

## DETERMINATION OF BIGA DISTRICT ECOLOGICAL RISK POTENTIAL USING CORINE LAND USE DATA




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**ABSTRACT.** Risk analysis is a process that enables the determination of possible hazards and the damages that will occur if these hazards occur, and the necessary precautions to be taken to minimize these damages. Risk analysis studies to be carried out in economically, demographically and geographically important regions such as Biga district are important for the sustainable development of the region and improving the quality of life of the people. In this study, the potential risk factors in Biga district were analysed in detail and the effects and probabilities of the risks were evaluated. As a result of this assessment, strategic recommendations and solutions were presented to reduce risks in the region. The data used in the study were produced from satellite images of land use, industrial areas and other environmental factors. In addition, official reports and databases of public institutions were also used. ArcGIS and QGIS software were used to determine the land use, slope, topography, aspect, spatial distribution of pollutants and ecological risks of the region. Ecological Risk Assessment Ecological risk assessment was carried out by taking into account criteria such as biodiversity, water quality, soil quality, air quality and pollution levels. The aim of this study is to establish a scientific basis for the measures to be taken to ensure the safety of people living in Biga district.

**Keywords:** landscape planning, ecological risk, corine, Biga

### INTRODUCTION

In general terms, risk or hazard is the possibility of an event occurring and being affected by the event. According to Kates and Kasperson (1983) risk is the degree of threat to what people values is a measure of hazards. Therefore, the degree of risk occurs depending on how much ecological degradation affects human living space. Risk analysis is a process that enables the identification of possible hazards and the damages that will occur if these hazards occur, and the preparation of necessary measures to minimize these damages (Alexander, 2000). Risk assessment is also done to prevent possible problems or hazards that you may encounter. Risk analysis studies to be carried out in economically, demographically and geographically important regions such as Biga district are of great importance for the sustainable development of the region and improving the quality of life.

In this study, the potential ecological risk factors in Biga district were analysed in detail and the effects and probabilities of the risks were evaluated. As a result of this evaluation, strategic recommendations and solutions were presented to reduce risks in the region. The study aims to establish a scientific basis for the measures to be taken to ensure the safety of people living in Biga district.

Biga district is a district of Çanakkale province located in the northwestern part of Turkey. Located on the coast of the Marmara Sea, Biga attracts attention with its historical and cultural richness, agricultural activities and industrial investments. The district's economy is largely based on agriculture, livestock and industry. Biga is also an important center in terms of transportation and trade due to its strategic location. Biga's geographical location, climate and natural structure cause the risk factors in the region to diversity. The region carries a significant

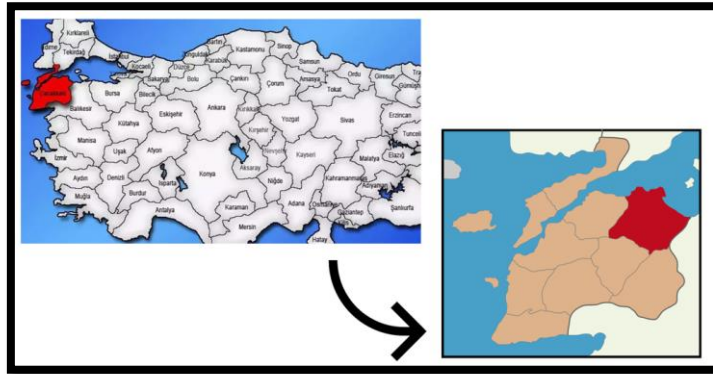
earthquake risk as it is located in the earthquake zone. In addition, increasing risks of floods and landslides due to climate change also threaten the region. The density of industrial facilities brings with it human-induced risks such as environmental pollution and industrial accidents (Doğal Afet Risk Yönetim Raporu, 2019).

Available analysis methods generally fall into two main categories; qualitative and quantitative (Cutter, 2003). Qualitative methods assess risks qualitatively based on expert opinions and experience; examples of this category include SWOT analysis, A Hazard and Operability (HAZOP) and The Federal Emergency Management Agency (FMEA). Quantitative methods, on the other hand, assess risks numerically and include techniques such as statistical analysis, probabilistic risk assessment (PRA) and Monte Carlo simulations. While statistical analysis attempts to predict future risks based on past performance of data, PRA and Monte Carlo simulations quantify the likelihood and impact of possible risks (Demir, 2017). These methods provide a more objective assessment opportunity by revealing the probability and likelihood levels of risks with numerical data (Smith, 2013).

## MATERIALS AND METHODS

### *Material*

Biga district of Çanakkale province is located in the southwest of the Marmara Region (Fig. 1). It borders the Sea of Marmara to the north, Gönen and Manyas to the east, Yenice and Çan districts to the south, and Lapseki district to the west. Biga's total surface area is approximately 1,354 km<sup>2</sup> and has strategic importance due to its geographical location. The geographical structure of the district is quite diverse. Biga has a generally rugged and mountainous structure, and the extensions of the Kaz (İda) Mountains are located in the north of the district. The southern parts consist of flatter and plainer areas. Among the important rivers of the region are Kocabaş Stream and Gönen Stream. These streams are vital for agriculture and livestock activities (URL-2).



*Fig 1. Geographical location of Biga District.*

Biga district is located in the transition region of the Mediterranean and Black Sea climates, which diversifies the climate of the district. Summers are generally hot and dry, while winters are mild and rainy. The annual average temperature varies between 14-1600 C. The annual average rainfall in the district is around 600-700 mm. These climatic features provide a suitable environment for agricultural activities (URL-1).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	4.8	5.7	8.5	12.3	17.2	21.9	24.6	24.5	20.6	15.4	11.1	6.6
Min. Temperature (°C)	1.4	1.9	4	7.3	12.1	16.9	19.8	20.2	16.6	12	7.7	3.6
Max. Temperature (°C)	8.4	9.7	13	17	22	26.5	29.3	29.2	25	19.3	14.9	10.1
Precipitation (mm)	84	82	74	51	46	37	23	17	43	82	70	101
Humidity (%)	82%	80%	74%	72%	68%	63%	59%	62%	66%	76%	80%	83%
Rainy Day (d)	9	8	8	6	5	4	3	3	5	6	6	9
Sunny Hour (hour)	4.5	5.3	7.1	9.0	10.5	11.6	11.6	10.3	8.6	5.9	5.1	4.6

**Fig 2.** 10-year average meteorological data of Biga District (URL-1).

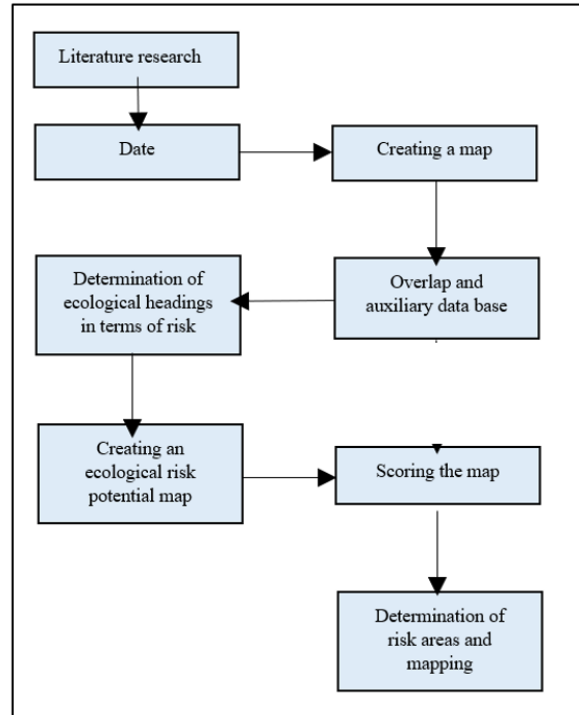
The natural structure of Biga is covered with rich vegetation and forest areas. In addition to agriculture and animal husbandry activities, forest products are also an important economic resource in the district. Forests in the region are of critical importance in terms of both protecting natural life and controlling erosion.

The population of Biga district is approximately 50,000 as of 2023. A large part of the population lives in rural areas, where agriculture and animal husbandry are the main sources of income. The district center is an area where trade and service sectors are concentrated. When the rainfall distribution of the population is examined, it is observed that the rate of young population is high. This situation increases the Labor force potential in the region, but it also brings with it social problems such as unemployment and migration.

The economy of Biga district is largely based on agriculture, animal husbandry and industry. Agricultural products such as wheat, barley, corn and sunflower are grown intensively in the district, and cattle and sheep breeding are also an important source of income. Biga's fertile lands provide a great advantage in terms of agricultural production. The industrial sector has an increasing importance in the economic structure of the district. Especially with the establishment of organized industrial zones, various industrial facilities and factories operate in Biga. This brings diversity to the district's economy and increases employment opportunities. However, increasing industrial activities also brings environmental risks. Biga district has faced various natural disasters throughout history.

Biga is a district that stands out with its historical and cultural richness. Biga, which has hosted various civilizations throughout history, has many historical artifacts from ancient times to the Ottoman Empire. Parion Ancient City located in the district is one of the most important archaeological sites of the region. This historical heritage plays an important role both in increasing tourism potential and preserving cultural richness.

Biga district has faced various natural disasters throughout history. In particular, the risk of earthquake is one of the most important natural threats in the region (Türkiye Deprem Tehlike Haritası, 2020). Biga is located close to the North Anatolian Fault Line and therefore carries a high risk of seismic activity (URL-3). In addition, disasters such as floods and landslides, which increase due to climate change, also affect the region. In areas where industrial activity is intense, there are human-induced risks such as industrial accidents and environmental pollution (URL-7). This situation processes serious threats to both environmental health and public safety.



*Fig 3. Flow chart*

## ***Method***

### *Date Gathering:*

- a. Primary date sources: Soil, water and climate data were obtained from relevant public institutions.
- b. Secondary date sources:
  - a. Satellite images: Land use, industrial areas and other environmental factors were analysed using Google Earth and other satellite images (URL-8).
  - b. Official reports and databases: TÜBİTAK, Ministry of Agriculture and Forestry, Ministry of Environment and Urbanization, State Hydraulic Works General Directorate and data provided by local University.

### *Date Analysis:*

- a. Geographic Information Systems (GIS): Land use, slope and other topographic features of the region were mapped using ArcGIS and QGIS software. GIS analyses were used to determine the spatial distribution of pollutants and ecological risks.
- b. Remote Sensing: Land use and environmental changes in the region were analysed using satellite images and aerial photographs. These data play a critical role in determining industrial zones and natural disaster risks.

### *Evaluation criteria:*

- a. Ecological risk assessment: Ecological risk assessment was carried out by taking into account criteria such as biodiversity, water quality, air quality and pollution levels (URL-7).

- b. Risk maps: Using GIS software, areas with high-risk potential were evaluated according to the weight criterion and mapped, and these areas were presented visually.

## RESULTS

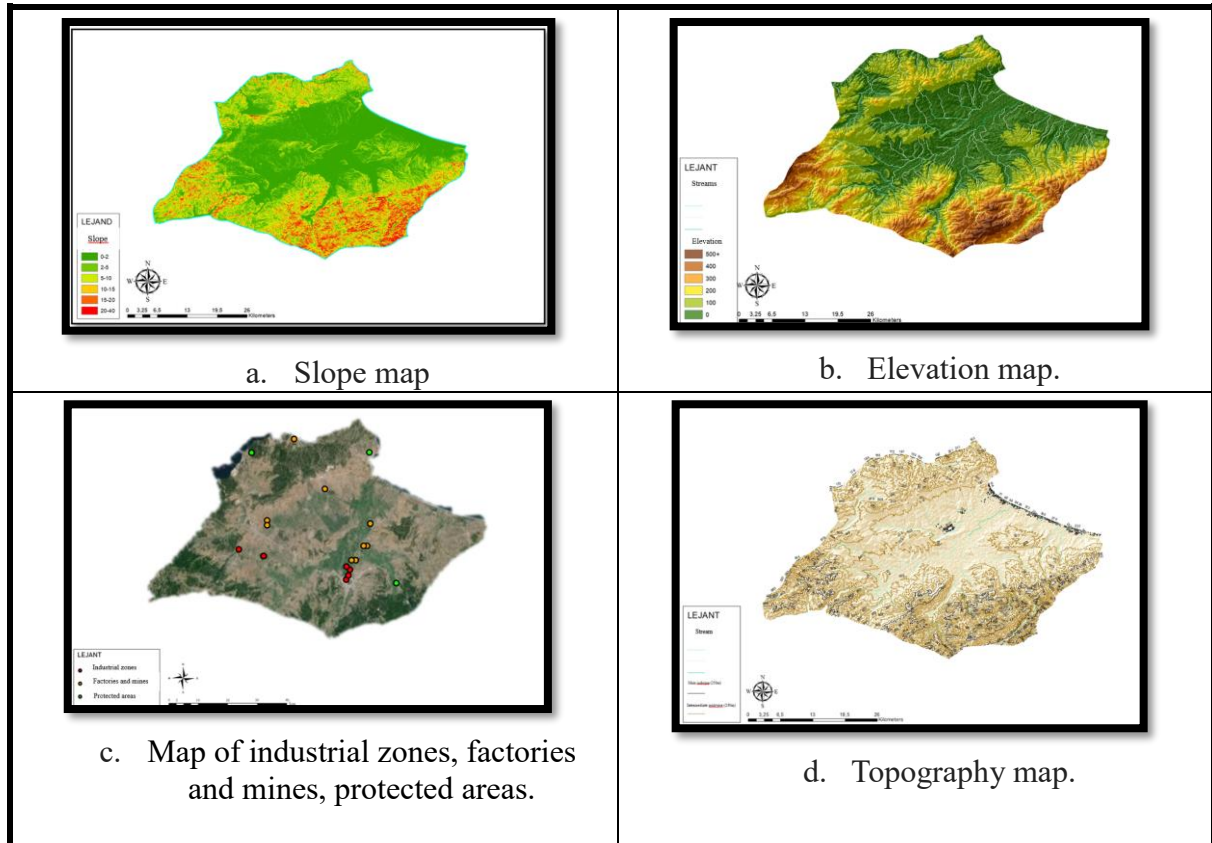
As a result of the research, geographical and topographic analyses conducted to determine the ecological risk potential of Çanakkale Biga district revealed important findings. The slope, physical and topographic features of the region were examined in detail with the help of CORINE Land Use data and Google Earth satellite (URL-8) images used in our study. According to the analysis results obtained, it was determined that the topographic structure of the Biga district is quite rugged and there are high slope areas especially in the northeastern and southeastern regions. These areas are of critical importance in terms of soil erosion and landslide risk.

Analyses of land use show that agricultural areas, forest areas and settlements are common in Biga district. Industrial zones are concentrated in areas close to the district center. The potential for industrial pollution is quite high in areas where industrial facilities are located (URL-11). Maps and field studies clearly reveal the pollution potential in these areas (URL-9). Natural disaster risks of Biga district were also examined in detail. As a result of slope and topographic analyses, landslide risk areas, especially in high slope areas, were identified. Potential landslide areas in these regions were mapped and evaluated in terms of ecological risk.

Environmental pollution and ecological risks also formed an important part of the study. Soil and water sampling in areas close to industrial zones shows that soil and water quality has decreased in these areas (URL-10). Areas with particularly high heavy metal concentrations have been identified as critical areas in terms of ecological risk (URL-9).

Basic map bases used in creating the ecological risk map.

The slope map (URL-4) of the study area was created using the CORINE (URL-5) satellite image (Fig. 4.a.). While the slope in the south of the country is 20-40%, the middle area between the north and south elevations has a slope of 2%, which is suitable for agriculture (URL-6). In the southern part of Biga district, the altitude reaches up to 500 m. In the central areas the altitude is the same as sea level (Fig. 4.b.). As seen in Figure 4.c., industrial zones, factories, mines and protection areas in Biga district are very close to each other. Figure 4.d. details the topography of the Biga region. It helps identify natural structures such as mountains, valleys and rivers, as well as areas with ecological risk potential.



**Fig 4.** Base maps used to determine ecological risk potential.

Scoring was done by dividing the land within the administrative borders of Biga into 1x1km<sup>2</sup> grids (Table 1.). While scoring, all kinds of ecological risk (flood, landslide, mine, factory, industry) were scored individually for the entire grid system and potential ecological risk areas were determined. Squares with total mean scores of 16 and 17 were classified as areas with 1st degree ecological risk potential, while squares with mean scores of 10, 11, 12, 13, 14, 15 were classified as areas with 2nd degree ecological risk potential. During the preparation of these classification and maps, in addition to the superimposition maps, data on base maps and protected areas etc. were obtained.

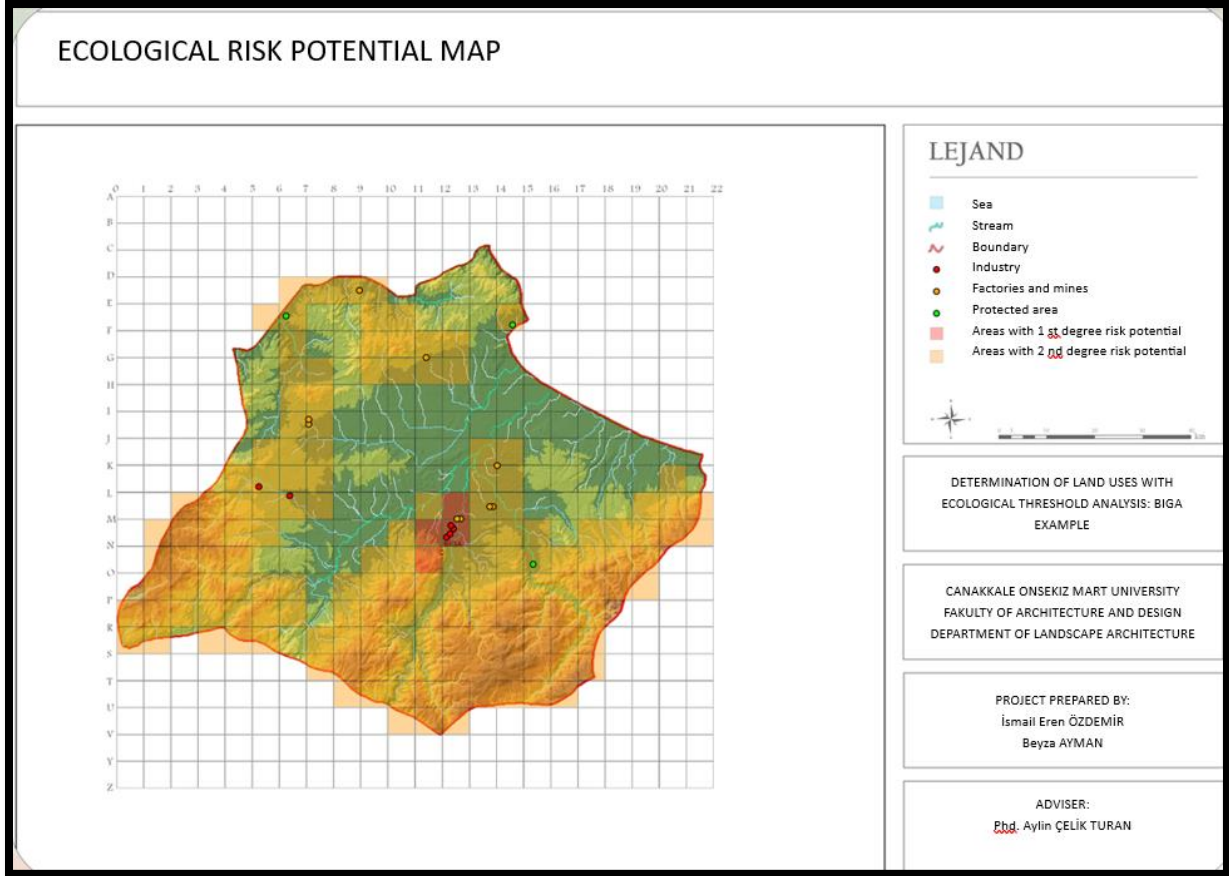
**Table 1. Weight score criteria.**

	Flood	Erosion	Industry	Factory	Protected Area	TOTAL
<b>B13</b>	1	1	1	1	1	5
<b>C12</b>	3	1	1	1	1	7
<b>C13</b>	1	1	1	1	1	5
<b>C14</b>	1	1	1	1	1	5
<b>D6</b>	4	1	1	1	3	10
<b>D7</b>	5	1	1	2	1	10
<b>D8</b>	5	1	1	5	1	13
<b>D9</b>	5	1	1	4	1	12
<b>D10</b>	5	1	1	1	1	9
<b>D11</b>	5	1	1	1	1	9
<b>D12</b>	5	1	1	1	1	9
<b>D13</b>	4	1	1	1	1	8
<b>D14</b>	4	1	1	1	1	8
<b>E5</b>	4	1	1	1	4	11
<b>E6</b>	5	1	1	1	5	13
.	.	.	.	.	.	.
.	.	.	.	.	.	.
<b>M11</b>	5	3	4	4	1	17
<b>M12</b>	5	1	5	5	1	17
<b>M13</b>	5	1	2	3	1	12
<b>M14</b>	5	1	1	2	1	10
<b>M15</b>	5	1	1	1	2	10
<b>M16</b>	5	1	1	1	1	9
<b>M17</b>	5	2	1	1	1	10
<b>M18</b>	5	3	1	1	1	11

Air conditions such as PM<sub>2</sub>, PM<sub>10</sub>, NO<sub>x</sub> and SO<sub>2</sub> of the industrial zones located within the study area affect the negative aspects of the weather conditions. As a result of all the data collected and the analyses performed, an ecological risk map was created for Çanakkale Biga district.

*Ecological Risk Map:*

The ecological risk map created for Çanakkale Biga district was obtained by superimposing various data. The map shows critical factors such as industrial zones, landslide areas, soil and water pollution in the region together and areas with high ecological risk area identified. Accordingly, M11, N11, L12 and M12 grids areas with 1st degree ecological risk potential and N12, O15, K4, N15 and N16 grids are areas with 2nd degree ecological potential (Fig. 5).



*Fig 5. Biga district ecological risk analysis map.*

## CONSEQUENCES

Based on the findings of this research, various suggestions were made to reduce the environmental and ecological risk of Çanakkale Biga district. First of all, in order to reduce the risk of landslides in high-slope areas, it is important for local governments to update their emergency plans and raise citizens awareness of natural disasters. However, since environmental pollution has been determined to be high in industrial zones, industrial facilities need to strengthen their waste management and treatment systems and act in accordance with environmental standards. In order to prevent soil and water pollution, regular monitoring is necessary and effective policies must be developed to prevent pollution. Protecting green areas and creating new green areas is critical to environmental sustainability. Raising public awareness is also important to deal with environmental risks. Education and awareness campaigns should be organized and public responsibilities toward the environment should be emphasized. Finally, environmental sustainability policies need to be strengthened. By strengthening environmental protection and sustainability policies, local governments can contribute to reducing environmental risk and moving the region towards a sustainable future.

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