (3.2).

No	DATA SOURCE	FACTORS	WEIGHT
1	IBB Open Data	Proximity to Hospitals	0.03142
2	Google Maps	Proximity to Shopping Centers	0.03142
3	OSM	Proximity to Main Road Junction	0.03142
4	IBB Open Data	Proximity to Metro Stations	0.10323
5	IBB Open Data	Proximity to Metrobus Stations	0.10323
6	Google Maps	Proximity to Airports	0.04189
7	IBB Open Data	Proximity to Education Institutions	0.02513
8	Google Maps	Proximity to University	0.03142
9	OSM	Proximity to Main Road	0.04189
10	IBB Open Data	Proximity to Harmful Areas	0.02513
11	IBB Open Data	Proximity to Police Stations	0.00898
12	IBB Open Data	Proximity to Health Institutions	0.02513
13	IBB Open Data	Proximity to Park and Green Areas	0.02513
14	IBB Open Data	Proximity to Fire Stations	0.00898
15	USGS	Aspect	0.02513
16	USGS	Slope	0.02513
17	USGS	Lake View	0.03142
18	USGS	Sea View	0.06284
19	USGS	Bosphorus View	0.10323

Table 1. 1 : Before Canal Istanbul Project, Factors and Weights

No	DATA SOURCE	FACTORS	WEIGHT
1	IBB Open Data	Proximity to Hospitals	0.03142
2	Google Maps	Proximity to Shopping Centers	0.03142
3	OSM	Proximity to Main Road Junction	0.03142
4	IBB Open Data	Proximity to Metro Stations	0.10323
5	IBB Open Data	Proximity to Metrobus Stations	0.10323
6	Google Maps	Proximity to Airports	0.04189
7	IBB Open Data	Proximity to Education Institutions	0.02513
8	Google Maps	Proximity to University	0.03142
9	OSM	Proximity to Main Road	0.04189
10	IBB Open Data	Proximity to Harmful Areas	0.02513
11	IBB Open Data	Proximity to Police Stations	0.00898
12	IBB Open Data	Proximity to Health Institutions	0.02513
13	IBB Open Data	Proximity to Park and Green Areas	0.02513
14	IBB Open Data	Proximity to Fire Stations	0.00898
15	USGS	Aspect	0.02513
16	USGS	Slope	0.02513
17	USGS	Lake View	0.03142
18	USGS	Sea View	0.06284
19	USGS	Bosphorus View	0.10323
20	USGS	Canal View	0.10323

Table 1. 2 : After Canal Istanbul Project, Factors and Weights

The European region of Istanbul was limited as the study area. The data to be used for the valuation study of this region were obtained from the datasets shared by Google Maps, IBB Open Data, USGS, Open Street Map.

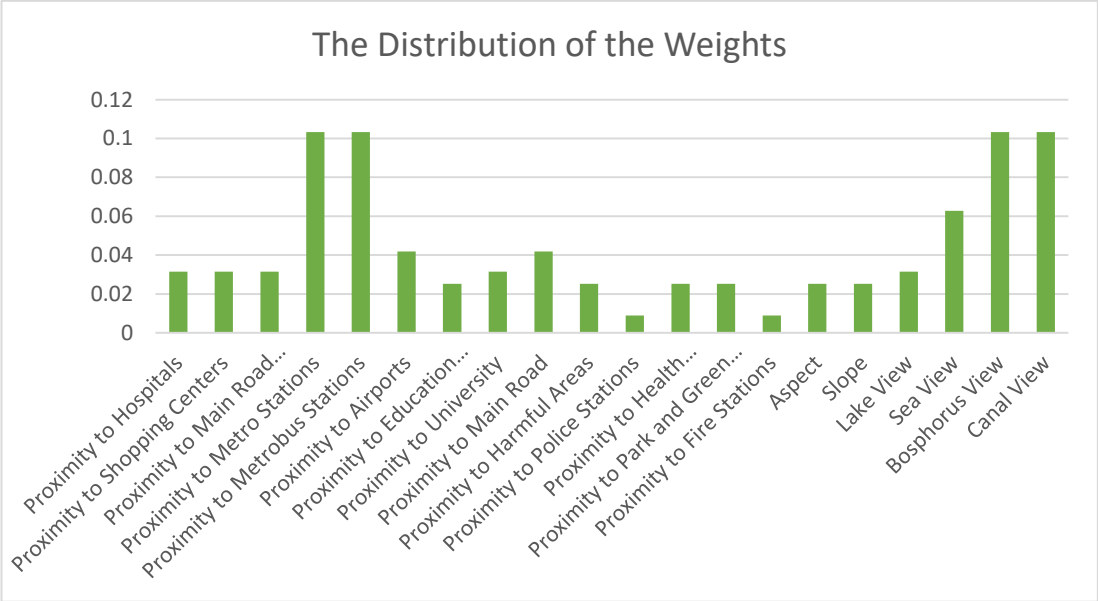

Figure 3. 2 : The Distribution of the Weights

In the analysis of proximity to airports, universities, educational institutions, health centers, harmful areas, police stations, fire stations, vector data of buildings were converted into point data and used as point data. In the proximity analysis, only vector data was used for proximity analysis to the main road line. Point data was used for other proximity analyses. In addition to these, slope, aspect and landscape analyzes were made within the scope of surface analyzes and visibility analyses.

In this study, ASTER (The Advanced Spaceborne Thermal Emission and Reflection Radiometer) data was used as the Digital Elevation Model (DEM). ASTER data is used to create detailed maps of land surface temperature, reflectance and elevation. ASTER data was used to generate slope, aspect and landscape maps. ASTER DEM data has a spatial resolution of 30 meters. Within the scope of this study, DEM images covering the Istanbul region were downloaded from the EARTHDATA website.

3.3 Establishment of Nominal Real Estate Valuation Model

The nominal real estate valuation model using selected criteria and determined weights was created using QGIS software. The analyzes were calculated with the "Raster Calculator" tool of QGIS software and nominal-based value map production was performed.

3.4 Spatial Analysis

Factors that will affect the value of a real estate should be listed and it should not be forgotten that local factors should be added while listing these factors. These factors should be examined in detail. In this study, pixel-based spatial analyzes were performed using QGIS software. Three basic analyzes were made within the scope of spatial analysis: Proximity, Surface, Visibility Analysis.

3.4.1 Proximity Analysis

Within the scope of GIS based nominal value map generation, the "Euclidean Distance" tool was used with QGIS software for proximity analysis. The Euclidean distance is based on the distance between the midpoints of the cells. Euclidean distance calculates the shortest bird flight distance from one point to another. In this analysis, vector data was converted to raster and raster data was used as a source.

Raster maps were created as a result of proximity analysis. These proximity maps were classified to take values between 0 and 100. In the classification made, values are given

according to walking distance and convenience of transportation by vehicle. For example, for a school to be within walking distance, up to 400 meters will affect the value 100%. It affects 90% for distances between 400 and 600 meters, and 50% for distances between 1 and 2 kilometers. It is suitable for transportation by car for the distance to the main road junctions and it affects 100% for the distance up to 1 kilometer. The furthest distance that can affect the value in both access distances was determined as 5 kilometers. As an example of proximity analysis, the proximity analysis to the hospitals produced for the pre-canal project is carried out in Figure (3.3). Maps of other proximity analyzes are given in the APPENDIX section.

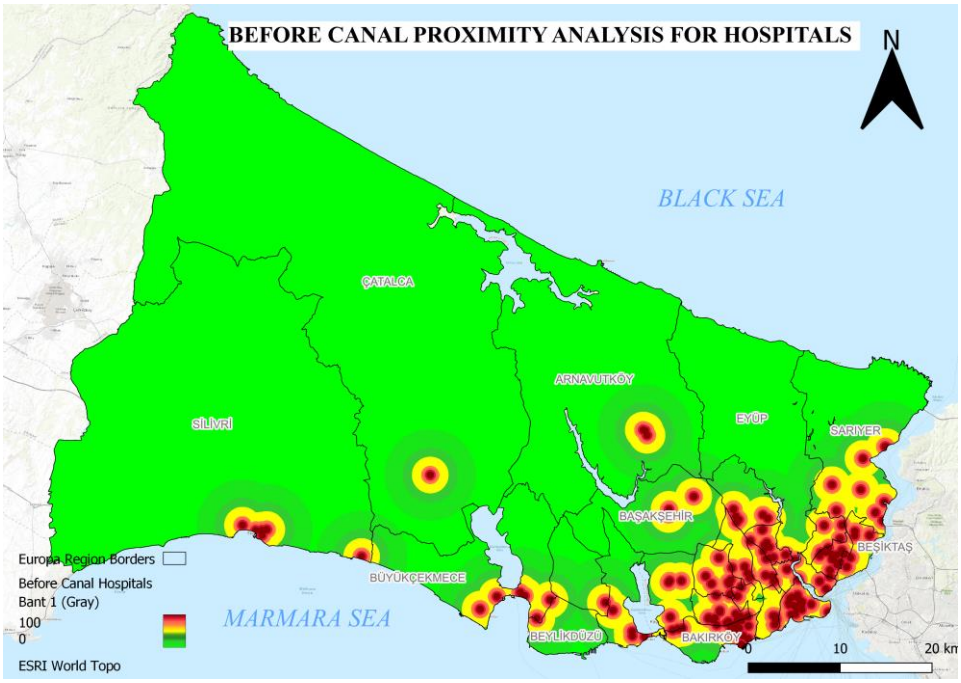

Figure 3. 3 : Before Canal Proximity Analysis for Hospitals

The distance of a real estate from hospitals is one of the factors that directly affect the value. It is critical to be close to hospitals, which are very important for human health. Being close to the hospital within walking distance (400 meters) affects the value 100%. It also supports new formations around hospitals and has a high potential to create a center. Hospital location data was used as point data in the study area of Istanbul Europe region, and after rasterization, proximity analysis was performed. Within the scope of the study, QGIS software was used and Euclidean Distance calculation was made.

3.4.2 Surface Analysis

In the ASTER DEM image, each cell has a specific height (z) value. For the calculation of the slope used for slope analysis, it is found by the maximum rate of change between two neighboring cells. The preferred criterion for immovable properties is the absence of slope, a flat land is preferred. If the slope is high, we conclude that the land is uneven, and land with a high slope, both in terms of cost and productivity, negatively affects the value. In this study, percent slope value was used. The percent slope is formulated as the ratio of the rise side of a right triangle to the side of the sun multiplied by one hundred.

Within the scope of the study, ASTER DEM data with a resolution of 30 meters was used to perform the slope analysis. Using the “slope” tool of the QGIS software, the slope map was created for the study area for before and after canal. The slope analysis map is given in the APPENDIX section.

ASTER DEM data was prepared for the maps produced after the canal was built. ASTER DEM data was clipped along the canal path and the cell values (height) were refreshed to 0. The created ASTER DEM data was used in the analyzes made after the canal was made. Before the canal was made, the originally downloaded ASTER data was used. The data types used in both studies are the same and the classification scores are the same. Thus, a more objective evaluation was aimed.

In the slope analysis, slope maps were classified in such a way that the effect of 0 to 1% slope value on the value is 100%, the effect of 90% for the fields with 1% to 2% slope on the value, and 0% effect of the fields with 12% or more slope value on the value.

Aspect refers to the direction of the slope of each cell at the maximum rate of change with respect to neighboring cells. Aspect refers to the facades of the real estate in real estate valuation. Considering the geographical location of Turkey, it is preferred that the buildings face south.

Within the scope of surface analysis, QGIS software and "Aspect" tool were used for aspect analysis in the production of both nominal value maps. In the aspect analysis, values between 135° and 225° represent the regions whose slope faces south. For this reason, the effect of the regions facing South on the value is 100%, the effect of the

remaining values on the value is classified as 0%. The aspect analysis map produced for the after canal is given in Figure (3.4).

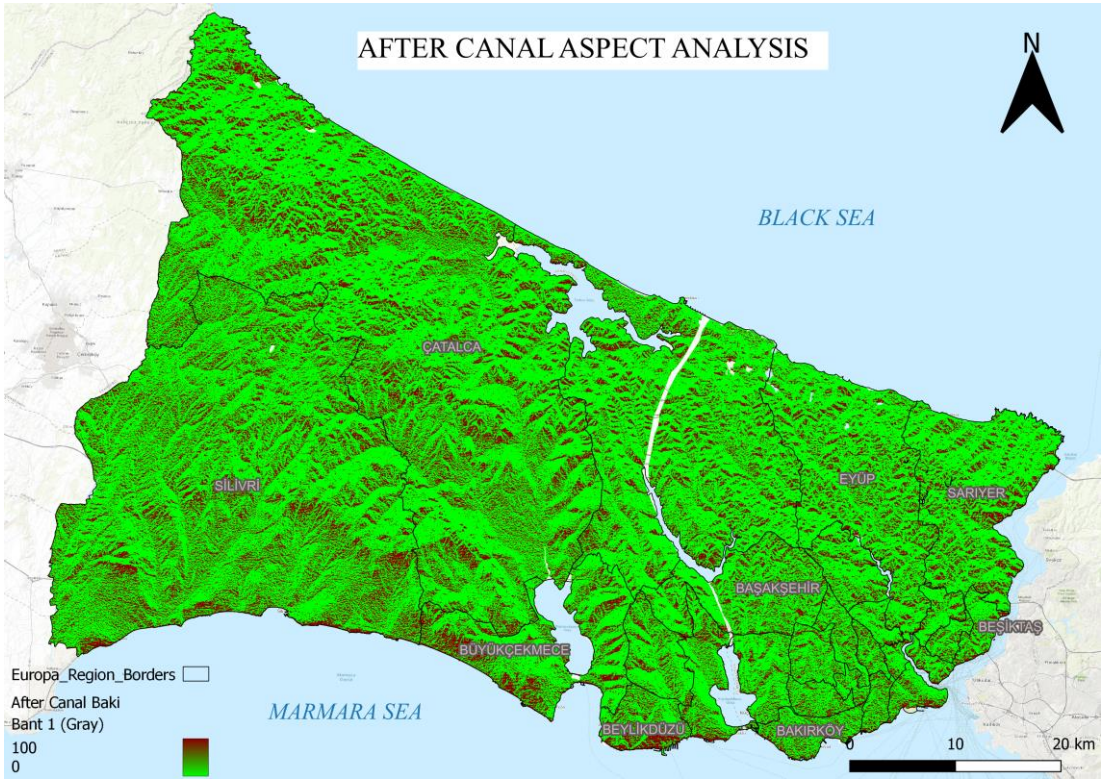

Figure 3. 4 : After Canal Aspect Analysis

3.4.3 Visibility Analysis

Visibility analyzes allow to identify raster surfaces visible to the observer. Visible and invisible surfaces are determined as value thanks to the visibility analysis.

Within the scope of the work for visibility analysis, 2 different visibility analysis studies were carried out for before canal and after canal. For the visibility analysis carried out within the scope of the pre-canal nominal value map production, three different visibility analyzes were carried out, namely the view of the Bosphorus, the sea and the lake. QGIS software and "Visibility Analysis" plugin were used for visibility analysis. Random points on the sea surface were determined by using the "Random Points in Polygons" tool for the sea and Bosphorus view. Random points were determined for the lake view using the "Random Points on Lines" tool. “Viewshed” visibility analysis was performed for surfaces that can see these points. The effect of the sight seeing areas on the value was determined as 100%, and the blind areas were determined as 0%.

In the new model, which will be formed after the canal is built, the view of the canal was also taken into account. Random points were determined in the canal region by using the "Random Points on Polygons" tool for the canal route. Thus, visibility analysis was performed for areas with canal views. The result of the "Viewshed" visibility analysis of the canal scene determined along the canal route is shown in the Figure (3.5) below. Thus, a map of the regions with canal views was obtained. ASTER DEM data with a resolution of 30 meters was used as the Digital Elevation Model. The maps of the visibility analyzes of the sea, lake and Bosphorus scenery produced for the before and after canal situations are given in the APPENDIX section.

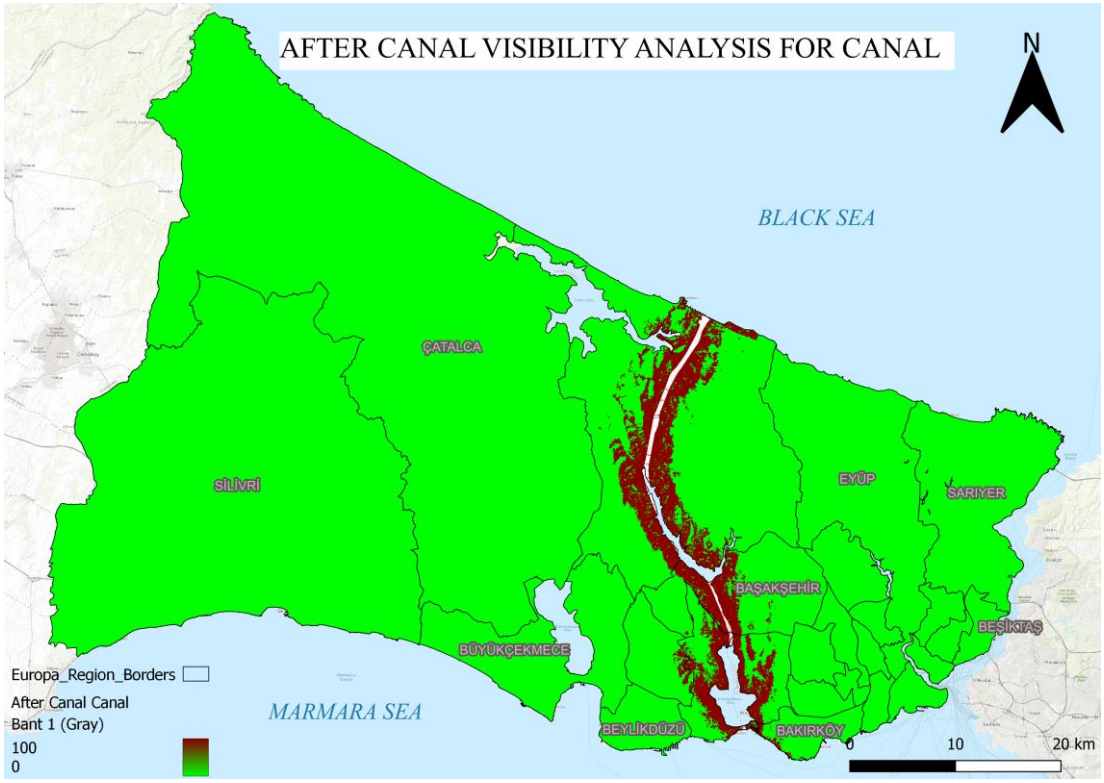

Figure 3. 5 : After Canal Visibility Analysis Canal Route

3.5 Istanbul Province European Region Nominal Real Estate Value Map

In the European region of Istanbul, the nominal value maps produced according to the zoning plan to be formed before and after the canal project is made consist of pixels with a resolution of 10 meters. In order to produce a value map with a pixel size of 10 meters, the model was run by selecting parameters such as the data of the study area

and pixel size. A total of 39 analyzes were performed in the production of two nominal value maps.

In the value maps produced, values are expressed as percentages. In the nominal value map produced before the canal project, the highest value is 100% and the lowest value is 4.071653%. The highest value for the nominal value map produced according to the zoning map that will be formed after the canal project is completed is 100% and the lowest value is calculated as 4.075864 %. Figure (3.6) and Figure (3.7) show the nominal value maps before and after the Istanbul Europe region canal project. The increase in the value of the areas on the canal route is remarkable.

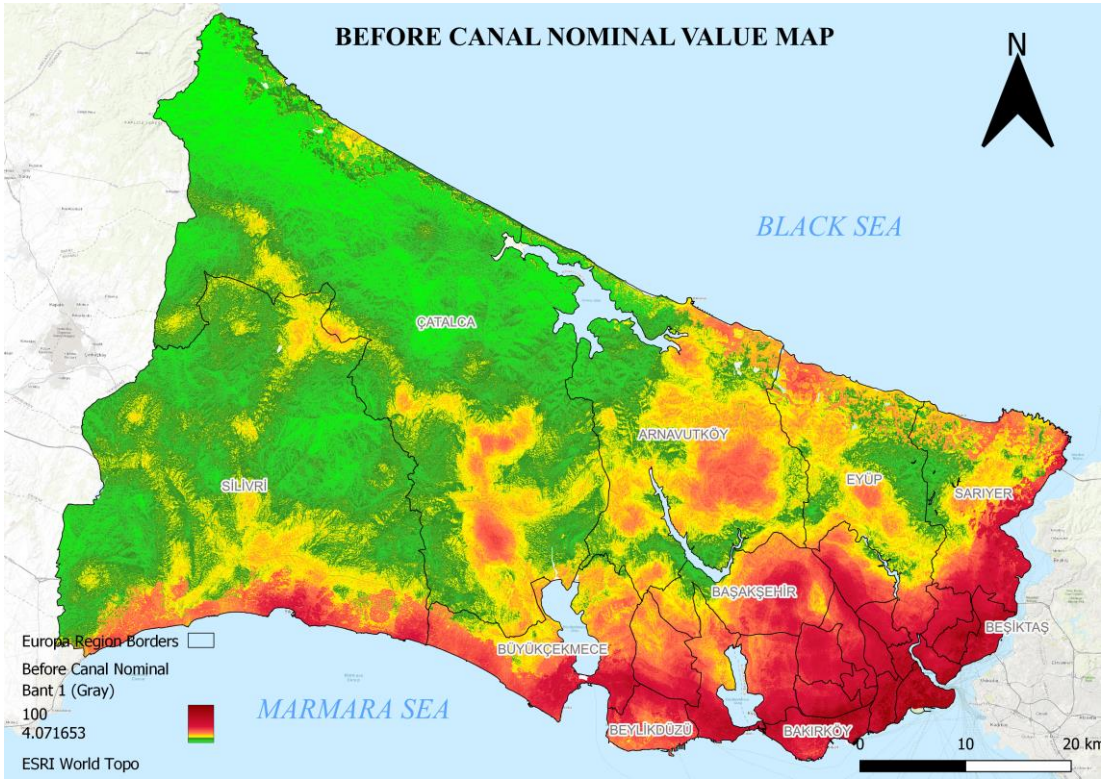

Figure 3. 6 : Before Canal Nominal Value Map

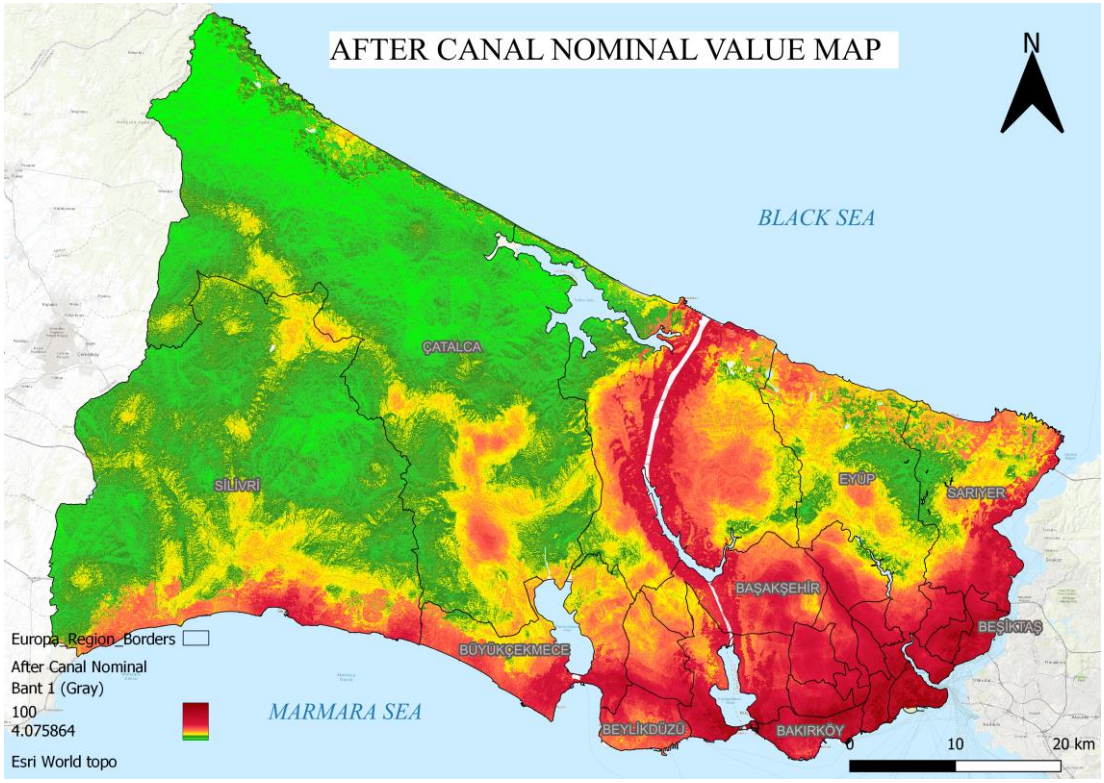

Figure 3. 7 : After Canal Nominal Value Map

When the nominal based maps produced are examined, the value changes are visible. For example, the before canal and after canal nominal value maps for the Sazlıdere Dam region of the Istanbul European region are compared in Figure (3.8). After the Canal project around the dam, a significant increase in value was realized.

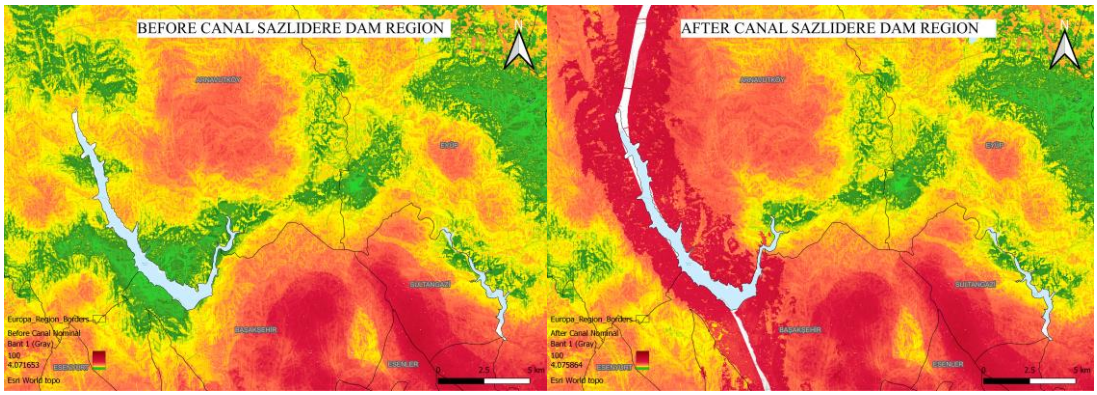

Figure 3. 8 : Before and After Canal Sazlıdere Dam Region

A nominal value map was produced on the route of Canal Istanbul and the nominal values produced for both nominal value maps were compared on a parcel basis and considering only nominal values. For the comparison made by considering the parcels,

the current parcel map data before the canal project was obtained. The clipping process was performed according to the parcel data, the zoning project of the canal Istanbul project. For each parcel, the "mean" nominal value for each parcel was obtained by using the QGIS software "Zonal Statistics" tool. Using the parcel map of the Canal Istanbul Reconstruction Project, the mean nominal value for each parcel was obtained for the Canal Project with QGIS software. Before the Canal Project, the parcels in the study area were calculated as 263102.3 points in total. After the Canal Project, the total value of the parcels for the same study area was calculated as 380180.0 points. It was determined that the Canal Istanbul project increased the total average parcel nominal value of the project area by 117077.7 points. The parcel maps used for the total nominal change in the canal project parcels are shown in Figure (3.9).

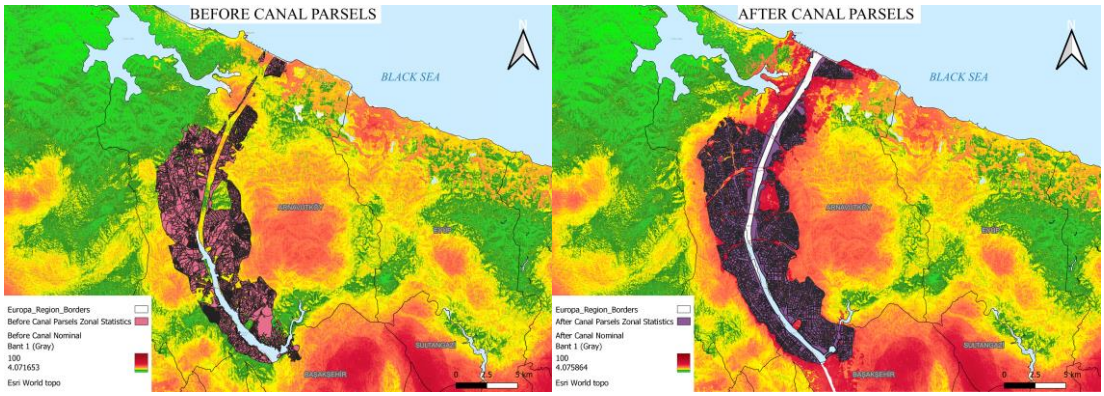

Figure 3. 9 : Before and After Canel Parsels

The effect of the Canal Istanbul project on the nominal values in the Istanbul European region was determined using the QGIS software "Raster Calculator" tool. When the change in value is examined, there have been intense regional value increases in the canal route. The nominal value increases around the canal vary. In addition, the Canal Project has not always affected the value upwards. In some regions, it has been determined that it affects the value negatively. The nominal value change map is shown in Figure (3.10).

It was determined that the nominal value increased by a maximum of 41.859367 points on a pixel basis compared to the before canal, and the decrease in the nominal value was determined as a maximum of 16,688103 points.

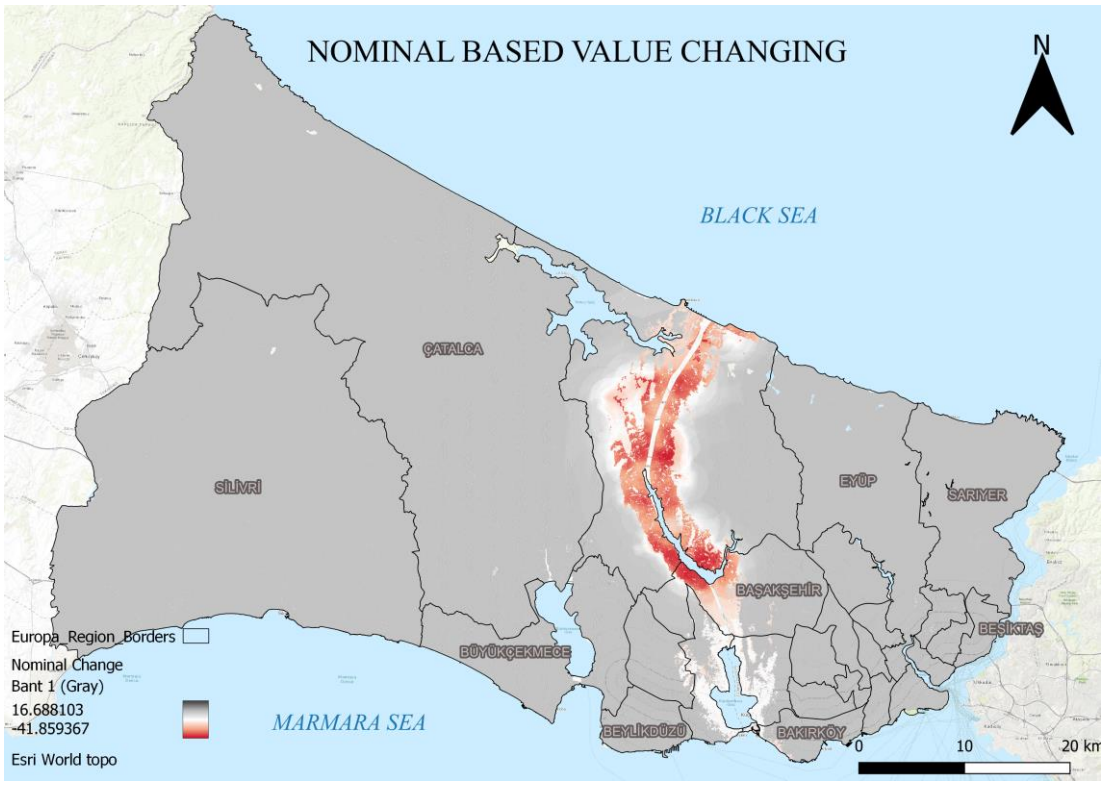

Figure 3. 10 : Nominal Based Value Changing

4. FINDINGS

The findings obtained as a result of the studies carried out on the analysis of the real estate value change that will be created in the vicinity of the Istanbul Province European Region Canal Istanbul Project with GIS, are summarized below.

-Nominal valuation method facilitates valuation studies in large areas. Contrary to valuation methods that take a lot of time, large areas allow for a practical and objective valuation study when the right data is selected and used. Thanks to GIS software, analyzes are carried out in a short time.

- Determination of local criteria is important in determining the criteria to be used in the valuation. The use of correct data and up-to-date data for the valuation study increases the timeliness and accuracy of the study.

- It is critical to use the literature to determine the weights to be used for value map generation. The analyzes created are used in the production of value maps with GIS software by using their weights.

- 19 criteria were used for the nominal value map produced before the canal project was made. For the nominal value map produced after the canal project, 20 criteria were used. With the canal project, a view of the canal was added in addition to the visibility analysis.

- In the valuation study, the same criteria were used in the production of both nominal value maps and the study was carried out with current data. The pixel size of the generated value maps was produced at a resolution of 10 meters.

- The GIS-based nominal valuation method has revealed the impact of mega projects such as the Canal project on immovable values in large areas in a short time. Along with projects, effective value change can be observed for any area with adjustable pixel size, parcel change can be determined with high accuracy with value maps produced up to 10 meters resolution.

- When the two nominal value maps created are compared, nominal-based value change can be easily determined. It has revealed the immovable value effect that a project that has not yet been made will create in the environment.

5. RESULTS

-Nominal real estate valuation method is one of the stochastic valuation methods. Nominal valuation method enables to produce fast and highly accurate real estate value map by using variables such as criteria, location, resolution to be created together with GIS supported analysis. In this study, the effect of the Canal Istanbul project, which is planned to be built in the European Region of Istanbul, on the real estate values has been examined.

The value map was created using GIS according to the determined criteria. Raster-based maps of the criteria were produced using proximity, visibility and surface analyses. After the raster maps were produced, the weighted sum of the pixels and nominal values were calculated.

In this context, two nominal-based value maps with a pixel resolution of 10 meters were produced. One of them is the current Istanbul Europe region nominal value map for the before canal project, and the other generated value map is the nominal value map produced according to the new zoning plan that will be formed after the Canal Istanbul project.

When the two nominal value maps are compared, the increase in value along the canal route is clearly revealed. Adding and comparing the average nominal values of the parcels for the canal region increased the nominal value of the project area by 117077.7 points.

- When the two maps are compared, the value changes over 100% on a pixel basis were calculated and the pixels that were positively and negatively affected by the value change were determined and classified.

- The Küçükçekmece lake, which was used as a lake before the canal was built, will be considered as a canal after the canal is built. However, an increase was observed in the real estate values of the Küçükçekmece region, which had a high value before the canal.

- While the project has positive effects on value, negative effects have also been observed. An increase in the value of one region can negatively affect the value of other regions.

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APPENDICES

APPENDIX A: Maps

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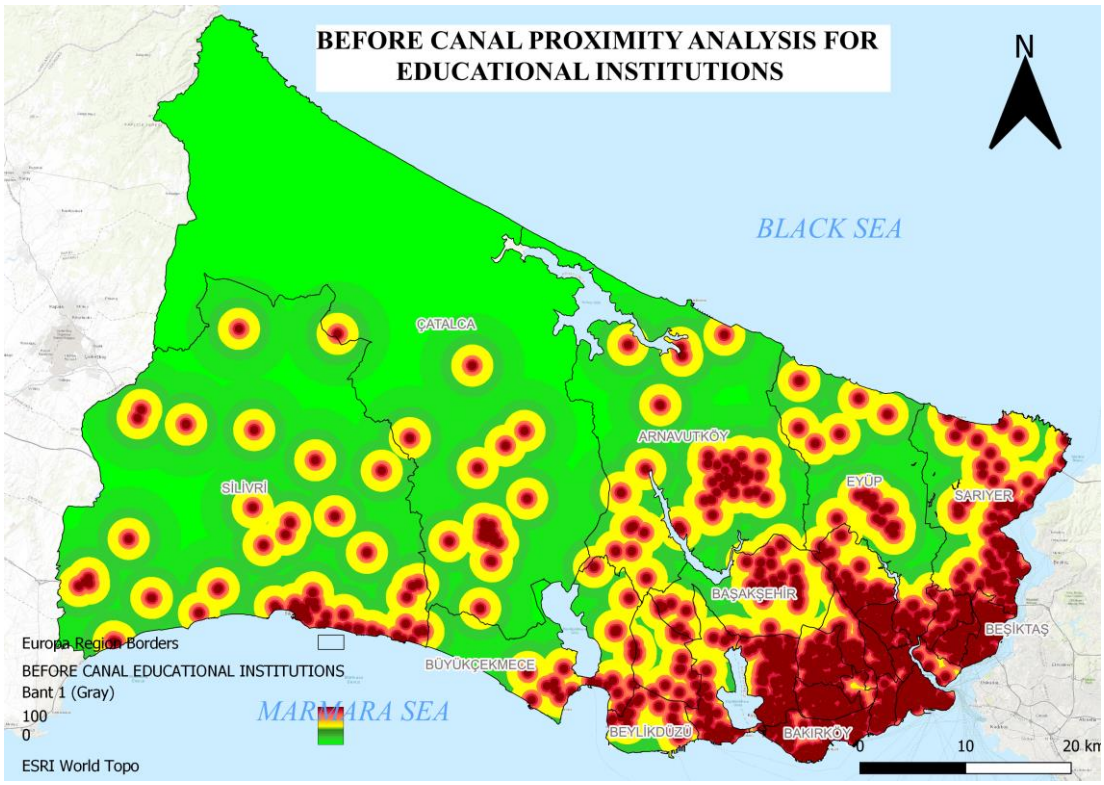
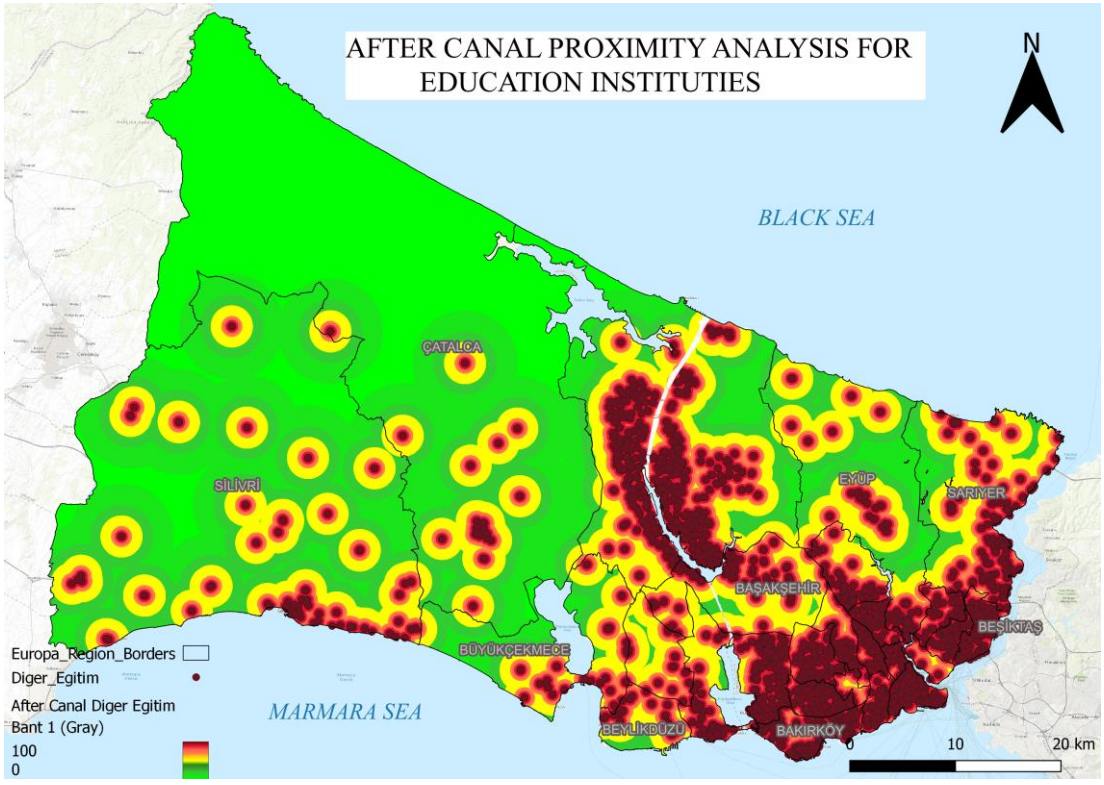
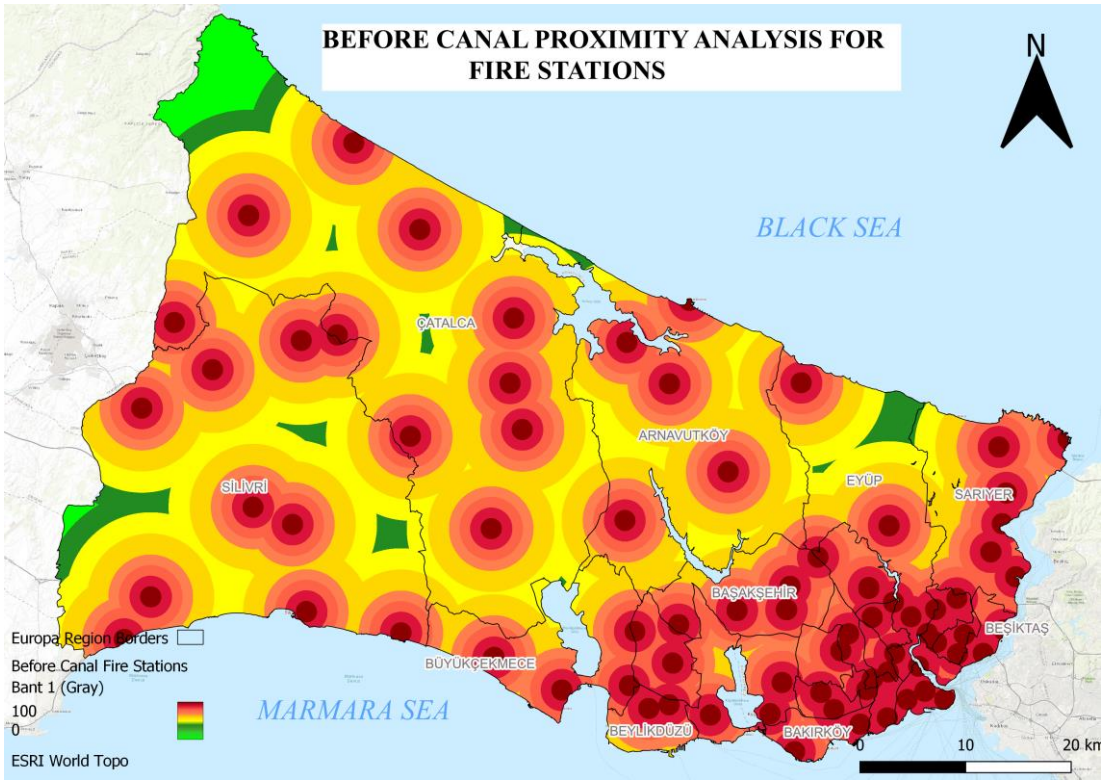


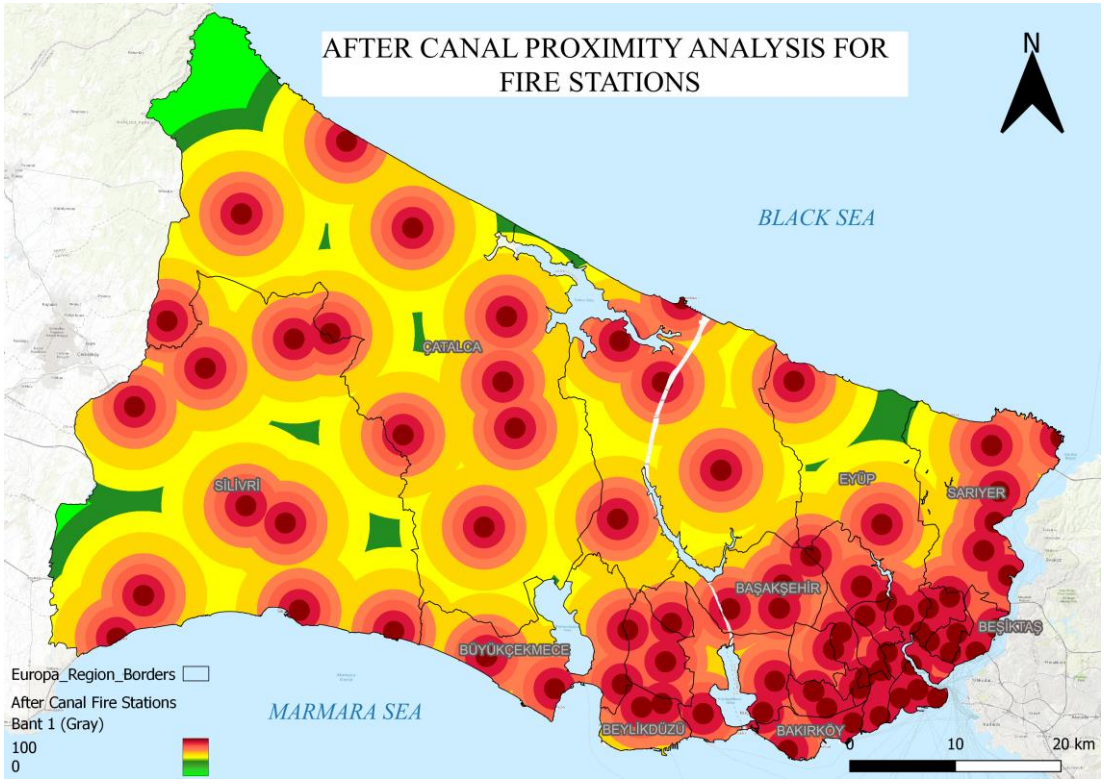
(1) before canal proximity analysis for educational institutions



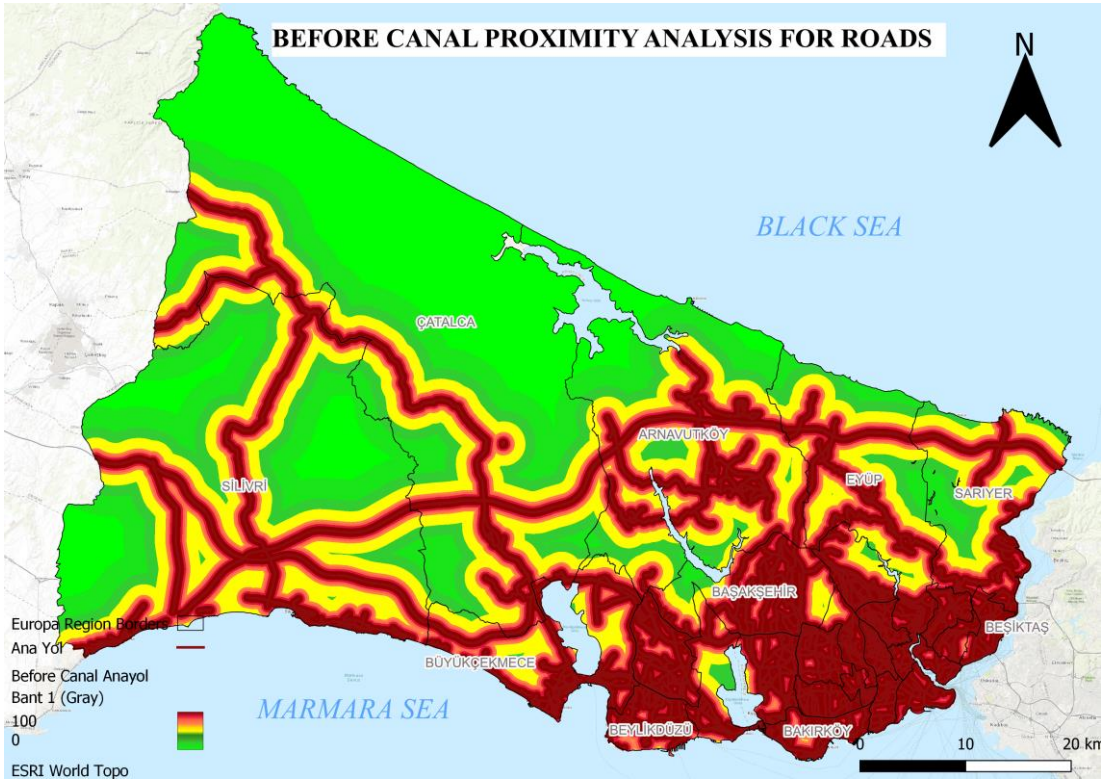
(2) before canal proximity analysis for educational institutions



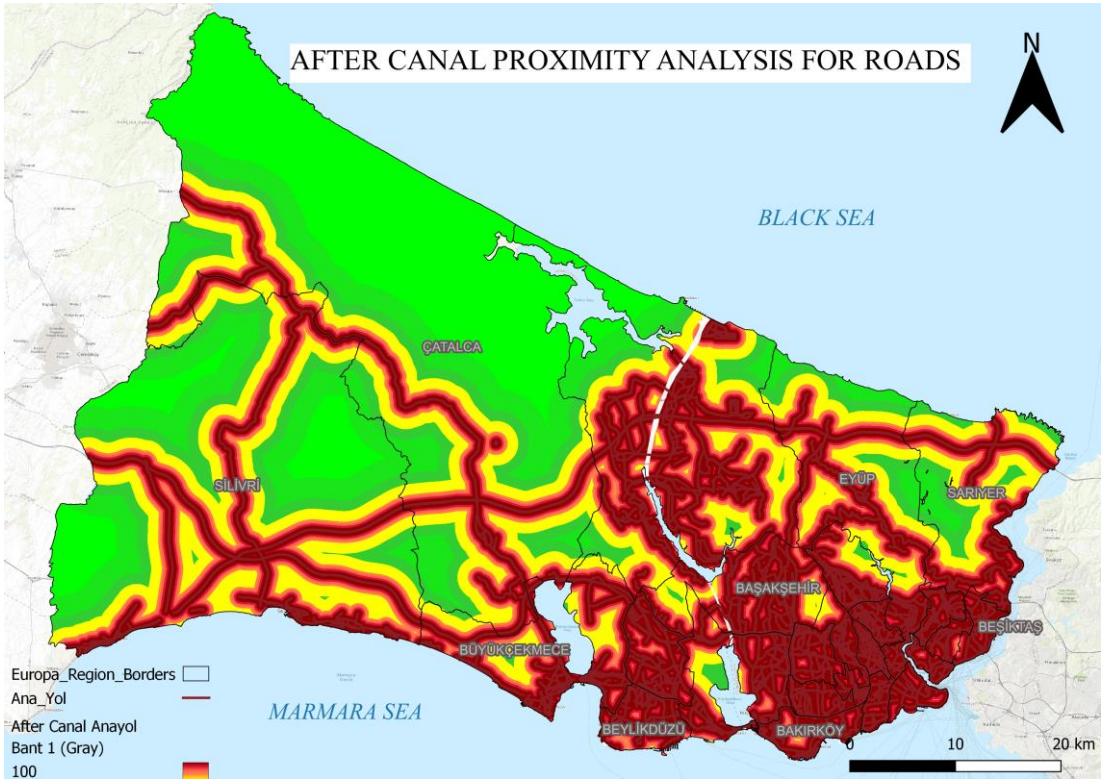
(3) before canal proximity analysis for fire stations



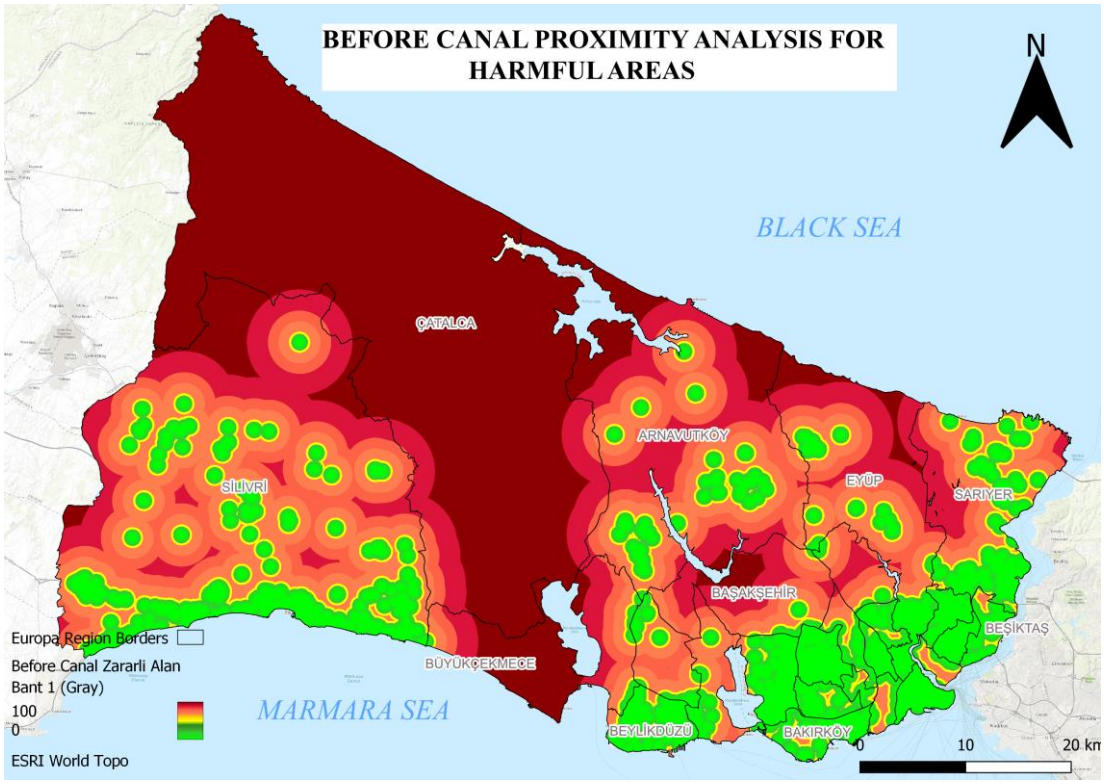
(4) before canal proximity analysis for fire stations



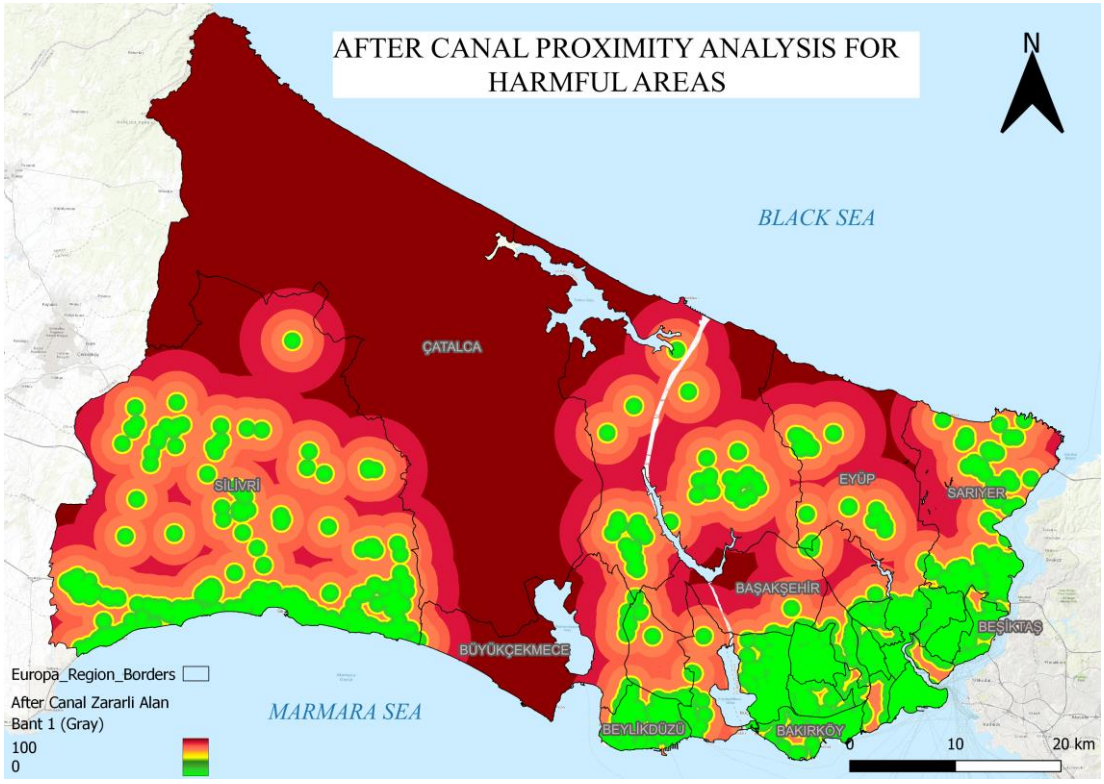
(5) before canal proximity analysis for main roads



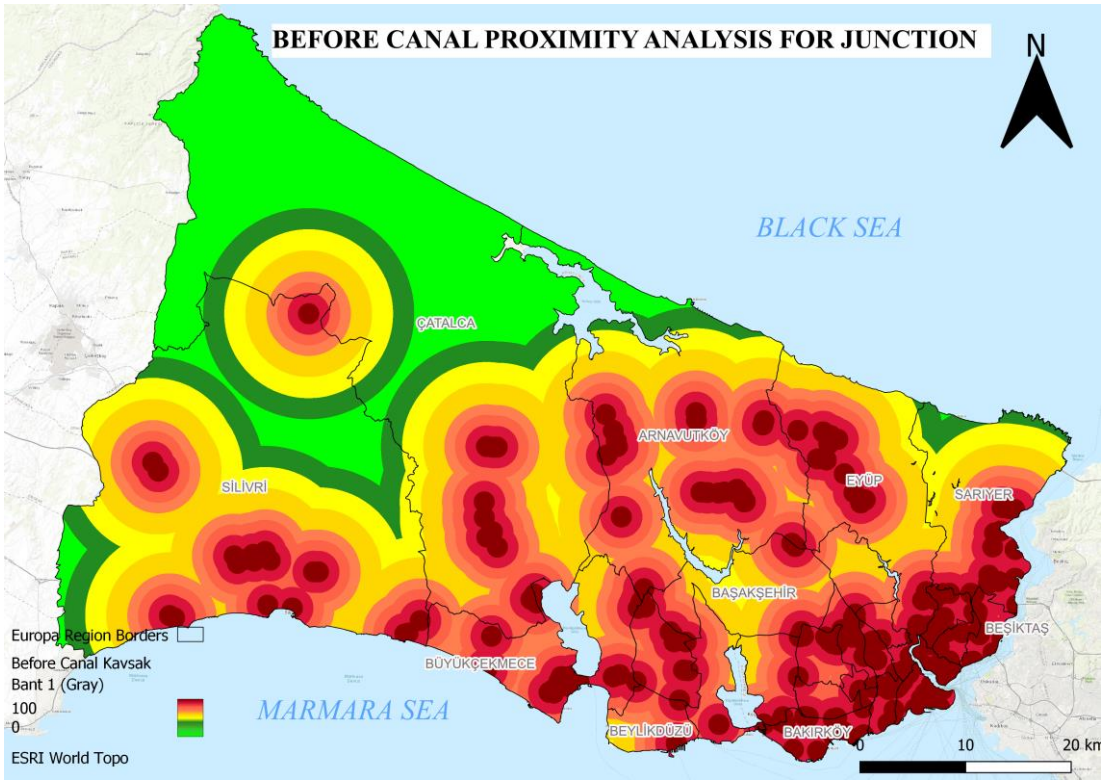
(6) after canal proximity analysis for main roads



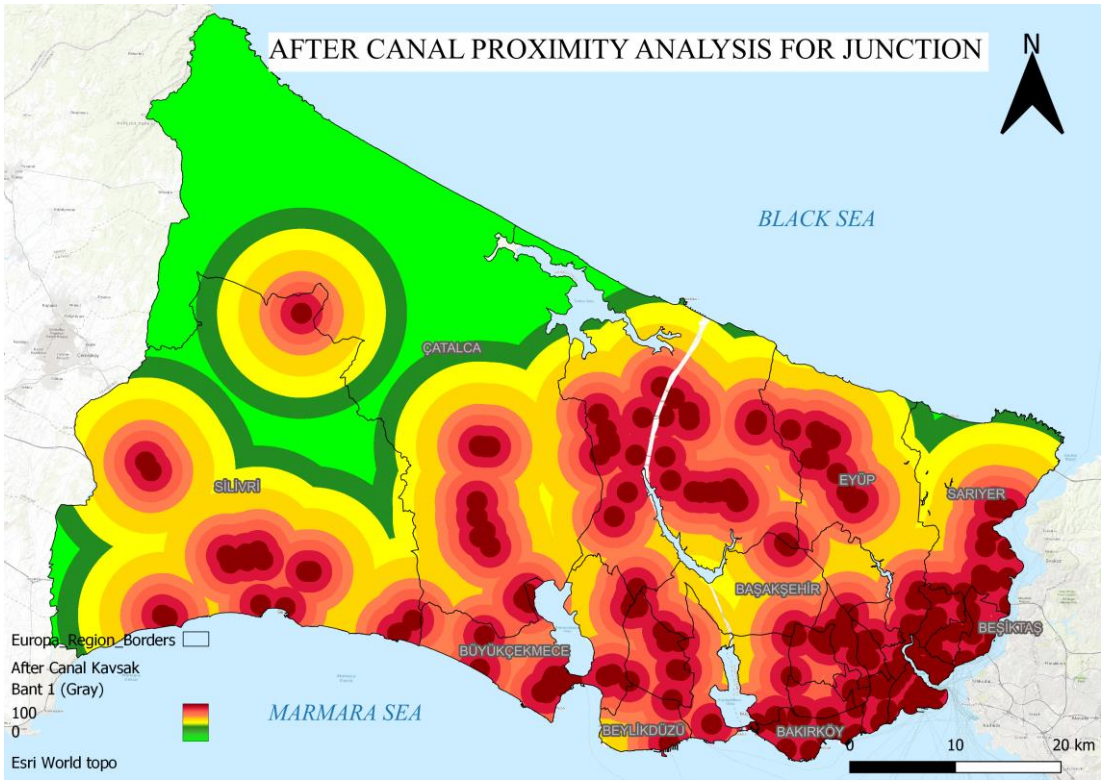
(7) before canal proximity analysis for harmful areas



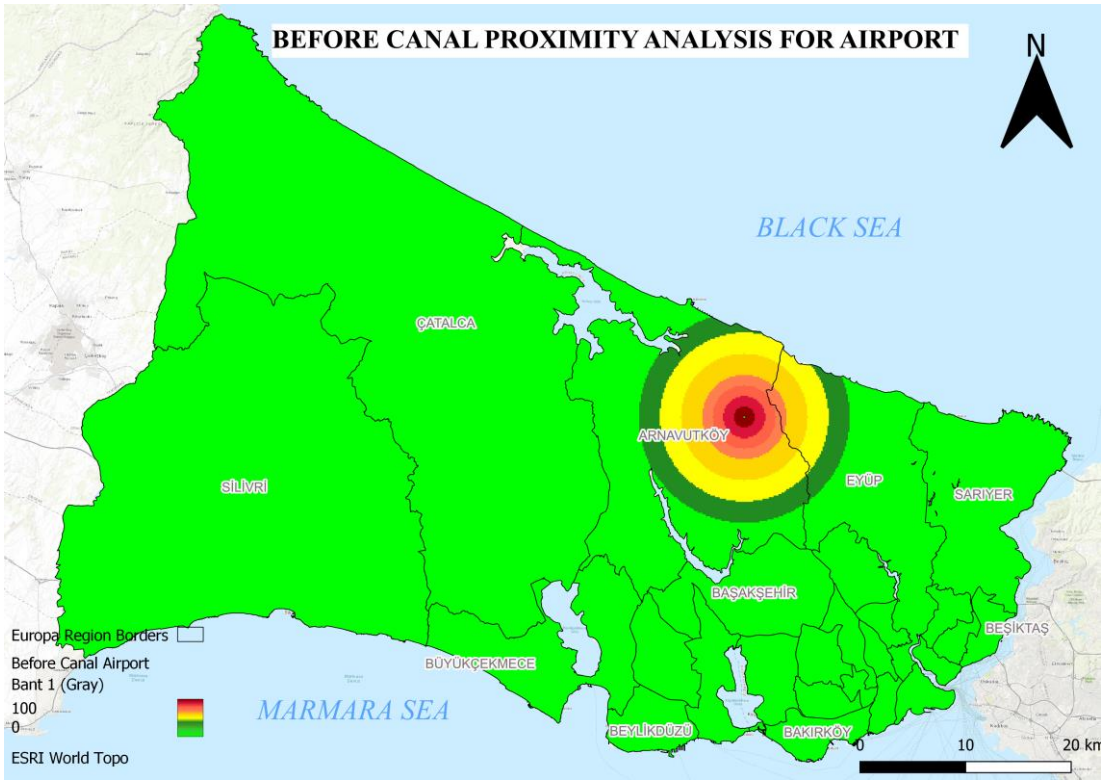
(8) after canal proximity analysis for harmful areas



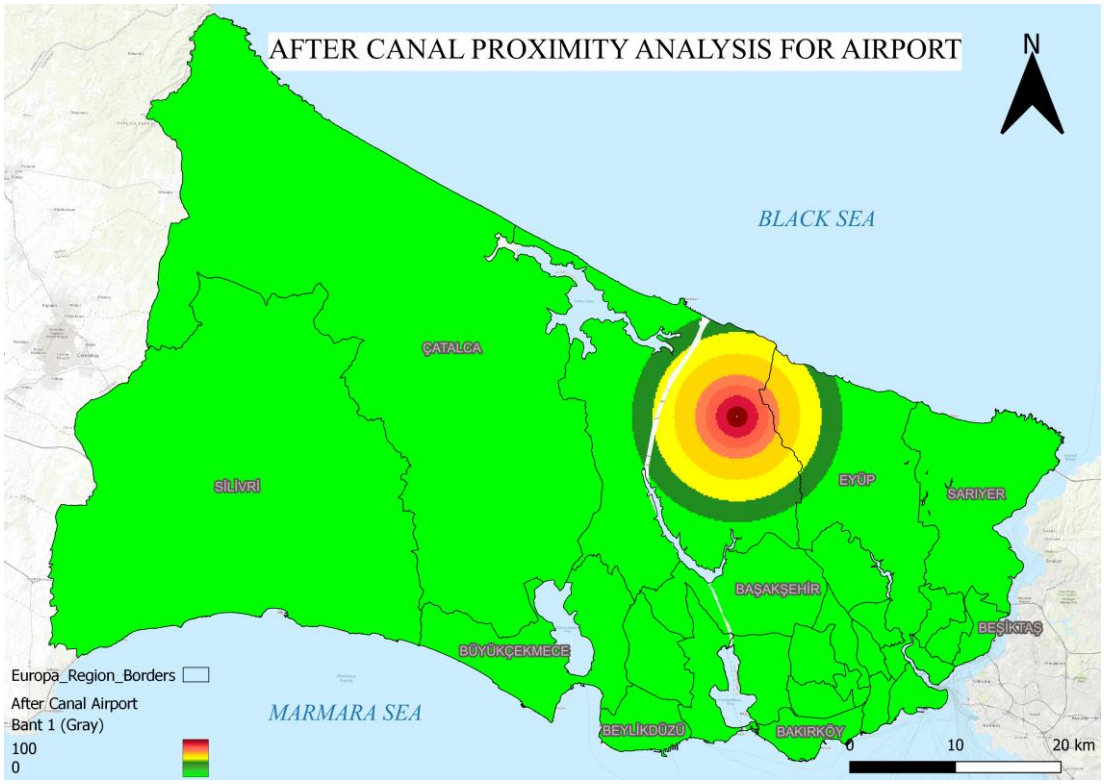
(9) before canal proximity analysis for junction



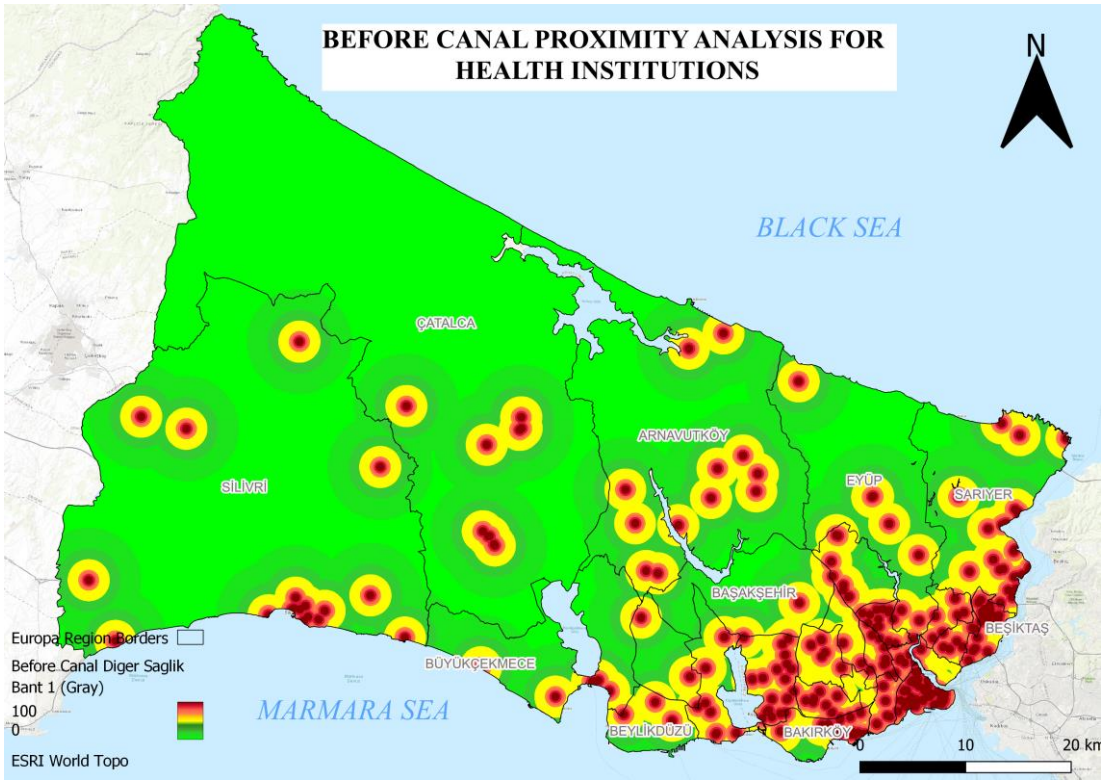
(10) after canal proximity analysis for junction



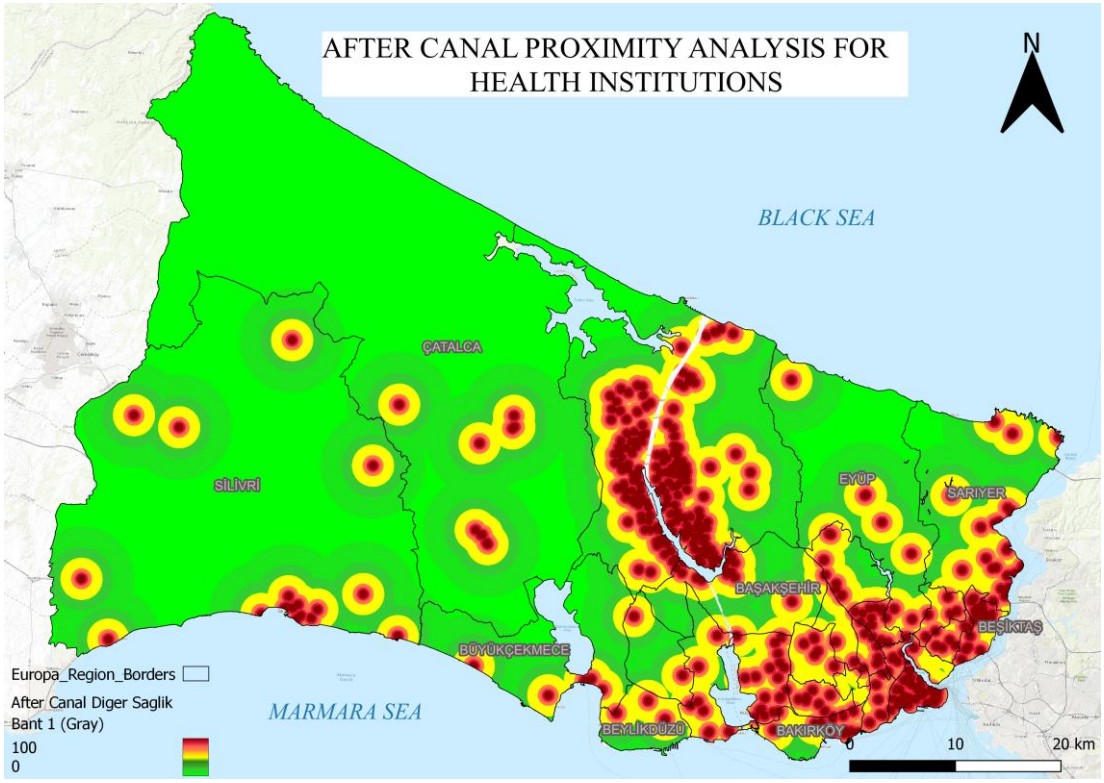
(11) before canal proximity analysis for airport



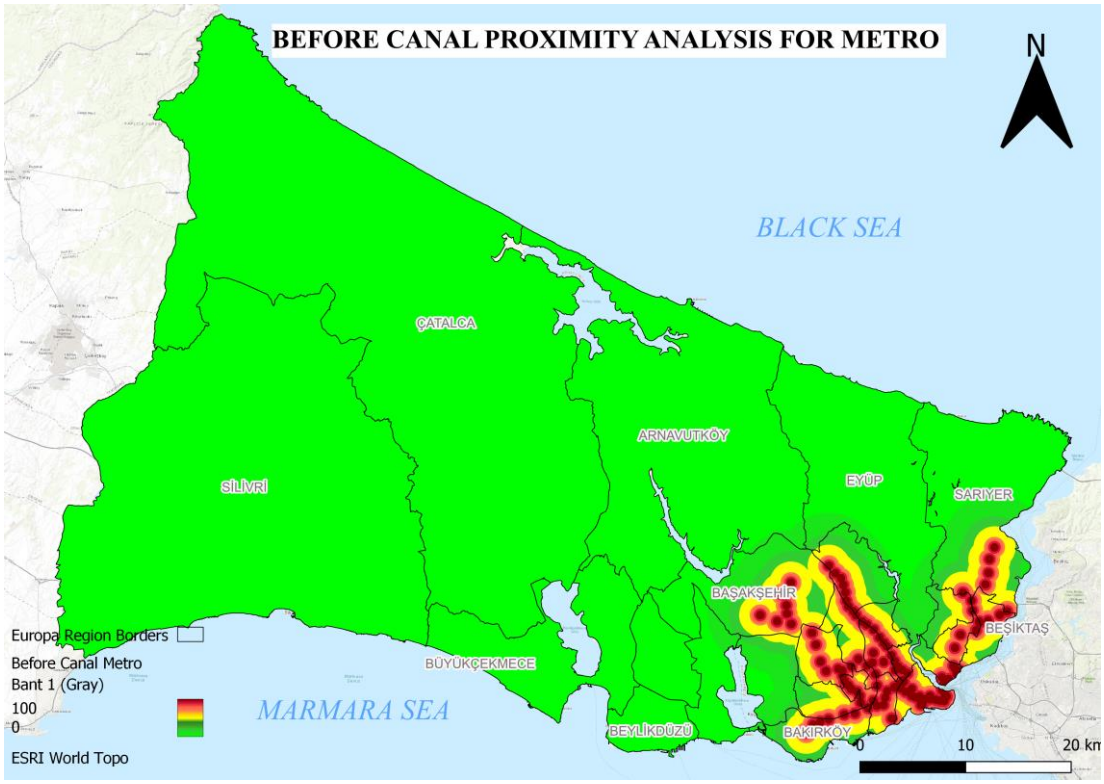
(12) after canal proximity analysis for airport



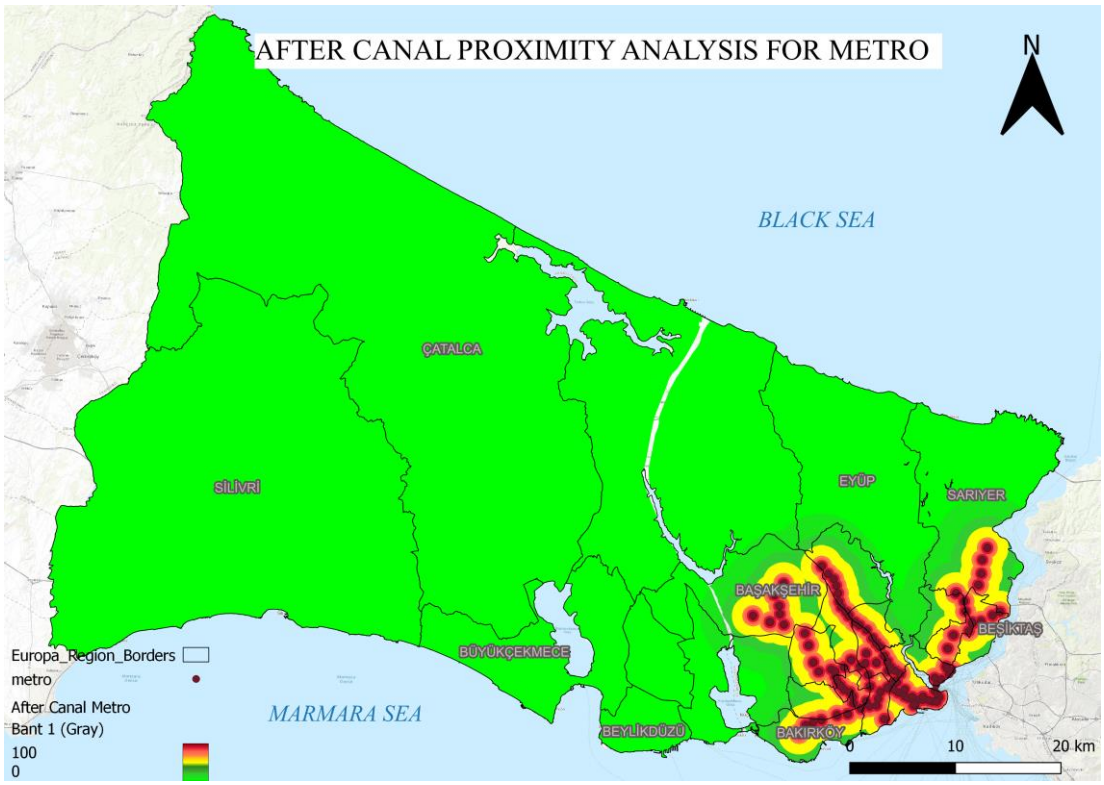
(13) before canal proximity analysis for health instituties



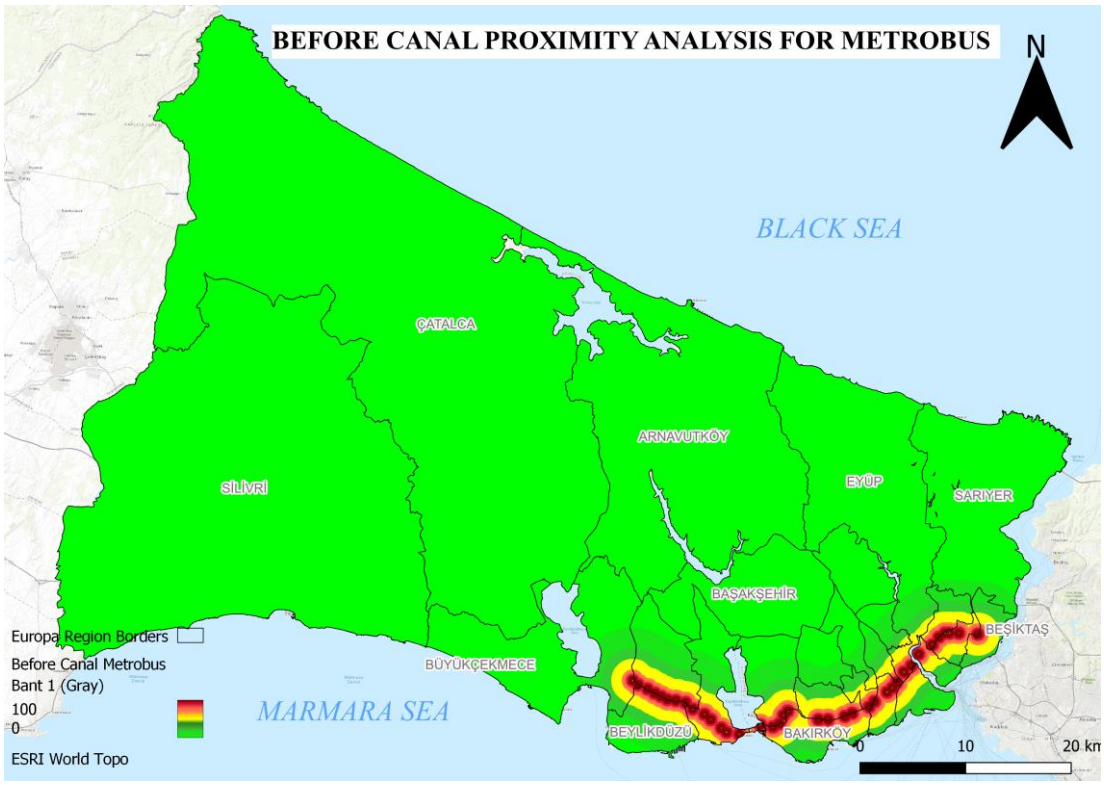
(14) after canal proximity analysis for health instituties



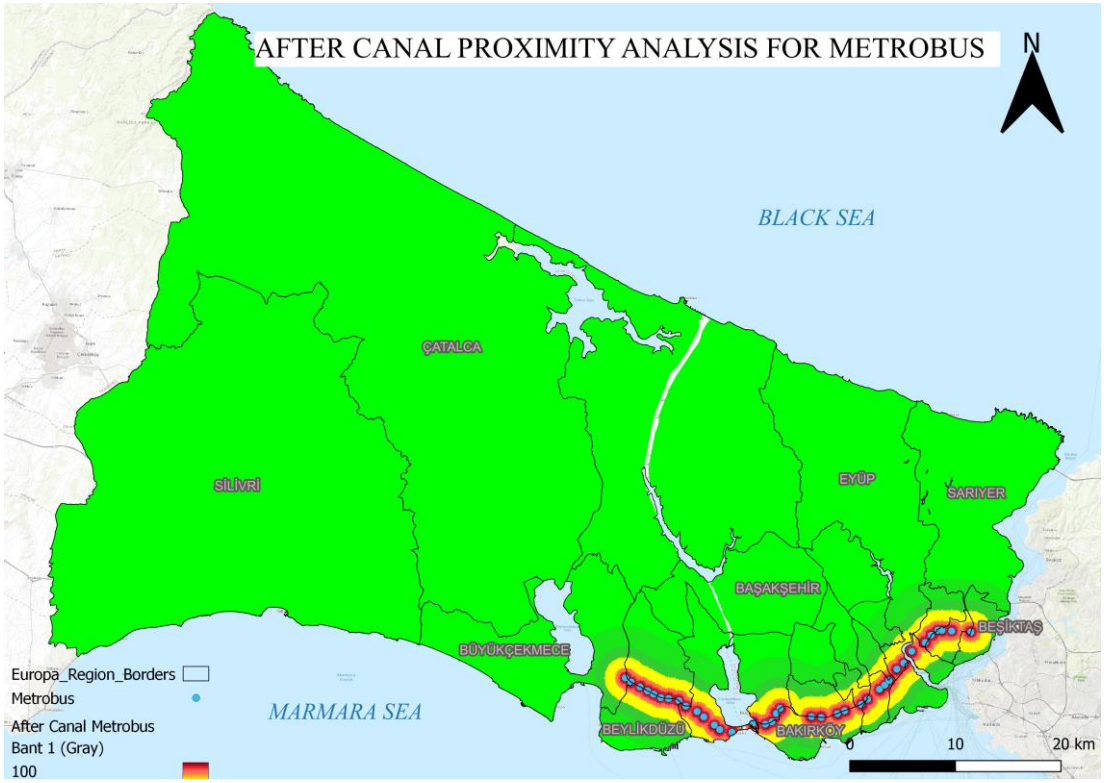
(15) before canal proximity analysis for metro



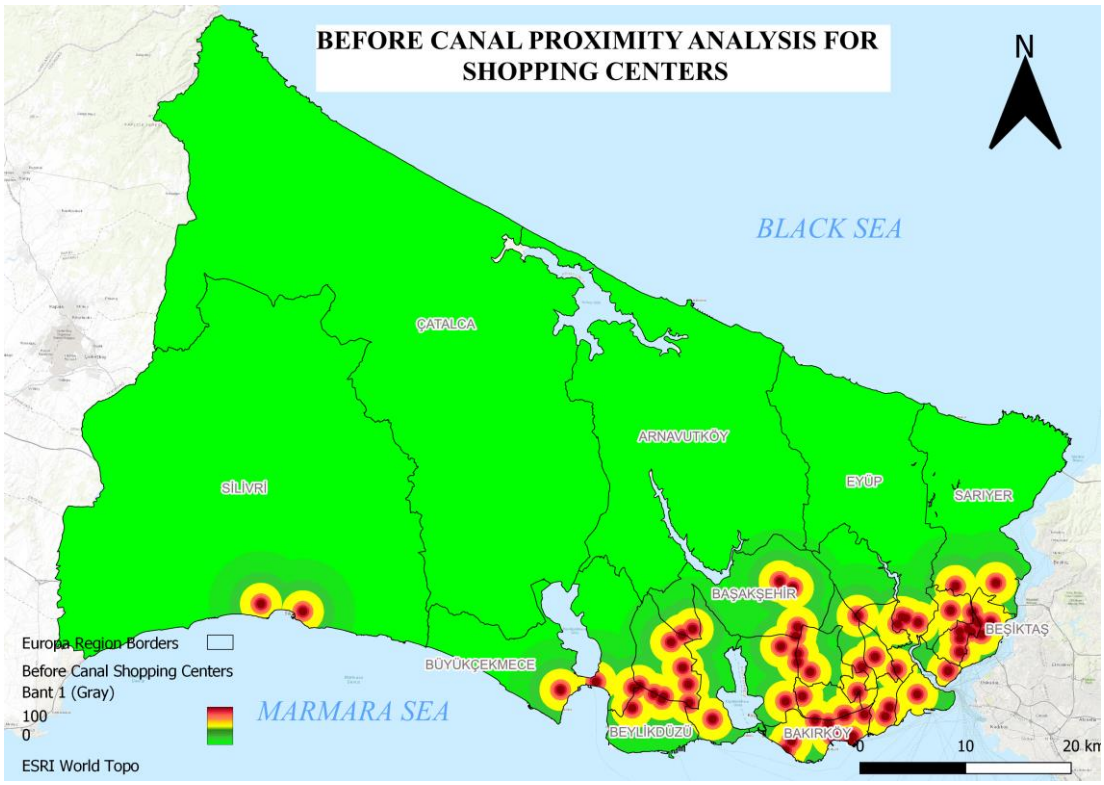
(16) after canal proximity analysis for metro



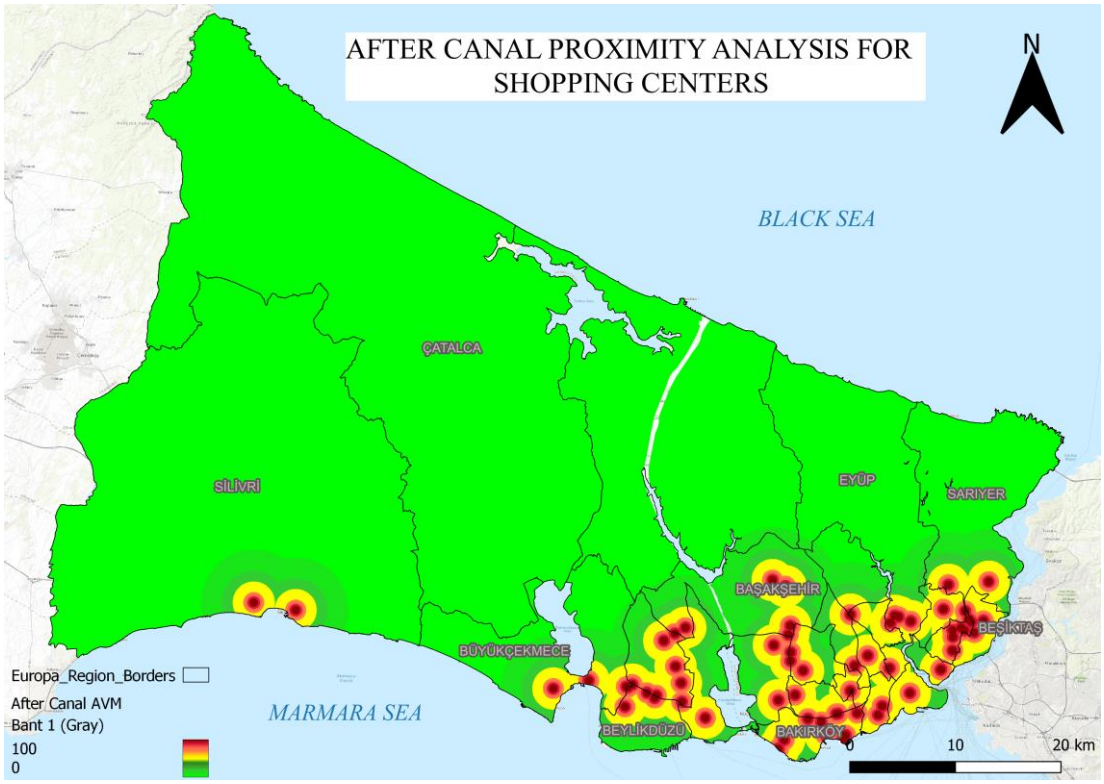
(17) before canal proximity analysis for metrobus



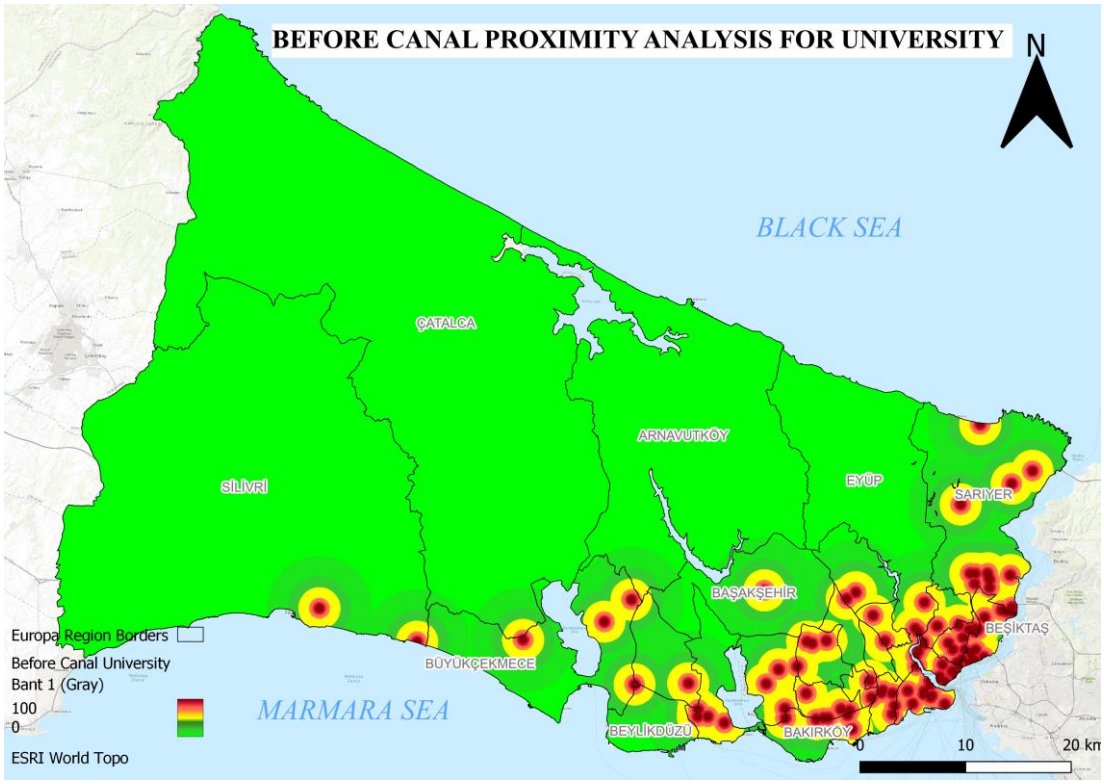
(18) after canal proximity analysis for metrobus



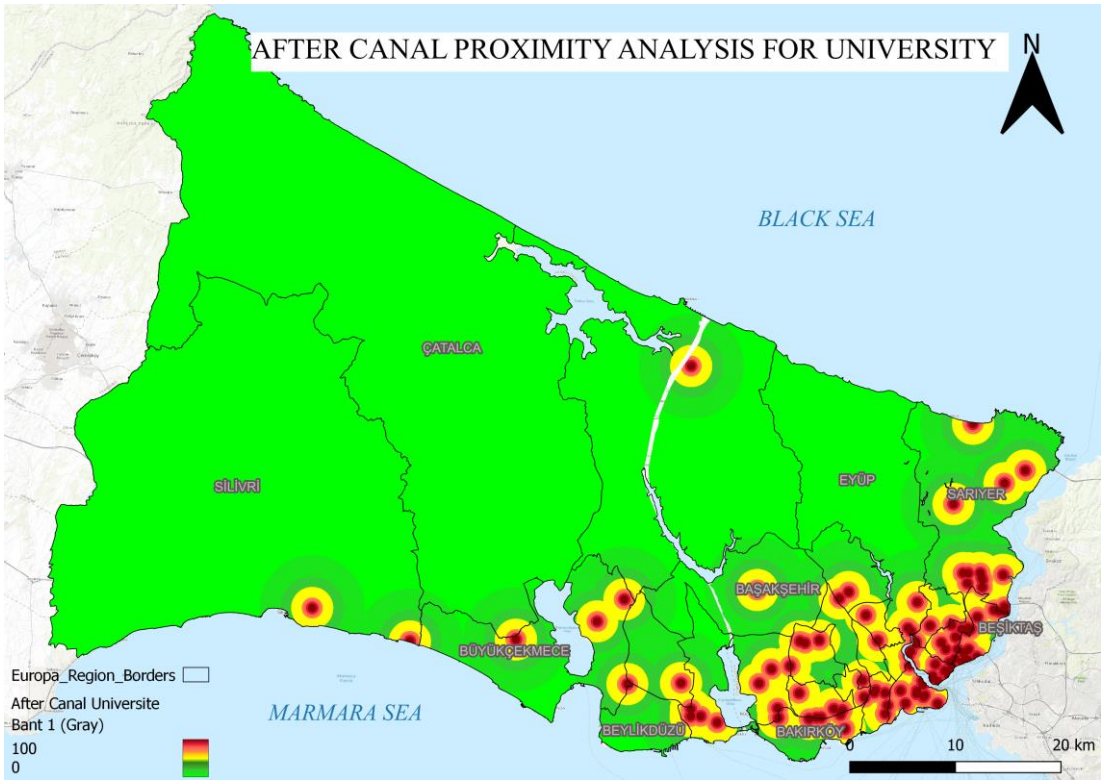
(19) before canal proximity analysis for shopping centers



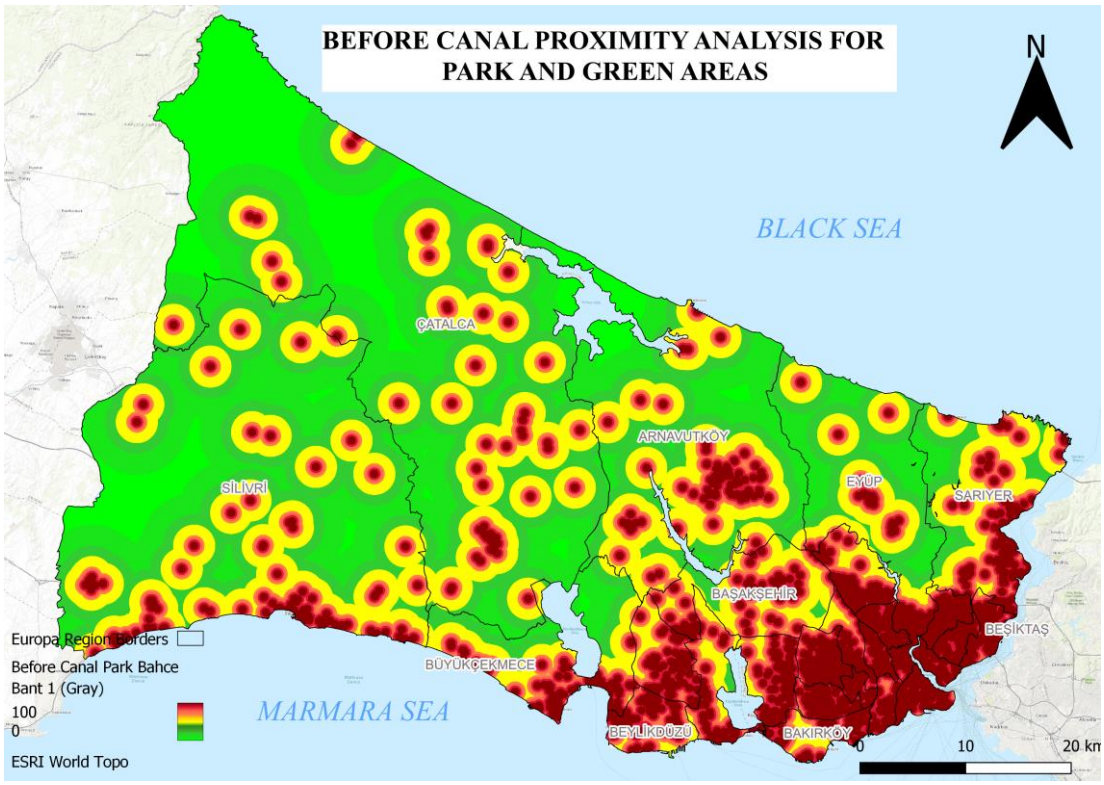
(20) after canal proximity analysis for shopping centers



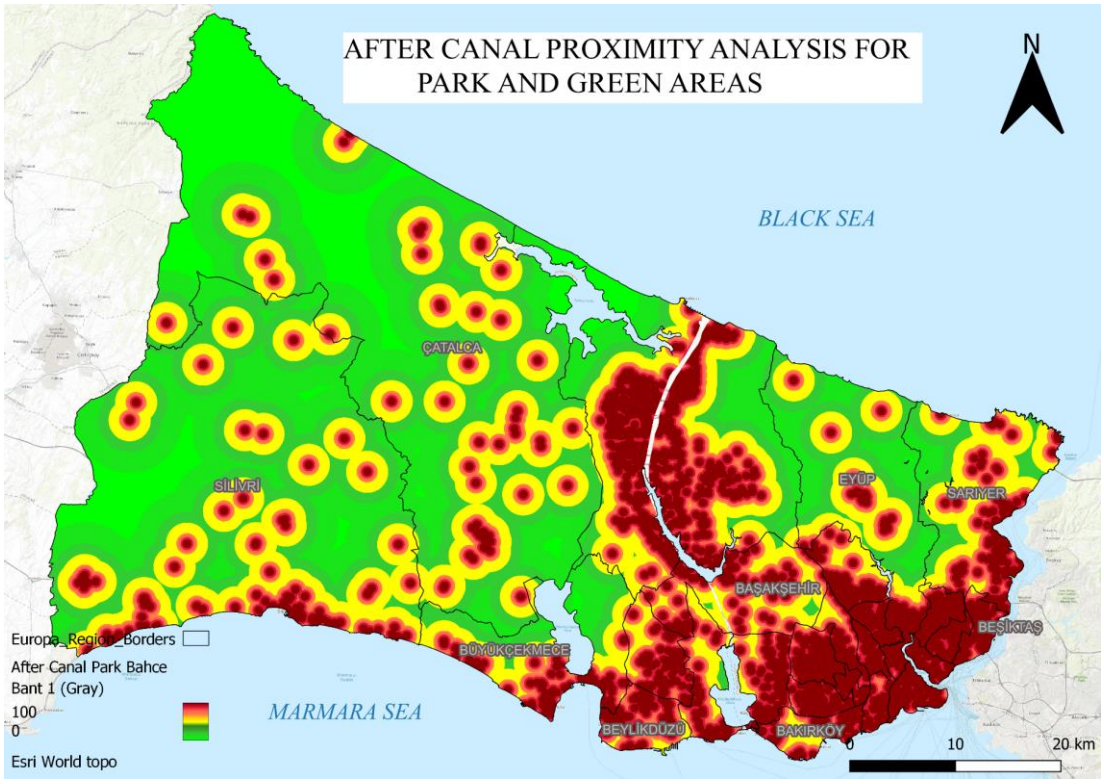
(21) before canal proximity analysis for university



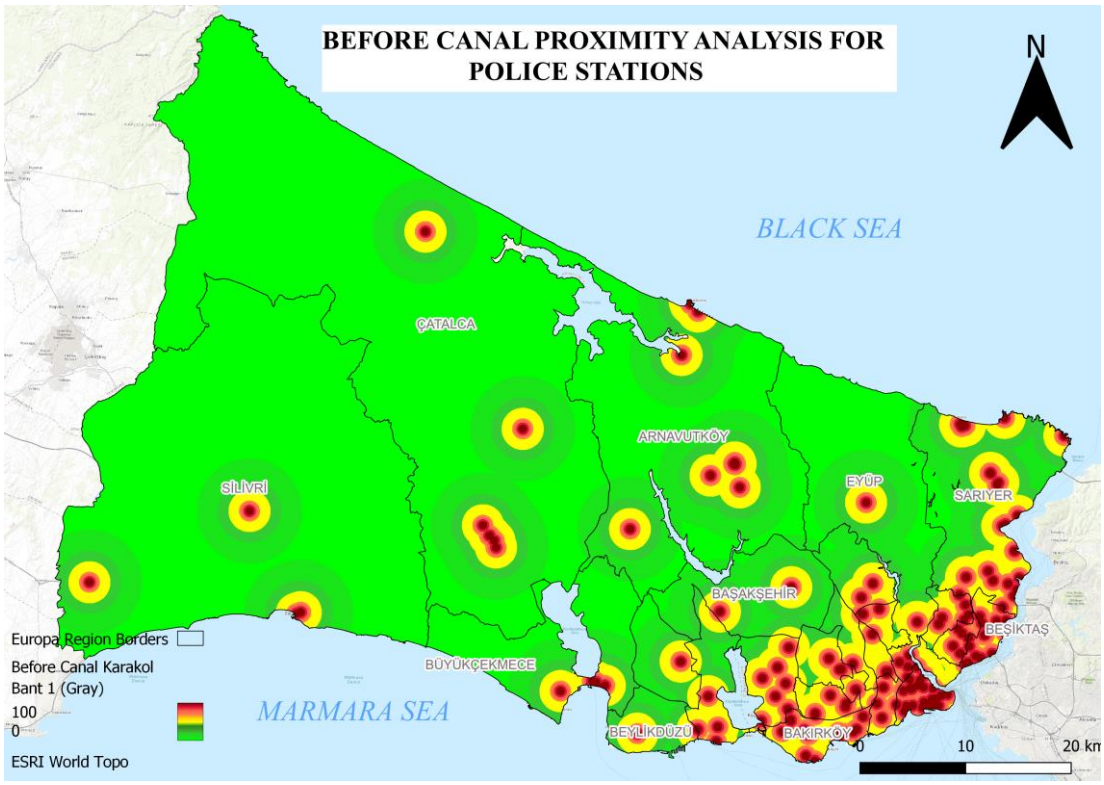
(22) after canal proximity analysis for university



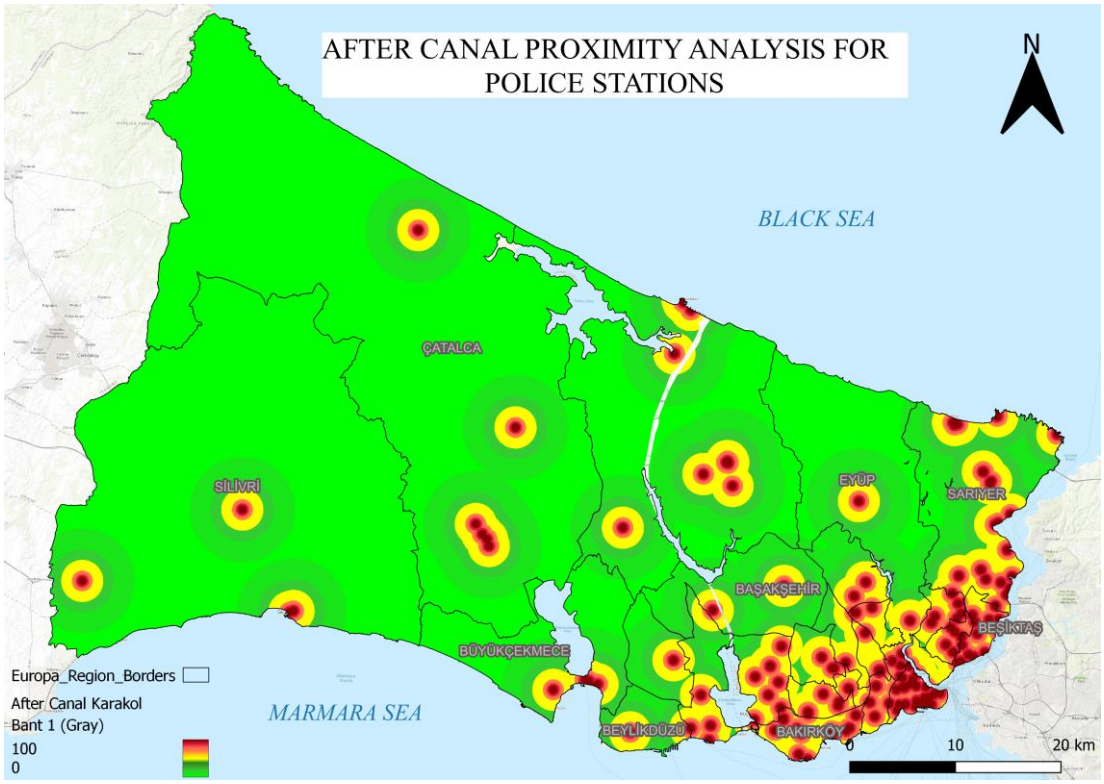
(23) before canal proximity analysis for park and green areas



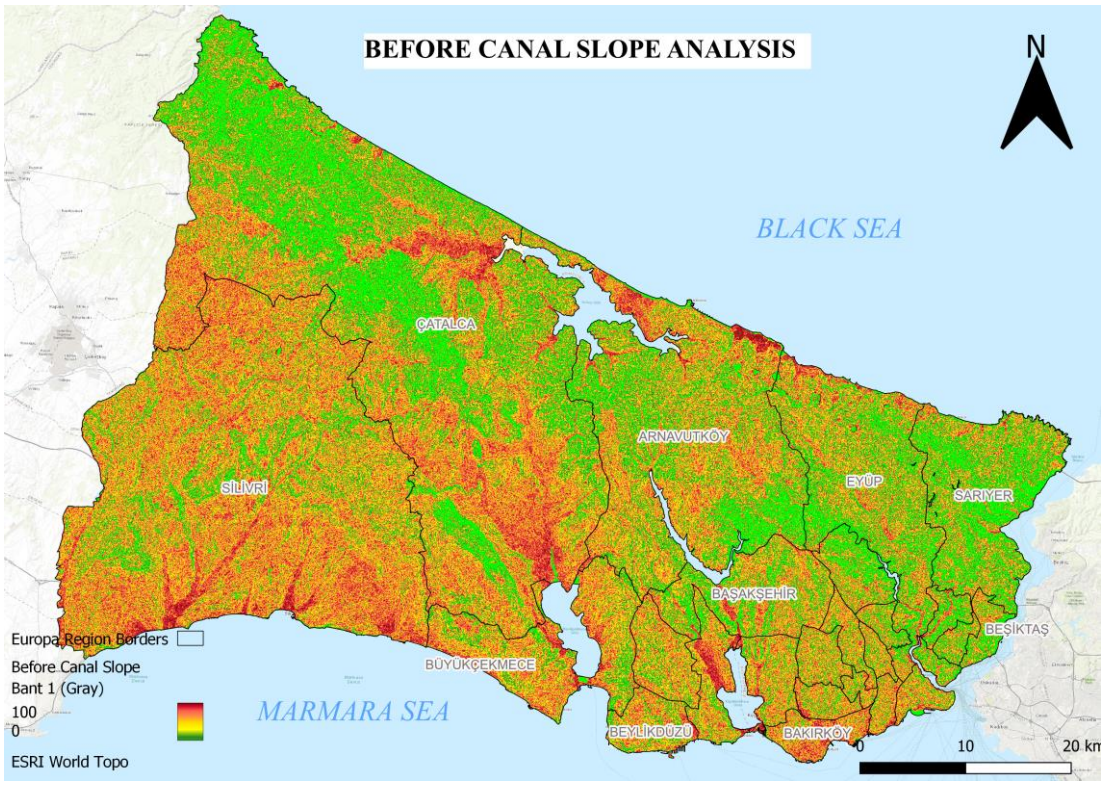
(24) after canal proximity analysis for park and green areas



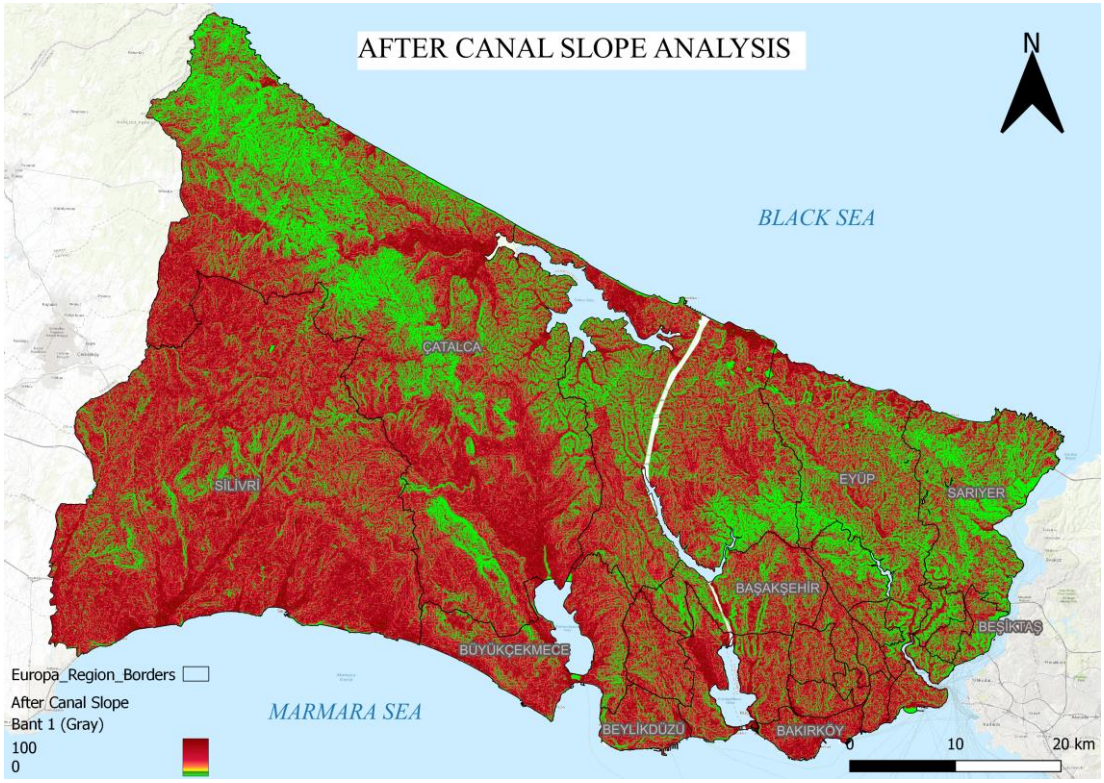
(25) before canal proximity analysis for police stations



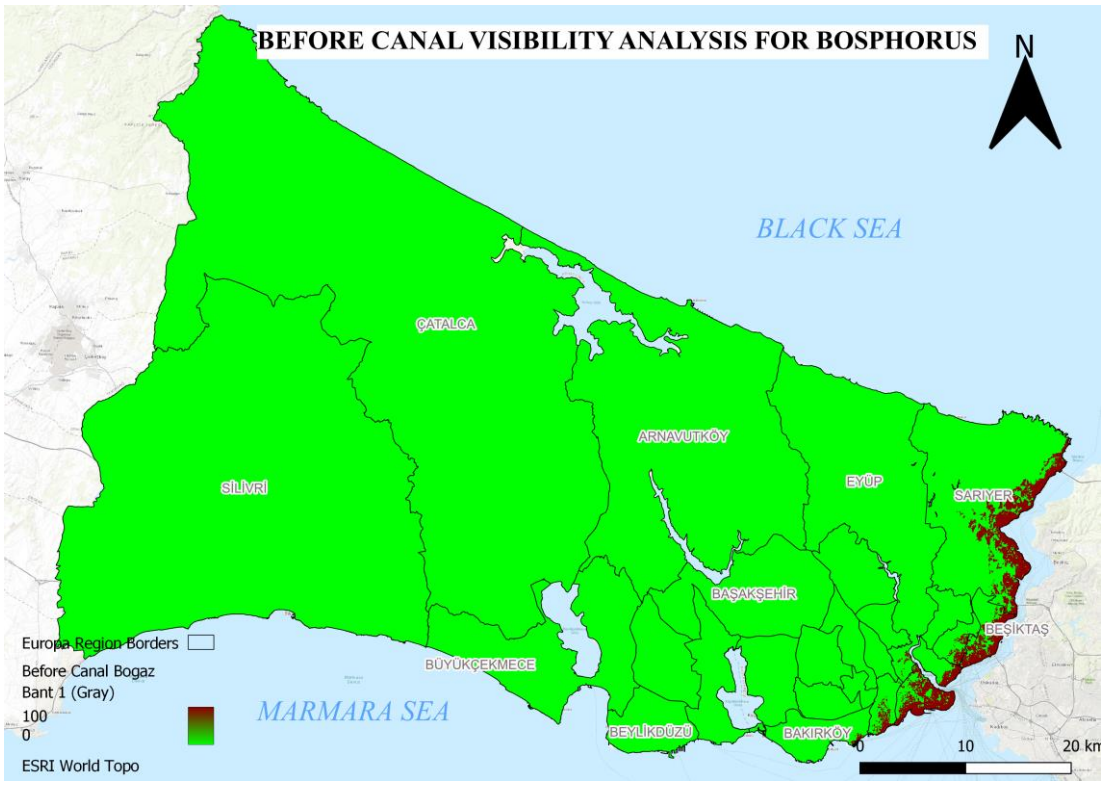
(26) after canal proximity analysis for police stations



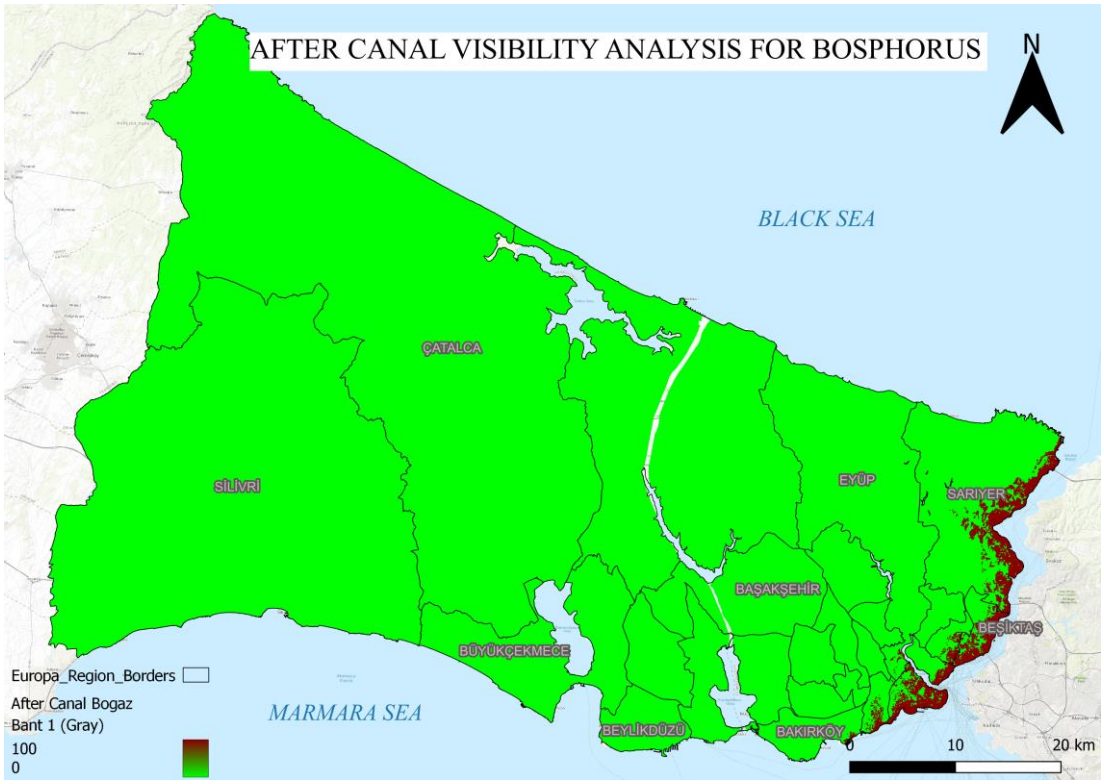
(27) before canal slope analysis



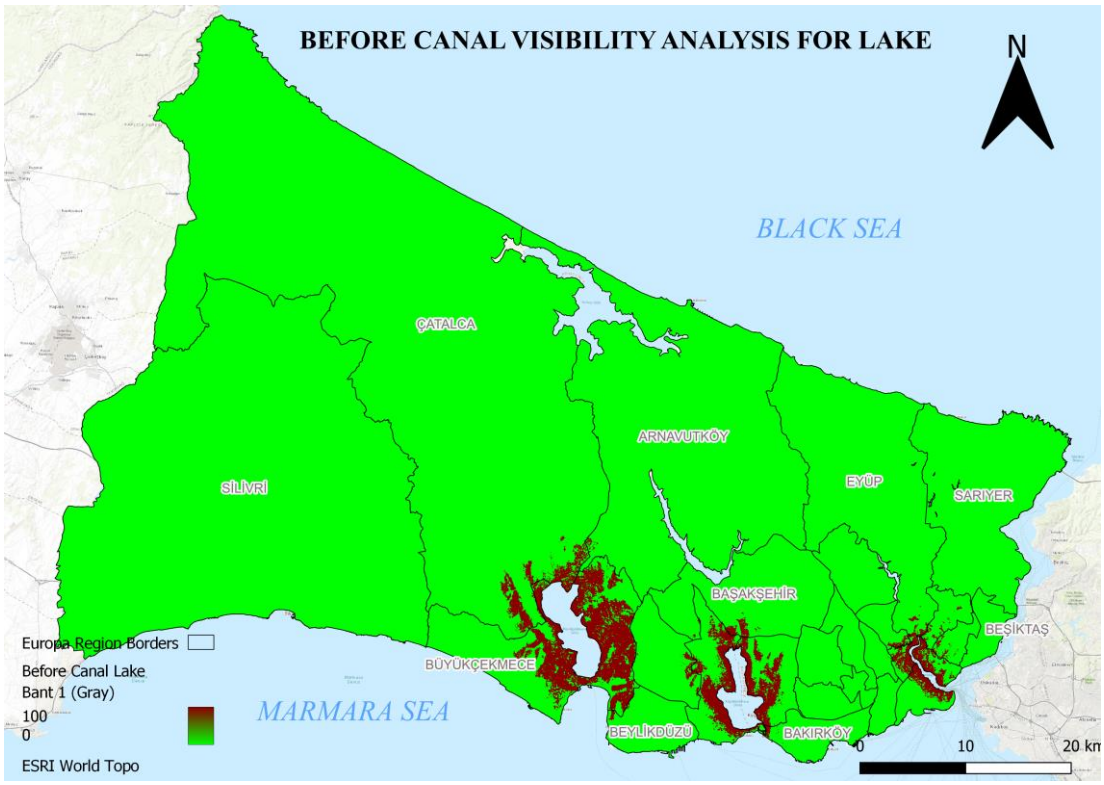
(28) after canal slope analysis



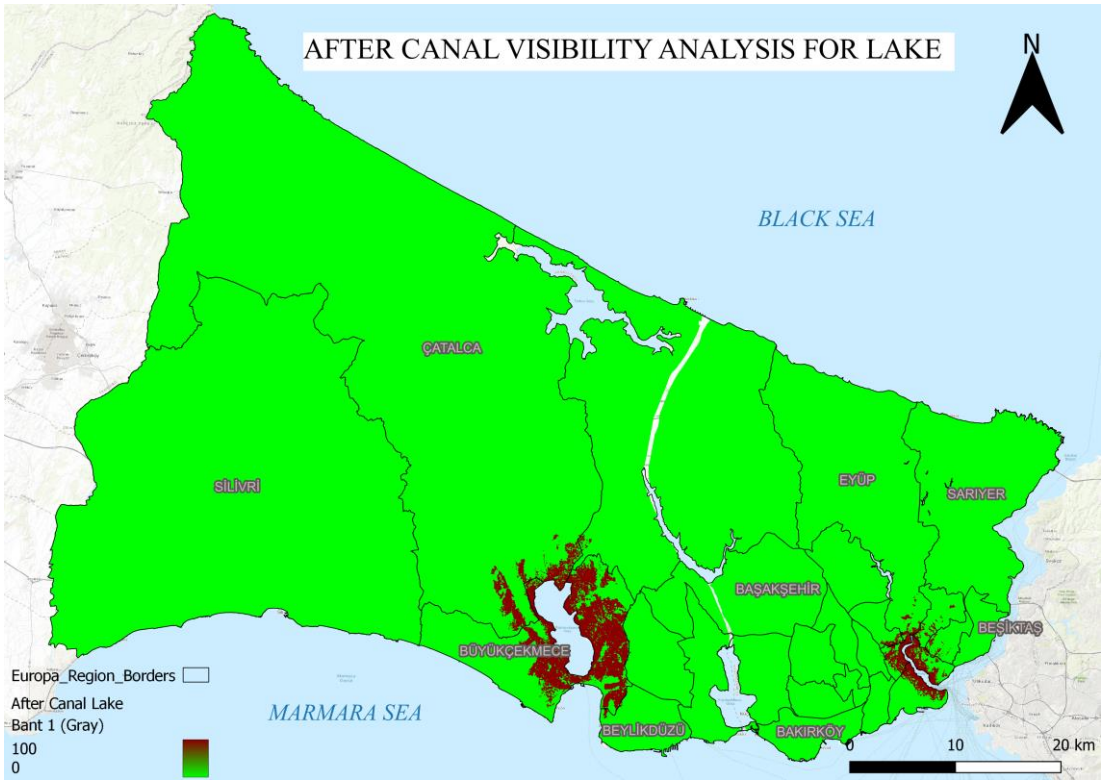
(29) before canal visibility analysis for bosphorus



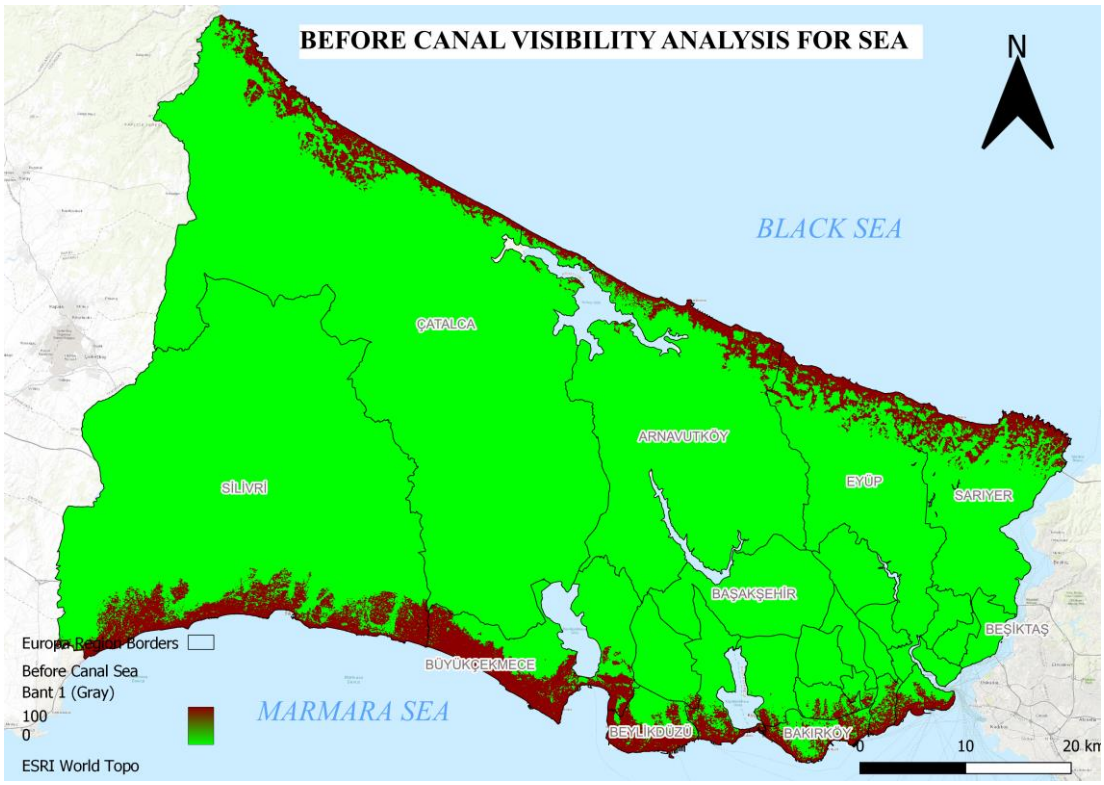
(30) after canal visibility analysis for bosphorus



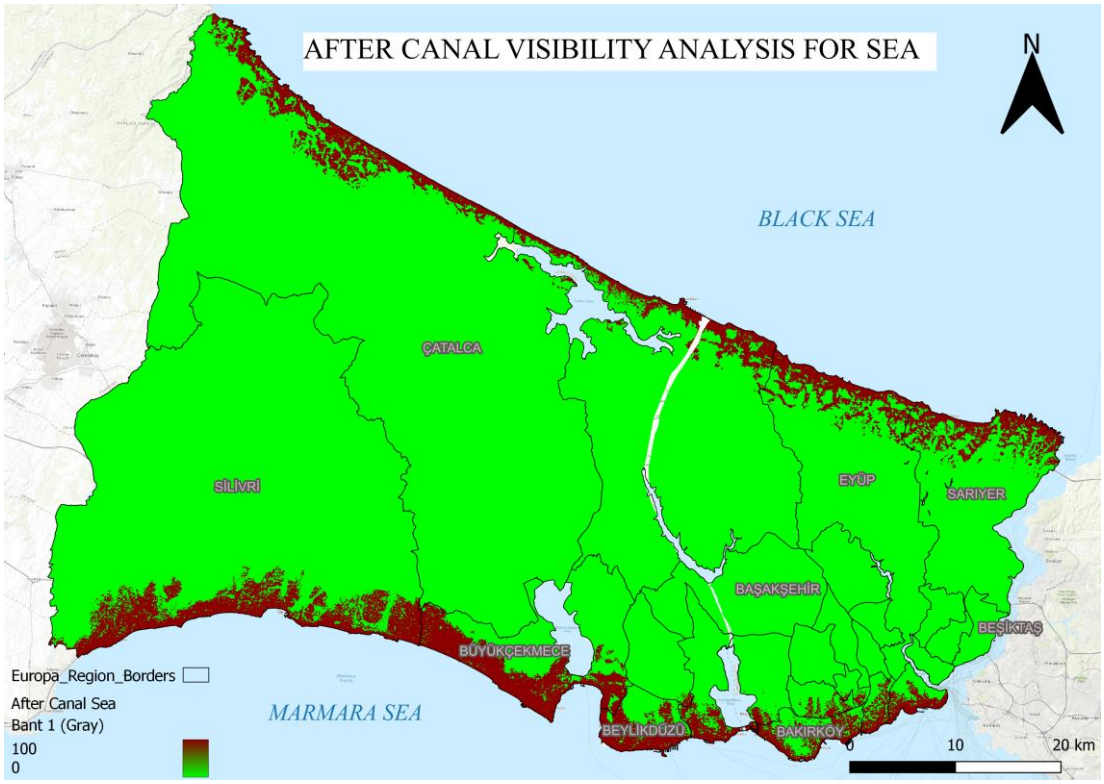
(31) before canal visibility analysis for lake



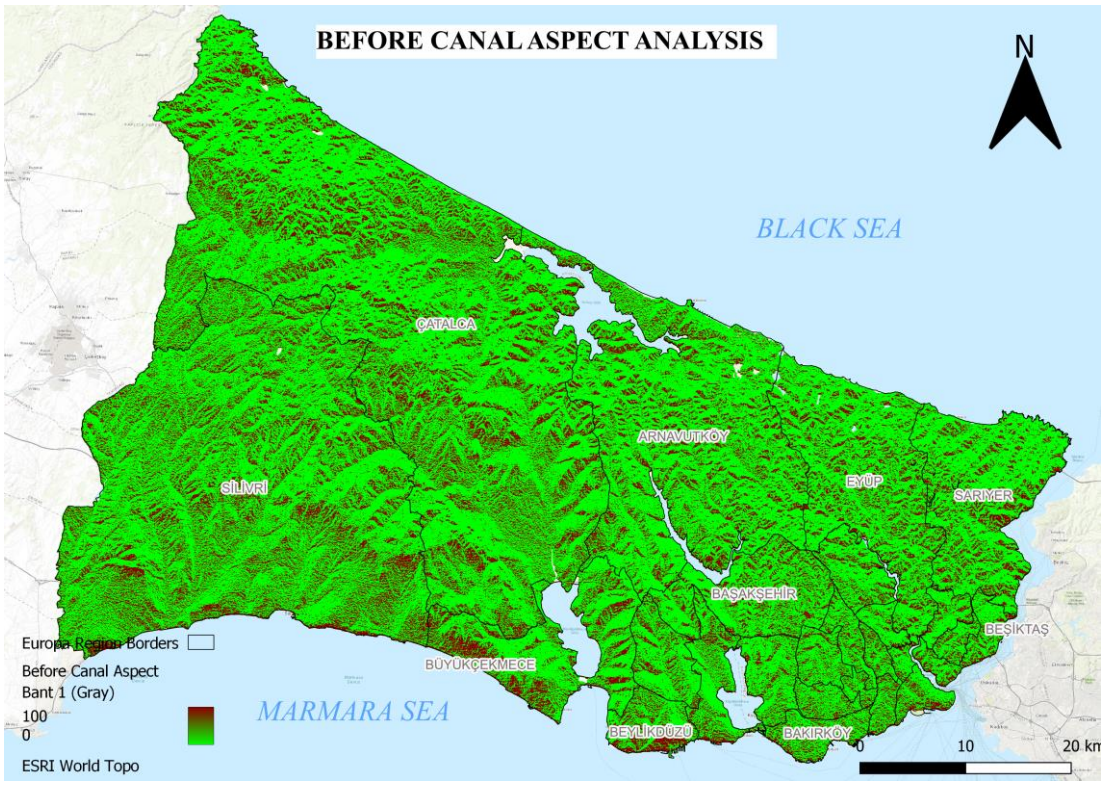
(32) after canal visibility analysis for lake



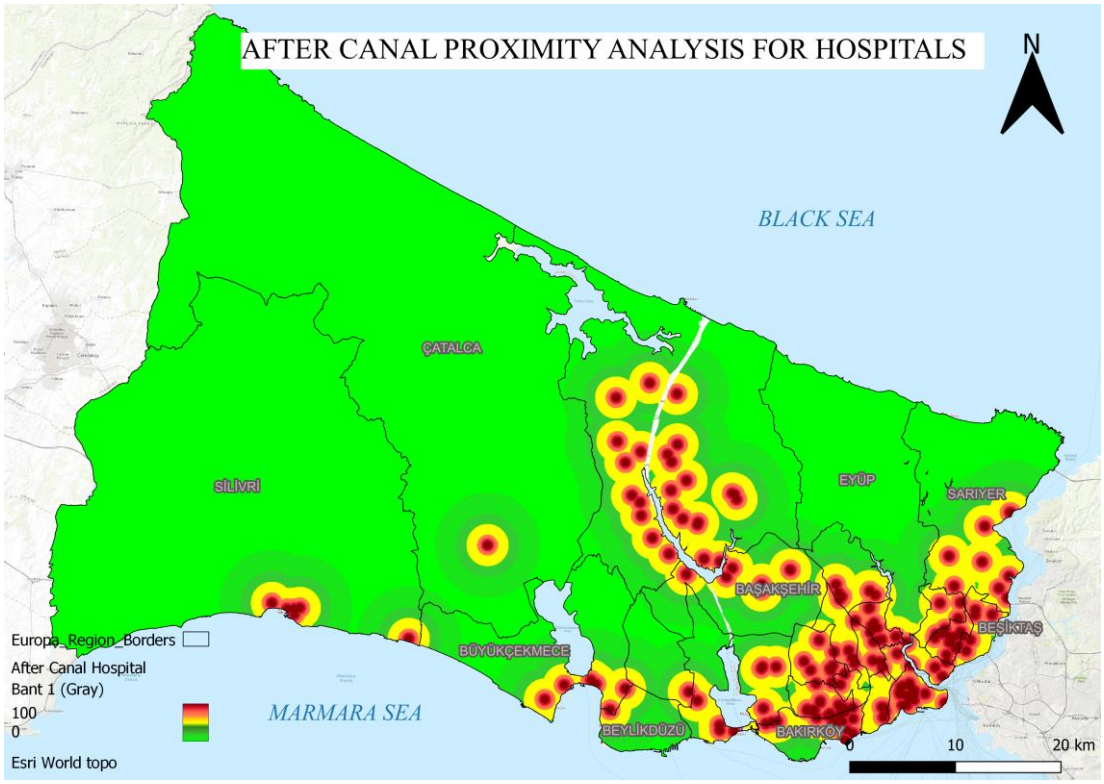
(33) before canal visibility analysis for sea



(34) before canal visibility analysis for sea



(35) before canal aspect analysis



(36) after canal proximity analysis for hospitals

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