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Original Article

Environmental Justice and the Distribution of Urban Recreational Areas in Astana (Kazakhstan)

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Abstract - *The authors of the study believe that urban planning tools and coherent planning of urban green spaces are the primary available methods for mitigating air pollution in Astana. In the survey, urban recreational areas of Astana (urban parks, squares, and gardens) are considered the primary sites of urban green space concentration, serving as the primary source of air filtration and as natural barriers that intercept polluted air flows. However, in addition to the number of recreational areas, they must be distributed evenly throughout the city. In this regard, the study is based on the concept of environmental justice. A statistical juxtaposition of environmental hotspots with social susceptibility features is conducted to determine whether a double burden or double blessing is occurring in the Astana districts. The authors calculated the spatial distribution of air pollution from the city's primary source, Thermal Power Station-2. The study's main finding is that the distribution of urban recreational areas in Astana is unequal. In the city districts most exposed to air pollution and with the lowest income levels, there is a need for additional urban recreational areas to protect residents from air pollution. In contrast, the district with the lowest air pollution and the highest income rate in Astana has the most significant number of urban recreational areas. The study aims to contribute to the emergence of the concept of environmental justice in Kazakhstan by examining the unequal distribution of urban recreational areas in Astana.*

Keywords - *Urban planning, Recreational areas, Environmental justice, Vegetation, Green spaces.*

1. Introduction

Today, the physical expansion of megacities and population growth are driving rapid urbanization, a key factor in environmental deterioration in cities.

Currently, cities are home to roughly 86% or 2.5 billion people living worldwide, who are exposed to air pollution levels that are considered hazardous to humans.
Almost 1.8 million deaths are associated with air pollution [1]. There is a scientific unity regarding the point that the extended exposure to air pollution significantly increases the possibility of stroke, cardiovascular diseases, and cancer [2-4]. Therefore, financial consequences are significant, in the first place, reflected in the greater expenditures on public health [1].

According to the research that was implemented in 2014 by the World Bank and Kazakhstan's Ministry of Environment and Water Resources, it was identified that Kazakhstan's annual economic expenditures are reaching £1.3 billion because of the air pollution-related health influence, which is roughly 0.9% of the national GDP [5].

In recent years, Kazakhstan has undergone sharp urban development, which has led to numerous environmental challenges in urban areas. In this regard, Astana, the capital, experienced nearly twice the population growth over the last 15 years, making it the fastest-growing city in the region.

Currently, Astana covers an area of 801.54 square kilometres and has a population of 1,417,214.

During the examination of environmental air pollution in Astana, several studies identified critical concentrations of Particulate Matter (PM2.5 and PM2.5-10) in ambient air and in atmospheric precipitation (snow and rainfall), which could pose health risks. The authors concluded that the challenges posed by air pollution in Astana are not limited to visual and olfactory effects; the dangers to public health are far more serious. Inhalable particles contain bioavailable toxic metals, posing a significant risk of several serious illnesses among city inhabitants [6].

Numerous investigations have demonstrated that urban greenery, especially tree planting, has a major influence on air quality. Trees filter the air naturally and are barriers that arrest toxic materials that are suspended in the air [6-10]. Planting trees is a traditional and highly effective method for mitigating urban heat island effects, reducing carbon dioxide concentrations, and capturing air pollutants on leaves [11]. The study focuses on Astana's recreational areas (defined in official regulatory documents as urban parks, gardens, squares, and boulevards) because they exhibit the highest vegetation density in the city.

In the context of ecosystem services, recreational green spaces are often discussed in academic disciplines such as urban forestry, horticulture, and urban ecology [12]. These areas are also frequently used in air quality research as reference locations to represent a local background level, distinct from high-traffic pollution hotspots [13-15].

Astana urban planners have a significant tool to protect inhabitants from air pollution risks. Master plans for cities contain information on residential development areas, roads, recreational areas, vegetation, and potentially harmful sites [16-18]. This makes urban planning a valuable tool for mitigating environmental risks. Although urban planning and public health historically shared goals, there is little overlap between these fields today [19].

Several studies suggest that environmental justice can serve as a foundation for reconnecting these two fields and addressing challenges related to environmental risks [19-21]. In this context, guidelines for urban planners should include such theories.

Ulrich Beck [22], in his prominent scientific work 'Risk Society', famously stated, 'Need is hierarchical, smog is democratic,' pointing out that the most effective way to manage risks is to distribute them equally among all parties involved [23, 24]. Therefore, policies aimed at achieving an equitable distribution of environmental risks should focus on preventing certain groups from falling below minimum environmental protection standards [25].

Multiple detailed investigations have been conducted on urban air pollution in Kazakhstan [6, 7]. Although there is some local research on exposure to air pollution and concentrations of particles in the atmosphere of the city of Astana, data on means of reducing such exposure are scarce. The study presented here is the first to target urban recreational zones in the city of Astana as a means of primary protection of its citizens against air pollution.

Furthermore, there is a lack of research that focuses on just the spatial distribution of recreational areas in Astana. The aim of this research is to fill this research gap by localizing the notion of environmental justice in the Kazakhstani urban planning discussion and testing whether protective recreational infrastructure is fairly allocated by districts of different levels of pollution and socio-economic characteristics.

2. Study Area and Context

2.1. Study Area: Astana

Astana is located at 51°10' 9.8112" N and 71°26' 56.6664" E on a steppe plain in the north-central part of Kazakhstan. The city is located in a zone with a sharp continental climate and is the second-coldest capital city in the world. Winters are severe, lasting 5–6 months (October to April), with average temperatures as low as −30 to −35 °C.

Since Astana became the capital in 1997, its population has almost tripled, from 275,000 residents to over 1 million in 2020. At the time of the study, the city consisted of four administrative districts: Almaty, Saryarka, Baikonur, and Yesil (Figure 1). The first three districts comprise the old part of the city, while the Yesil district was developed from scratch on the left bank of the Yesil River and houses the city's prominent landmarks.

Fig. 1 Four districts of Astana city

This rapid population growth has led to increased building density and reduced green spaces. This trend has also increased the capacity demands on the city's Thermal Power Station–2 (TPS-2), which relies solely on coal due to the unavailability of natural gas. This reliance on coal for 6–7 months of heating inevitably leads to severe air pollution [5]. In 2022, the National Hydrometeorological Service of Kazakhstan declared Astana the most polluted city in the country.

2.2. The Concept of Environmental Justice

The concept of Environmental Justice (EJ) is applied in the context of social justice and equality, particularly in relation to state policy, legal guarantees, and public safety [26]. In recent decades, the unequal distribution of environmental benefits and risks among different social groups has become a significant concern [27]. Environmental deterioration often disproportionately affects racial and ethnic minorities and those with lower incomes. Scholars have noted that the ecological well-being of minorities is frequently neglected in favor of economic growth, thereby violating principles of social justice [28-30].

Certain social groups suffer from poor health and low standards of living due to other people's social and economic advancements. This inequity also applies to the unequal extent of the socially and environmentally positive goods, such as the social and physical accessibility of city parks and other forms of nature [28]. In the EJ framework, there are two principles of justice - the positive distributive principle (equality of access to a positive environment) and the positive procedural principle (equality of access to control and participation of all social groups in the environmentally related decision-making processes).

In the concept of a “risk society”, Ulrich Beck [22] notes that the environment (in its negative impacts) poses a public health risk (or a public risk) [24]. There are also social inequalities, as poorer individuals are at a far higher risk of living and being exposed to environmentally relevant high-risk situations due to their location and/or their inability to leave (or move out) from such crowded and/or contaminated spaces [23]. Beck also states that “need is hierarchical, but smog is democratic”. In terms of the extreme risk challenging a wider society, the risks are borne by less wealthy social groups at first (the social principle of the risk) and also cumulative in a zone where there is a poor, less wealthy, or deprived community, especially if such communities have industrial activities (the “boomerang” effect).

In the study by Pakina and Batkalova [32], the authors examined the role of vegetation in post-Soviet cities, such as Almaty (the former capital of Kazakhstan). The author investigated how Almaty’s vegetation has changed since the Soviet period and during Kazakhstan's independence, and how these changes affect the city's environment and quality of life. Pakina and Batkalova [32] evaluated the environmental sustainability of Almaty’s districts by juxtaposing air pollution levels with the capacity of trees to absorb pollutants. The research results identified inequality in vegetation structure within the city, with environmental burdens in some districts, particularly in industrial zones.

2.3. Air Pollution in Astana

Agibayeva et al. [6] thoroughly assessed the air quality in Astana. Within the course of the investigation, the authors studied the air quality in Astana in 2021 – 2023. The research objective was to evaluate the chemical composition, morphology, and particle forms (PM2.5, PM10) to explore the manner of toxic element translocation to the human body. The research revealed that the severe PM levels, with a mean of 28.7 μg/m^3 for PM2.5, exceeded the annual international WHO standards by a factor of 5.75. Throughout the heating (winter) period, maximum concentrations of 534 $\mu g/m^3$ for PM2.5 and 1564 $\mu g/m^3$ for coarse particles were measured. Electron microscopy revealed that soot and coal ash are the main constituents of winter air, establishing the source as fossil fuel burning. In summer, mineral and road dust predominate. High concentrations of sulphates, vanadium (V), nickel (Ni), and manganese (Mn) have been detected in snow and rain, indicating environmental pollution through precipitation. Iron (Fe) and vanadium (V) exhibited high solubility in artificial lung fluid, suggesting that they readily enter the body upon inhalation. Thus, coal is the primary pollutant adversely affecting population health in Astana.

Beiseneva et al. [7], using Pearson correlation analysis, identified a direct relationship between specific air pollution particles and mortality. In addition, the research identified the Thermal Power Station-2 in Astana as the primary source of air pollution, which uses coal to generate electricity [7].

There are several sources of air pollution in Astana, such as vehicular emissions. However, for the most part, vehicular emissions are distributed evenly across the city. The most significant contributor to air pollution in Astana is a stationary source located in one district. Accordingly, in the context of the environmental justice analysis, the study focuses on stationary sources of air pollution.

2.4. Green Spaces

The term 'green spaces' may not be commonly used among scholars in forestry, biology, or ecology. However, it is frequently used in public health and epidemiology to indicate exposure to greenery. According to Bealey et al. [33], increasing tree cover on 34% of available land in two UK cities would have resulted in an overall reduction of PM10 of 18-20%. As stated by Lin et al. [34], persistent, dense, and tall vegetation barriers are extremely efficient in knocking down and eliminating air contaminants. Consequently, the concentration of air pollutants is reduced behind the vegetation barrier, and the air quality for the inhabitants of the shielded zone is improved.

3. Materials and Methods

3.1. Statistical Analysis

Analytical and descriptive statistical methods were applied to assess environmental inequality in the city's districts.

Descriptive statistics, including means, ranges, and percentages, were used to summarize socio-economic and environmental indicators.

The Pearson Correlation Coefficient (PCC) was exploited to assess the strength of linear correlation:

1. Between air pollution and income;
2. Between air pollution and vegetation density;
3. Between income and the distribution of the green areas.

All calculations were conducted using Microsoft Excel and IBM SPSS Statistics (version 26).

The critical level of significance is set at a $p < 0.5$.

3.2. Spatial Distribution of Air Pollution

Traditionally, air pollution hazards from industrial facilities have been used to assess the hotspots of environmental exposure [36].

The characteristics of districts with and without hazard units were compared to determine environmental inequality. In 2023, 54,000 tonnes of emissions were released into the atmosphere in Astana, with TPS-2 accounting for 89% of this volume [7] (Figure 2).

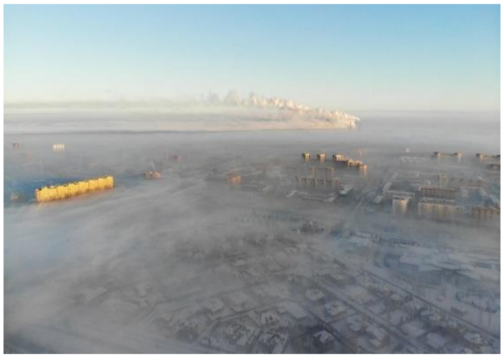

Fig. 2 The thermal power station-2 in the background is causing smog to cover Astana

In Kazakhstan, the Enterprise Hazard Category (EHC) is calculated according to the following formula:

$$EHC = \sum \frac{M_i}{MPC} A$$

MPC - average daily maximum permissible concentration of i substance.

Mi - the mass of emission of i substance, tonnes/year;

A - dimensionless coefficient to relate the degree of harmfulness of the i substance to the harmfulness of air pollution.

Table 1. Provides the values for coefficient A

Constants	Hazard class			
	1	2	3	4
A	1.7	1.3	1	0.9

Table 2. Categorization of enterprise divisions by hazard category

Hazard class	Value
I	EHC ≥ 106
II	106 ≥ EHC ≥ 104
III	104 ≥ EHC ≥ 103
IV	103 ≥ EHC

After performing calculations, the EHC value for TPS-2 was determined to be 3.758 × 10^6, indicating that the enterprise falls into the I hazard category.

In Kazakhstan, the Tishchenko OND-84 method is used to assess atmospheric pollution from the production area. According to this method, at an average source temperature, for a source with a normal fan-shaped emission distribution, the zone of minimum contaminant concentration is located approximately 20 pipe lengths from the source. The maximum contamination spreading zone is 40 pipe lengths.

The methodology has limitations, as it must account for specific meteorological components and pipe characteristics. Therefore, it is necessary to refine the method by incorporating additional data and calculations to generate more detailed recommendations.

During the design of TPS-2 in 1972, factors such as wind patterns and wind-speed variations at chimney height (approximately 150 meters) were not accounted for. Although the average wind speed in Astana is 3-4 m/s, during the winter heating season, when the TPS-2 is operating at total capacity, the wind speed can reach up to 25 m/s.

3.3. Pollution Dispersion Modelling

To map the spread of pollution from TPS-2, the authors refined the Tishchenko OND-84 methodology to account for Astana's specific wind patterns. The calculation for the sanitary protection zone radius Li was performed for each of the eight points of the wind rose using the following formula:

$$L_i = L_0 \frac{P}{P_0}$$

Li - the radius in the i-direction from the source to the sanitary protection zone, accounting for the wind rose (km).

P - the average annual frequency of wind directions (%);

Po - frequency of wind directions of one rhumb at which the wind rose (Po=100/8=12.5 (eight-rhumb wind rose);

L_0 - the value of the radius without correction for the wind rose (km).

ArcGIS software was used to map the area of atmospheric pollution in the TPS-2 production area (Figure 3). Furthermore, a visual analysis of the sanitary protection zone surrounding TPS-2 was conducted (Figure 5).

3.4. Recreational Areas

In the study, recreational areas are considered as city parks, squares, boulevards, and public gardens, as defined in the urban planning and environmental standards of the Republic of Kazakhstan (e.g., SN RK 3.01-01-2013).

Astana's urban recreational areas were selected on the basis of systematic conditions to ensure comprehensive coverage: recreational areas must meet the definition, be at least 0.5 hectares (to exclude microspaces), and be publicly accessible. As a result, 45 areas were selected in four districts of Astana (Almaty, Baikonur, Saryarka, Esil). Exclusion criteria: private gardens, industrial green belts, temporary spaces. Selection process: an initial list was compiled from the Master Plan, verified by satellite imagery (Google Earth Pro) and field visits in 2025.

3.5. Data Source

The Bureau of National Statistics reported, for 2025, the number of trees, average monthly wages, and emissions of solid and gaseous pollutants from stationary sources in each district of Astana (Figure 4) [35]. This data is publicly available on the Bureau's website.

A comparative analysis was conducted on the data obtained from the Astana district. The authors analyzed the distribution of green spaces in Astana. The authors used GIS technologies to identify and categorize green spaces into urban parks, gardens, boulevards, green belts, and squares (Figure 5).

3.6. Study Limitations

The spatial data on vegetation areas may not fully account for small green spaces. The air pollution dispersion model does not account for real-time indicators or chemical correlations in the atmosphere. Socio-economic data were aggregated at the district level. The district-level data is unavailable. Some historical data on the planning were unavailable due to access restrictions.

4. Results

4.1. Calculation of the Spatial Distribution of Air Pollution

The authors modified the current Tishenko OND-84 method to account for the number of meteorological conditions and the piping's technical characteristics.

The calculations defined the directions and distances of the air pollutants in the area (Table 3).Using ArcGIS, a map was created based on the results presented in Table 3 (Figure 3).

Table 3. Calculations defining the directions and distances of air pollutants in the area

The value of the radius in the i direction	Repeatability of winds (P), %	$\frac{P}{P_0}$ =12,5%	Maximum distance of pollutant transfer range (40 pipe lengths), km	Maximum concentration zone of pollutants (20 pipe length), km
L_n	8.6	0.688	3.3	1.65
L_{ne}	11.9	0.952	4.56	2.28
L_e	19.3	1.544	7.4	3.7
L_{se}	20.4	1.632	7.83	3.91
L_{se}	19	1.52	7.3	3.65
L_{sw}	6.7	0.536	2.57	1.28
L_w	6.6	0.528	2.53	1.26
L_{nw}	7.6	2.91	2.91	1.455

Fig. 3 The area of atmospheric pollution in the production area of TPS-2

4.2. Analysis of Spatial Inequality in Astana's Districts

The analysis is based on statistical data from the Statistical Committee and local authorities, as presented in Tables 4-7, which represent the 2024 indicators. The socio-spatial analysis revealed that the Almaty district, located in the old part of the city, has the lowest average monthly salary rates (Table 6). The Almaty district is the most exposed to air pollution from stationary sources and particulate pollutants (Table 4). However, the number of trees in the Almaty district is 3.5 times lower than in the Yesil district (Table 7). The diagrams show that the Yesil district experiences the lowest levels of air pollution and particulate emissions in the city (Table 4). The findings highlight the spatial unevenness of environmental quality across the city, particularly in districts affected by industrial emissions.

Table 4. Emissions of particulate pollutants (tonnes)

District	Emissions of particulate pollutants (tonnes)
Baykonur	400
Yesil	300
Saryarka	300
Almaty	9000

Table 5. Air emissions of pollutants from stationary sources (tonnes)

District	Air emissions from stationary sources (tonnes)
Baykonur	2.4
Yesil	3.6
Saryarka	1.4
Almaty	50.3

Table 6. Average monthly salary (USD)

District	Monthly average wage (USD)
Baykonur	754.4
Yesil	1.056.6
Saryarka	707.9
Almaty	672.3

Table 7. Number of trees by districts

District	Number of trees
Baykonur	828.259
Yesil	6.810.619
Saryarka	139.158
Almaty	1.904.206

One of the primary sources contributing to air pollution in Astana is TPS-2, whose sanitary protection zone should have served as a key regulatory mechanism for mitigating industrial impacts on residential areas; however, in practice, it fails to fulfill this function effectively.

In Kazakhstan, the design of production processes must adhere to sanitary and epidemiological requirements. As an industrial plant of hazard class 1, TPS-2 in Astana requires a minimum of 1000 m of sanitary protection zone.

Visual analysis of the TPS-2 area revealed a sanitary protection zone (Figure 4).

Fig. 4 Sanitary protection zone of TPS-2

According to the sanitary and epidemiological requirements, the main functions of the sanitary protection zone are as follows:

- Create a sanitary protection barrier between the enterprise's territory (or group of enterprises) and the territory of residential buildings;
- Develop green spaces that provide screening, assimilation, and filtration of atmospheric air pollutants while also increasing the comfort of the microclimate.

According to GIS-based spatial analysis of green spaces in Astana, the Yesil district contains more recreational areas than all other districts combined. Parks and public squares are the predominant types of recreational areas in the Yesil district, while gardens and boulevards are also present, albeit to a lesser extent. In contrast, the older part of the city, particularly the Almaty district, is characterized by a significant shortage of recreational spaces (Figure 5).

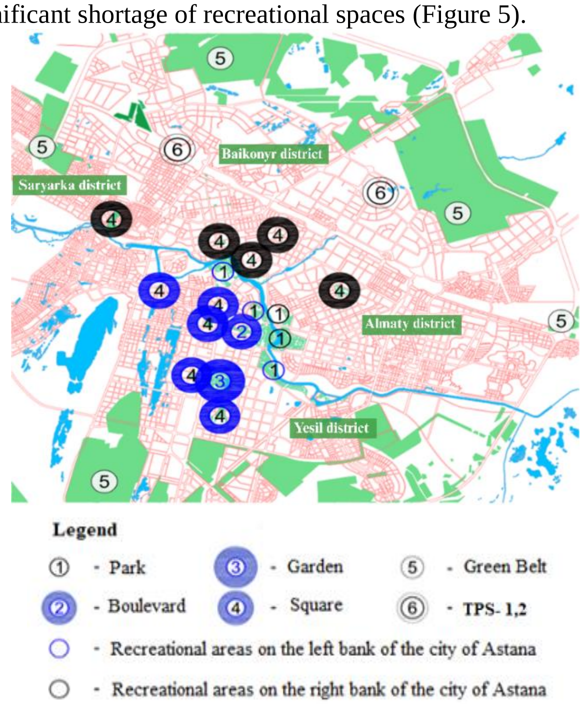

Fig. 5 Green spaces in Astana

5. Discussion

5.1. Spatial Distribution of Air Pollution

In 1972, the development of the TPS-2 was based on wind-speed and wind-rose calculations for that period to protect the city from air pollution. However, the formation of the green belt in Astana, along with the city's growing population, urban expansion, and regional climate changes, has altered the speed and direction of the wind roses. The TPS-2 was built on the outskirts to divert pollution from the city. However, the factors mentioned above were not accounted for, resulting in the release of pollutants from the TPS-2 into the city rather than outside it.

According to Figure 3, TPS-2 is the primary source of air pollution, with emissions predominantly extending to the southern and southeastern parts of the city, and the highest concentration observed within the Almaty district. Conducted visual analysis of the TPS-2 (Figure 2) indicates that the existing sanitary protection zone does not function as a green buffer that intercepts harmful particulates from the enterprise. The sanitary protection zone consists almost entirely of trees that could absorb the pollution. The spatial data in Figure 5 confirm the scarcity of vegetation in the Almaty district, which could protect local citizens from air pollution.

Consequently, pollutants emitted from TPS-2 disperse freely across the surrounding territory, exposing residents of the Almaty district to the highest concentrations of contaminated air. Although a sanitary protection zone of approximately 1000 meters in diameter can be visually identified around TPS-2 (Figure 5), it remains underutilized and fails to fulfill its protective purpose.

5.2. Spatial Evaluation of Inequality

The spatial distribution of income, ecological, and environmental indicators across Astana's districts is unequal, as indicated in Table 4-7. The Almaty district is more exposed to particulate pollutant emissions and air pollution from stationary sources in Astana than other districts in the city. Additionally, the figure illustrates the disparity in average monthly salaries.

The average monthly income in the Almaty district is 63% lower than in the Yesil district. Additionally, the number of trees and the environmental benefits in the Almaty district are 3.5 times lower than in the Yesil district. These findings are consistent with studies in the United Kingdom that have demonstrated unequal exposure to air pollution across income levels [37, 38].

The statistical juxtaposition of hotspots of environmental exposure with social-susceptibility features is used to identify districts exposed to a 'double burden' or a 'double blessing.' The results suggest that rapid urbanization, as it leads to hotspots of high population and associated environmental pressures, is a crucial driver for areas of 'double blessing,' where people with high socio-economic status enjoy a high-quality environment, or 'double burden,' where vulnerable groups are confronted with a poor environment [39].

5.3. Green Spaces

Most recreational areas are located in politically significant districts of the city, which is inconsistent with principles of equality. Furthermore, the city's historic center, particularly the Almaty district, requires additional recreational areas. This is also true for environmentally hazardous production points and areas, where recreational areas could serve as natural barriers to pollutants. Additionally, there is a noticeable disparity in the variety of green spaces between the city's two parts. On the other hand, the Yesil district, which is privileged due to the concentration of the city's leading attractions, is home to the city's most recreational areas.

5.4. Environmental Inequality

Conducted analysis revealed environmental inequality in Astana. Inhabitants of the Almaty district are most exposed to air pollution in Astana due to its proximity to the city's main sources of pollution. Furthermore, the district has the lowest income level, placing it under the “double burden”. The absence of recreational areas and vegetation in the district directly increases the risk of serious illnesses, as indicated by Agibayeva et al. [6] and Beiseneva et al. [5]. An adequate level of vegetation in the district could have mitigated air pollution exposure, thereby reducing the health risks associated with stroke, cardiovascular disease, and lung cancer. However, the total number of trees in the district is 3.5 times less than in the Yesil district, which is not directly exposed to the Thermal Power Station-2. Although there is a sanitary protection zone, Figure 4 shows that it does not function as a natural barrier capable of absorbing harmful particulates from Thermal Power Station-2 due to the absence of trees.

5.5. Policy Implications and Recommendations

According to the state’s sanitary and epidemiological requirements, the Thermal Power Station-2 should be surrounded by a 1000 m sanitary protection zone. While the sanitary protection zone is in place, it has little functional rationale given the lack of trees within it. Therefore, it is reasonable to amend the sanitary and epidemiological requirements by including a clause mentioning a minimum number of trees in the sanitary protection zones.

The principles of Environmental Justice and the Just City should guide urban planners in Astana. “Environmental blessings” such as urban recreational areas should be distributed equally within the city. Additionally, planners should consider socio-economic indicators, air pollution exposure, and environmental exposure hotspots to prevent the accumulation of environmental risks.

6. Conclusion

Studies conducted by local researchers have shown that TPS-2 is the primary source of air pollution in Astana [7]. Furthermore, other studies have shown that air pollutants in Astana exceed WHO and EU limits [40]. In contrast, this study aims to contribute to Kazakhstan's emerging environmental justice discourse by examining whether environmental risks in Astana are distributed equally. The first study in Kazakhstan, drawing on environmental justice research, explores the unequal distribution of air pollution burdens attributable to industrial facilities. The results provide some evidence of environmental inequalities. The study examines the unequal distribution of environmental risks in Astana based on air pollution data. The results indicate environmental inequality in Astana, with the Almaty district bearing a 'double burden.' The Almaty district has the lowest average annual income, with relatively few trees and limited urban recreational areas. However, the district carries the highest air pollution burden in Astana. The Almaty district is home to environmentally hazardous sites such as the TPS-2. Research on environmental inequality in Astana presents a significant opportunity to create a healthy living environment for all. By studying the underlying mechanisms of environmental inequalities, further research is hoped to enhance the development and adoption of social-environmental policy responses [37]. To date, concepts such as environmental justice are not mentioned in the main urban planning rules and documents (the Astana Master Plan and the General Scheme of the organization of the country's territories) in Astana and Kazakhstan. Astana, particularly the Almaty districts, requires additional urban recreational areas to mitigate environmental risks associated with air pollution. Nevertheless, planning more urban recreational areas in the city without considering concepts such as environmental justice will not reduce environmental risks. The study contributes to a deeper understanding of environmental inequalities in Kazakhstan. The unequal distribution of environmental risks in Kazakhstan is undoubtedly underestimated and requires further research.

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