

A comparative analysis of the environmental risk by planning regions in Bulgaria

Zornitsa Stoyanova^{1*}

¹UNWE, Natural resource economics department, 1700 Sofia, Bulgaria

Abstract. The environmental impact in a regional aspect differ depending mostly on the specifics of the regions and related regional differences, as well as the dynamics of development of the different economic sectors. In this regard, the probability of occurrence of the ecological risk in some regions is relatively higher than its occurrence in others. In this paper environmental risk is associated with negative impact on natural resources as soil, water, air, etc. The aim of the article is to be prepared a comparative analysis of the ecological risk by planning regions and on this basis to be drawn general conclusions about the place of each region in terms of impact on natural resources and to determine those regions in which the probability of occurrence of risk in ecological aspect is relatively higher. The paper provides a literature review of the concept of ecological risk according to regional differences, data analyses of indicators such as carbon dioxide emissions, discharged wastewater, disturbed territories and generated waste by planning regions. Based on the ranking of the regions in terms of the probability of ecological risk occurrence are proposed recommendations for the prevention and/or reduction of negative impact on the environment and natural resources in a regional aspect.

1 Introduction

Many factors influence the strength and scale of environmental risks in different regions. The environmental impact in a regional aspect differs depending mostly on the specifics of the regions and related regional differences, as well as the dynamics of development of the different economic sectors.

There are various theories that present the relations between environmental risk and regional differences.

Biogeography theory is a concept that examines habit fragmentation and is relevant to the conservation of biodiversity and the decrease of ecological risk to it [14]. According to island biogeography theory, regional differences in ecological risk are determined by factors such as isolation, habitat size, species diversity, and immigration levels. In their study Matthews and Triantis (2021) [13] considered that due to the small-scale nature of islands, the biodiversity of islands is at high risk.

According to the environmental filtering concept, the environment in different regions determines which species are suitable and can be grown in a specific region. In different

* Corresponding author: zstoyanova@unwe.bg

regions, climatic characteristics differ and some species could be exposed to a greater ecological risk than others. In this regard, one of the factors that predetermines the occurrence of ecological risk is the geographical location and its climate. There are regions such as coastal regions, arid and semi-arid regions, mountainous regions, in which this factor has a serious impact on the occurrence of ecological risk. For example, Rabbani et al. (2010) [5] shared that climate change is one of the most serious threats to people and their livelihoods in coastal regions. Other risks due to climate change are sea level rise, drought, changes in climate patterns, etc. Particularly vulnerable are arid and semi-arid regions, which face serious environmental risks such as water scarcity and desertification. Pressure on water resources in arid regions leads to the threat of rising salinities [15], which can affect ecosystems, agriculture and biodiversity. Mountain ecosystems also face risks related to climate change, including melting glaciers, altered water availability and habitat fragmentation and this have impact on species and ecological processes.

Another concept is landscape context theory. According to this theory, the surrounding environment and landscape such as land use, fragmentation, familiarity and spatial arrangement of habitats influence ecological risk. In this regard, regional differences related to land use and the fragmentation of species and habitats have an impact on ecological risk. Cao and Song (2022) [3] consider that land-use change can significantly affect the regional ecological environment, leading to drought, soil erosion, decrease in forest resources, and loss of biodiversity.

The consideration of environmental risk from the point of socio-economic theories is also an issue of interest. Many authors emphasize the impact of economic development, industrialization and resource extraction on environmental risk in a regional context. According to these theories, a factor that influences the occurrence of ecological risk is the industrialization of the area. Activities in highly industrialized areas and those where agriculture is well developed lead to significant pressure on regional ecosystems, increasing local environmental risks [2]. Mantarova (2014) [1] defines the uneven development of regions as a factor that affects environmental risks. She considers that the differences in regional development and their unevenness are a prerequisite for the generation of environmental risks and she adds that the activities in the urbanized territories and the concentration of population aggravate the pressure on the environment. The analysis "The Demographic and Socio-Economic Status of planning regions - current situation and prospects for development" (ESC, 2022) [4] states that urbanization increases the proportion of the population living with multiple environmental risks such as air pollution, noise, warming. Highly urbanized areas and areas with high population density are also at increased environmental risk due to habitat loss, pollution of water resources and fragmentation of natural ecosystems.

According to Zhai et al. (2020) [16] human activities and industrialization lead to serious consequences on natural resources and human health, creating ecological risk. Areas with intensive industrial activities may face ecological risks associated with pollution, waste generation, and the release of hazardous substances into the environment. Agriculture, urban sprawl and pollution from economic activities have significant negative impacts on the quality of life in a region.

The article examines regional differences in terms of the occurrence of environmental risks for natural resources in Bulgaria.

2 Materials and Methods

The aim of the article is to be prepared a comparative analysis of the ecological risk by planning regions and on this basis to be drawn general conclusions about the place of each

region in terms of impact on natural resources and to determine those regions in which the probability of occurrence of risk in ecological aspect is relatively higher.

Methodological framework of the paper includes: 1) Literature review of the concept of ecological risk in the context of regional differences; 2) Data analyses of indicators; 3) Place of each region in terms of the probability of ecological risk occurrence; 4) Recommendations for the prevention and/or reduction of negative impact on the environment and natural resources in a regional aspect

Data analysis is based on the information from National statistical institute and used indicators are carbon dioxide emissions, used water, discharged wastewater, disturbed territories and generated waste by planning regions.

3 Results and discussion

To assess the environmental risks by planning regions are analyzed indicators as carbon dioxide emissions, used water, discharged wastewater, disturbed territories and generated waste by planning regions for the period of 2012 – 2021.

The amount of waste for the period 2012-2021 at national level decrease from 3,249,000 tons to 3,058,000 tons. At planning region’s level, a decrease was observed only in North Western region. The decrease of waste in this region could be explained by the significant increase in municipal waste submitted for recycling. This is one of the environmental risk management measures. This is also the region in which the tendency to generate the least household waste is observed (Figure 1). North Western region is in first place, followed by North Central region. In 2021, only 8.8% of the waste in the country is generated in North Western region. The largest amount of household waste is generated in the South Western planning region - 32.9%, followed by the South Central region. In the other three planning regions, the generated waste in 2021 occupies 10.8% (North Central), 13.5% (North Eastern) and 14.5% (South Eastern).

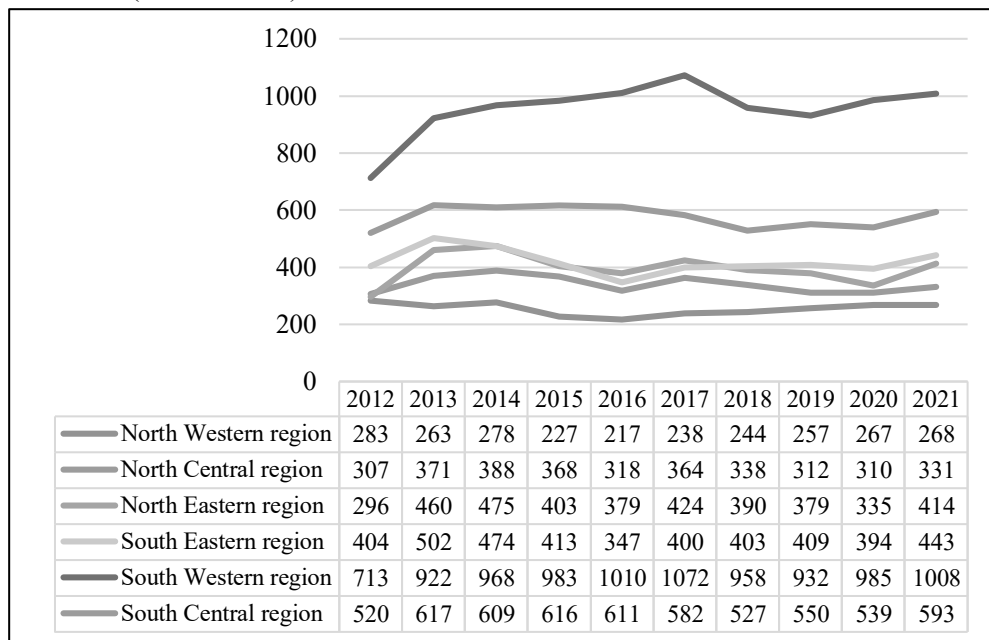


Fig. 1. Generated household waste, thousand tons, 2012-2021
Source: [10]

For the period 2012-2021, the total water used in five of the planning regions follows a decreasing trend (North Central, North Eastern, South Eastern, South Western and South Central). In the North Western region, the total water used follow increasing tendency. The largest amounts of water used are observed in the North Western region. This is the region in which the withdrawn water resources exceed more than 20 times the amounts in the region in which the withdrawn water is the least - North Central (Figure 2). The South Eastern planning region is second in terms of withdrawn water quantities, which ranged from 1,051 million cubic meters per year in 2020 to 1,722 million cubic meters in 2015. The South Central region ranks third in terms of amounts of water used, and for the period they vary from 613 million cubic meters/year in 2018 to 711 million cubic meters / year in 2016. The North Eastern, North Central and South Western are the regions where the amounts of water used are relatively less than in the other regions.

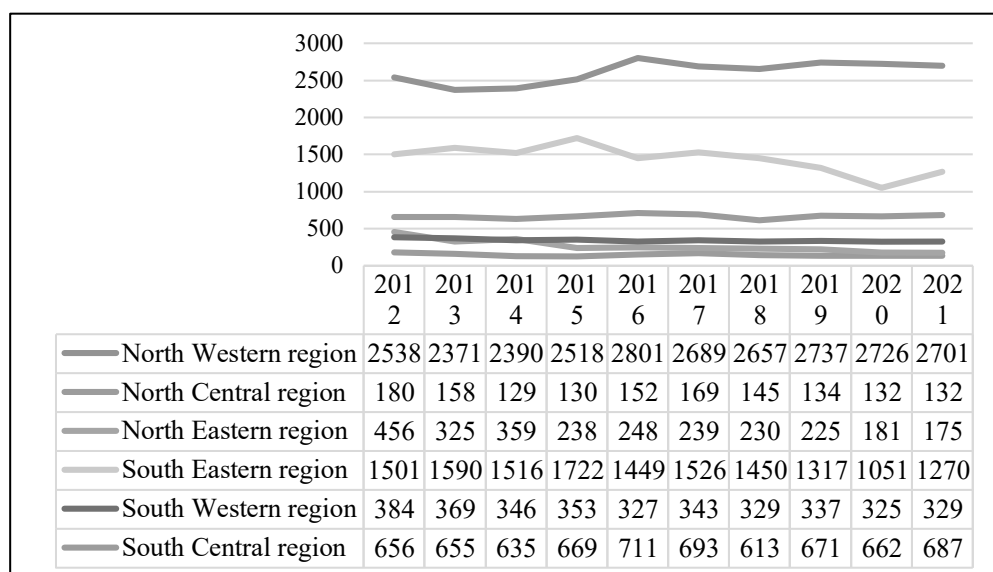


Fig 2. Water used by planning regions, mln. cub. m./year, 2012-2021

Source: [12]

The average water withdrawn for the analyzed period in the South Western region is about 344 million cubic meters/year. The North Eastern planning region is in fifth place in terms of amounts of water withdrawn, with the average amount for the period 268 million cubic meters/year. The region in which the amounts of water withdrawn are the least is the North Central region. The average amount in this region for the period is about 146 million cubic meters/year.

There is a trend of decrease in wastewater discharged without treatment for the period 2012-2021. Only in one of the planning regions in Bulgaria - South Central the trend is increasing (Figure 3). In 2021, the wastewater discharged without treatment is the most in the South Central region, followed by the South Eastern and South Western. The smallest amount of wastewater discharged without treatment was recorded in the North Eastern region – 3 million cubic meters/year and in North Central - 8 million cubic meters/year. The quantities between the wastewater discharged without treatment in the South Central region and in the North Eastern differ more than 15 times in favor of the North Eastern region from an ecological point of view.

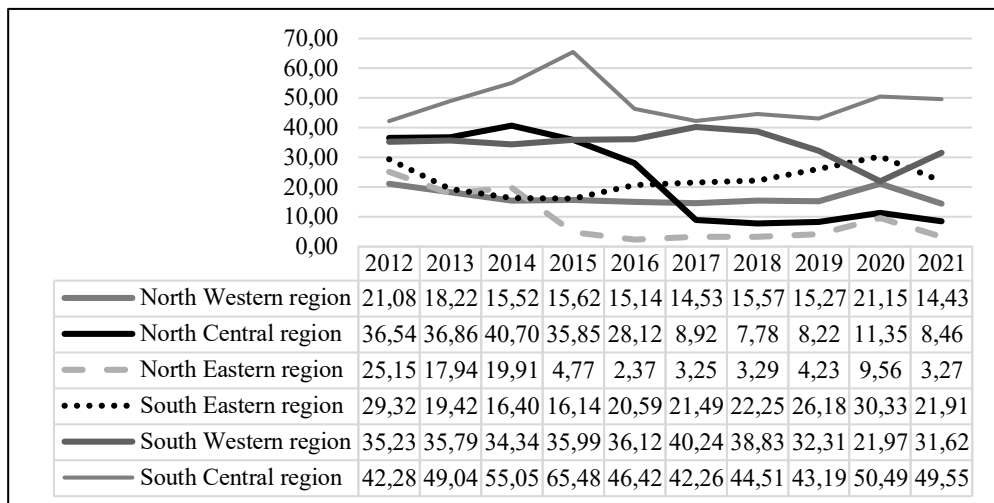


Fig 3. Wastewater discharged without treatment, million cubic meters/year
Source: [12]

The trend for the amount of carbon dioxide emissions in the atmosphere (t/sq.km) by planning regions for the period 2016-2019 is decreasing. For the period in four of the planning regions, they decreased significantly and in two of them there was a slight increase in 2019 compared to 2016, respectively in the South Eastern region they are 3.5 tons per sq./km. and in the South Central region 18.2 tons per sq./km (Figure 4). Emissions decreased the most in the South Western region with 820.2 tons per sq./km, followed by the North Central region with 306.9 tons per sq./km. In third place with 181.1 tons per sq./km is the North Eastern planning region. The most emitted carbon emissions for the analyzed period is observed in the South Eastern region, followed by the South Western planning region. The South Central and North Western regions emit the least amount of carbon dioxide per square km for the analyzed period.

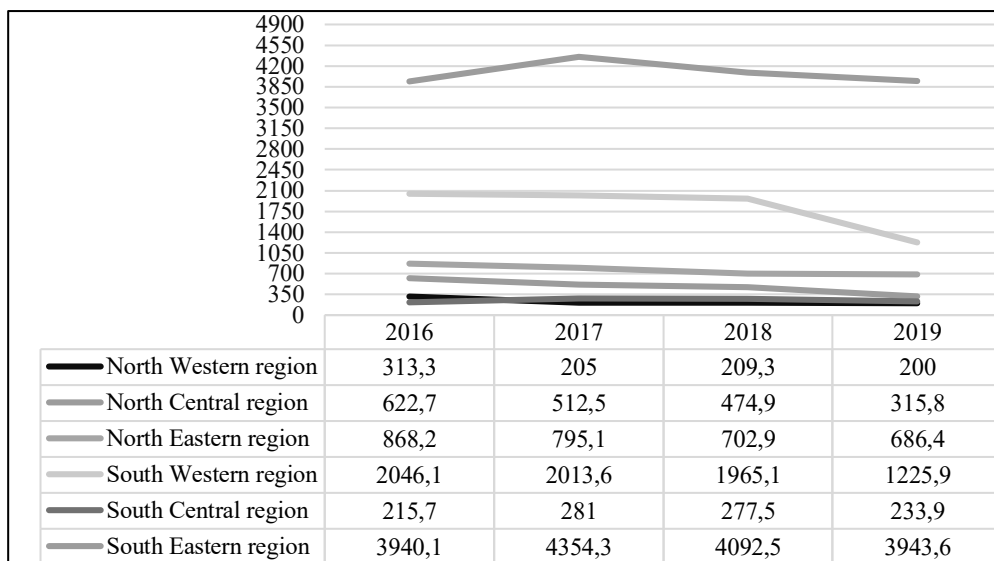


Fig 4. Carbon dioxide emissions in the atmosphere (t/sq.km) by planning regions for the period 2016-2019
Source: [6-9]

In terms of carbon dioxide emissions into the atmosphere (t/sq.km) in 2019, the North Western planning region has the lowest values – 200 t/sq.km per year, because the districts in this region are among those with the lowest levels of carbon emissions (Vidin – 2.5 tons/sq.km. per year and Montana – 2.6 tons/sq.km.per year). Relatively low carbon emissions are also observed in the South Central and North Central regions, respectively 233.9 and 315.8 tons/sq.km per year. In the North Eastern planning region, carbon emissions are 686.4 t/sq. km. per year and they are emitted mainly in Varna region (85%). Carbon dioxide emissions per sq. km. in the South Western region are 1225.9 t/sq. km per year, and they are mainly due to the fact that the capital Sofia falls within this planning region. The most significant are the emitted carbon emissions in the South Eastern region, which are 3943 t/sq. km. per year and are generated by the operation of the largest coal-fired thermal power plants on the territory of the district. Stara Zagora district emits 93% of them.

The share of disturbed territories in 2021 in the planning regions varies from 0.18 % of the territory of the region (North Western region) to 1.07 % in the South Eastern region (Table 1). In first place, both in terms of relative share and area of disturbed territories, is the South Eastern region with 211.42 sq. km disturbed territory. Similarly, both in terms of relative share and area, the least disturbed territories are in the North Western region - 34.64 sq. km. In the South Western planning region, the disturbed areas are 98.84 sq. km or 0.49 % of the total area of the region, which is relatively close to the average percentage of observed disturbed areas at national level, which is 0.42 %. Below the average for the country are the relative shares of the disturbed territories in the North Central, North Eastern and South Central regions, which are respectively 0.30 % (43.97 sq. km.), 0.26 % (37.67 sq. km.) and 0.20 % (44.01 sq. km.).

Table 1. Disturbed territory by planning region, 2021

Region	Disturbed territory		
	sq.km.	Share from the regional territory , %	Place of the region
North Western region	34.64	0.18	6
North Central region	43.97	0.30	4
North Eastern region	37.67	0.26	5
South Eastern region	211.42	1.07	1
South Western region	98.84	0.49	2
South Central region	44.01	0.20	3

Source: [11]

4 General conclusion and recommendations

Based on the analysis of the data and the assessment of the environmental risks related to the natural resources in planning regions, could be made general conclusions about the degree of occurrence of ecological risk in different regions in Bulgaria and about the trends that are observed in the direction of reducing the risk related to the environment and natural resources. The North Western and North Central regions are leaders in terms of household waste, with the least amounts generated there in 2021 (Table 2). The North Central and North Eastern regions are in the first places in terms of the analyzed indicators related to water resources. The lowest CO₂ emissions in 2019 were emitted in the North Western and South Central regions. One of the reasons for the low amount of emissions emitted in the South Central region may be the fact that this planning region has the most renewable energy

installations. The least disturbed territories are in the South Eastern and South Western planning regions.

Table 2. Place of the planning region in terms of risk for natural resources

Event related to ecological risk	NW	NC	NE	SE	SW	SC
Least generated household waste, 2021	1	2	3	4	6	5
Least Water used, 2021	6	1	2	5	3	4
Least quantity waste water discharged without treatment, 2021	3	2	1	4	5	6
Least CO ₂ emissions, 2019	1	3	4	6	5	2
Least Disturbed Areas, 2021	6	4	5	1	2	3

Legend: NW- Nord Western; NC - North Central; NE -North Eastern; SE - South Eastern; SW-South Western; SC - South Central

Source: own survey

In almost all the planning regions (except the South-Central region), positive trends are observed in terms of environmental risks (Table 3) for the period 2012 - 2021. In North Central, North Eastern and South Western regions, the trends are positive for the amounts of water withdrawn, discharged wastewater without treatment and CO₂ emissions. In the South Central region, the trends for the analyzed period for all the four indicators are negative. The data show that in five of the planning regions (except of North Western) the generated household waste is increasing.

Table 3. Trends related to environmental risk for the period 2012-2021

Ecological risk	NW	NC	NE	SE	SW	SC
Generated household waste	↓	↑	↑	↑	↑	↑
Water used	↑	↓	↓	↓	↓	↑
Quantity waste water discharged without treatment	↓	↓	↓	↓	↓	↑
CO ₂ emissions *	↓	↓	↓	↑	↓	↑

* Data for the emissions CO₂ are for the period 2016-2019

Legend: NW- Nord Western; NC - North Central; NE -North Eastern; SE - South Eastern; SW- South Western; SC - South Central

Source: own survey

To overcome the negative trends in terms of environmental risks in some planning regions, table 4 presents possible measures that can lead to the reduction of the risk to the environment and natural resources. Implementing these measures can significantly reduce water consumption, generated household waste, emitted emissions and disturbed area.

Table 4. Measures and actions for reducing the ecological risk

Ecological risk	Region with:	Measures
Most generated household waste, 2021	SW, SC	<ul style="list-style-type: none"> - Circular economy - Construction of recycling facilities - Household waste fee based on the quantity generated waste - National support for production that generate less household waste -Information campaigns to present the advantages of building a zero-waste society - Application of the concept of eco-design - Composting
Most Water used, 2021	NW, SE	<ul style="list-style-type: none"> - Use of water-efficient fixtures - Greywater recycling

		<ul style="list-style-type: none"> - Water-efficient landscaping - Innovation like smart irrigation systems - Water recycling systems in industries - Public awareness and education
Most quantity waste water discharged without treatment, 2021	SW, SC	<ul style="list-style-type: none"> - Implementation of source control measures (use of environmentally friendly and biodegradable products) <ul style="list-style-type: none"> - Reuse and recycling of water - Information campaigns about the importance of proper wastewater management - Development of proper wastewater treatment infrastructure at the community or governmental level
Most CO ₂ emissions, 2019	SE, SW	<ul style="list-style-type: none"> - Renewable energy encouragement - Energy efficiency improvement <ul style="list-style-type: none"> - Sustainable transportation - Low-carbon urban planning and design - Clean and efficient industrial processes trough innovation <ul style="list-style-type: none"> - Waste management implementation - Implementation of carbon pricing mechanisms <ul style="list-style-type: none"> - Public awareness and education
Most Disturbed Areas, 2021	NW,NE	<ul style="list-style-type: none"> - Land-use planning - Conservation and protection for areas <ul style="list-style-type: none"> - Sustainable urban development - Green infrastructure improvement <ul style="list-style-type: none"> - Sustainable agriculture - Ecosystem restoration - Sustainable forestry practices -Land-use regulations improvement -Public participation and education

Legend: NW- Nord Western; NC - North Central; NE -North Eastern; SE - South Eastern; SW- South Western; SC - South Central

Source: own survey

The publication is part of project No. KP-06-H55/1 from 2021 „Development of rural territories in the conditions of transforming Towards Sustainability Economy“, financed by National Science Fund of Bulgaria.

References

1. A. Mantarova, Environmental risks in the transforming society, Abstract of PhD thesis for obtaining the scientific degree "Doctor of Sociological Sciences" (2014)
2. B. Hu, X. Jia, J. Hu, D. Xu, F. Xia, Y. Li, *Int J Environ Res Public Health* **14**, 9, 1042 (2017)
3. C. Cao, W. Song, *Front. Environ. Sci.* **10**, 1077515 (2022)
4. Economic and Social Council, Analysis of the topic "The demographic and socio-economic status of the planning areas - current situation and prospects for development" (developed on the proposal of the President of the Republic of Bulgaria) (2022)
5. G. Rabbani, A. Atiq Rahman, N. Islam, *Climate Change and Sea Level Rise: Issues and Challenges for Coastal Communities in the Indian Ocean Region* (2010)
6. Institute for Market Economy, *Regional Profiles, Development Indicators* (2019)

7. Institute for Market Economy, Regional Profiles, Development Indicators (2020)
8. Institute for Market Economy, Regional Profiles, Development Indicators (2021)
9. Institute for Market Economy, Regional Profiles, Development Indicators (2022)
10. NSI, Environment, Waste from economic activity
11. NSI, Land use distribution of the republic of Bulgaria by type of durable land use of the land properties as of 31.12.2021
12. NSI, Water statistic
13. T. Matthews, K. Triantis, *Curr Biol.* **31**, 19, R1201-R1207 (2021)
14. W. Laurance, *Biol. Conserv.* **141**, 7, 1731-1744 (2008)
15. W. Williams, *Science, Policy and Management for Sustainable Use* **4**, 3-4, 85-91 (2002)
16. T. Zhai, J. Wang, Y. Fang, Y. Qin, L. Huang, Y. Chen, *Science of The Total Environment* **708**, 135153 (2020)