

# Actual questions of ecological and urban planning zones of the regions for the formation of territorial and industrial complexes (TIC)

Las cuestiones actuales de las zonas ecológicas y urbanísticas de las regiones para la formación de los complejos territoriales e industriales (TIC)

Author:

 Gaukhar Sadvakasova<sup>1\*</sup>

## ABSTRACT

**Introduction:** In the context of accelerated development of production, which is typical for the rapidly developing republics, which include the Republic of Kazakhstan, one of the urgent problems is the creation of favorable living conditions of the population. **Materials and Methods:** Among a wide range of questions necessary for solution of this problem in the Republic of Kazakhstan the sanitary-hygienic and ecological comfort of living of the population, and also, preservation of the natural environment become of special, in many aspects the priority importance. **Results and Discussion:** Improvement of research skills of ecological and urban planning specifics of the formation of population systems in the areas of Kazakhstan territorial and industrial complexes and the development of effective planning techniques of functional and spatial organization at the settlement systems is an important area of research. **Conclusions:** The author's research is presented in this framework.

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<sup>1\*</sup> Corresponding author. International Education Corporation, Kazakh Head Architectural and Construction Academy, Almaty, Republic of Kazakhstan, [gaukhar\\_sadvakasova@sci-univ.com](mailto:gaukhar_sadvakasova@sci-univ.com)

## INTRODUCTION

Ecological and urban planning principles of formation functional and planning structure of population systems in TIC zones of different types are tested with the help of experimental modeling and methods of system analysis on the basis of three TIC, which reflect the specific economic and environmental conditions of the Republic of Kazakhstan - Pavlodar-Ekibastuz, Mangyshlak and Karatau-Taraz. The ecological town-planning typology of population areas in the zones of TIC formation was the basis for the subsequent determination of rational directions of functional-planning structure of settlement systems in these areas.

The main question for study is:

1. What are the clusters of the actual method for the research of ecological and urban planning conditions for the formation the functional and planning structure of population systems in the development zones of the TIC in the Republic of Kazakhstan of different types.
2. How should the methods of designing settlement systems be improved in the specific economic and environmental conditions of these areas.

The article is structured as follows: the first section explains the research methodology. In the second, the analysis and results are presented with detailed graphical support by the author of the publication. The third section presents the current directions of ecological and urban planning zoning of the territory of the areas of formation of territorial-industrial complexes (TICs). The conclusions are presented in the form of recommendations.

In order to answer the question of understanding the peculiarities of the location of the territorial production complexes of Kazakhstan, it is necessary to identify the existing features of the placement of the territorial production complexes of Kazakhstan and the degree of study of the problem. Production is developing in Kazakhstan mainly in the form of large territorial production complexes (TICs), which, as a rule, include the placement in compact territories of several large enterprises of various industries. The exceptionally high concentration of production created in this case causes, as a rule, the summation of negative environmental impacts in the areas where enterprises are located. At the same time, in Kazakhstan, especially in the development zones of many TICs, the natural environment is characterized by reduced resistance to anthropogenic impacts. This creates a difficult situation, often associated with the irreversible degradation of the natural complex, excessive pollution of the air and water basins over large areas, disturbance of the soil and vegetation cover, depletion of the animal world and other negative consequences.

## THE MAIN ENVIRONMENTAL AND URBAN PLANNING PROBLEMS OF THE FORMATION OF THE TIC.

The problem of the interconnected development of the TIC, settlement systems in the zones of their formation and environmental conservation is exacerbated in the conditions of Kazakhstan, due to the wide variety of natural and climatic conditions (from the foothill regions of the Karatau-Taraz TIC to the semi-desert and partially desert regions of the Mangyshlak TIC) <sup>(1)</sup>.

Such a variety of landscape zones (mountains, steppes, forest-steppes, deserts, etc.) causes an exceptional differentiation of emerging problems and required environmental measures in the chain “production – resettlement – environment”. At the same time, despite such a variety of natural and climatic conditions of the regions in which the TIC develops, they all differ in one essential feature – the low restorative capacity of the natural environment to anthropogenic loads. From this follows the need for a new regional approach to solving the ecological and urban problems of intensively developing territories based on the choice of rational forms of settlement and the functional planning organization of the areas where the TIC was created. Nevertheless, the importance of a detailed account of the interaction of the main components of the environment with industrial and anthropogenic loads, as well as the environmental parameters of the development of these areas in various natural and landscape conditions, increases <sup>(2)</sup>. The implementation of this approach in solving specific problems of locating production and organizing resettlement in the development zones of the TIC when drawing up schemes and projects for regional planning and urban planning is hampered by the insufficient development of theoretical and methodological foundations and practical planning techniques in such specifically developing regions of the country as Kazakhstan. Therefore, further theoretical and design-practical study of environmental and urban planning problems in the specific conditions of the construction areas of the TIC in Kazakhstan seems to be one of the urgent tasks of urban planning science.

The insufficient development of these issues led to a number of unreasonable recommendations and practical measures for the planning and development of cities in Kazakhstan related to the development of the TIC: the scale of development of settlements was associated mainly with production and economic factors without taking into account

the “ecological capacity” of the territory in specific natural and landscape conditions; the mutual location of TIC facilities and places of residence of the population was decided mainly on the basis of the criterion of their transport accessibility, without taking into account environmental factors; when determining the directions for the development of the planning structure of populated areas and areas of settlement as a whole, only individual components of the environment were taken into account, and not the integral natural and ecological situation, etc.

An analysis of the current state and trends in the development of settlement in conjunction with the characteristics of the general ecological features of the natural environment made it possible to formulate the most pressing problems that need to be solved in order to improve the settlement and create favorable living conditions for the population associated with the developing TIC of Kazakhstan. At the same time, among the various socio-economic and urban planning problems of improving settlement that take place and will arise in the process of developing the TIC, special attention is paid to those environmental and urban planning problems, the solution of which can be largely provided by planning tools (naturally, in close connection with engineering and other means).

In the context of the development of production in the form of territorial production complexes, the identification of environmental and urban planning problems of settlement of a planning nature and their solution by planning tools are of particular importance in connection with the following circumstances.

A. As the analysis of the specific progress of the construction of production facilities of the TIC of Kazakhstan, especially in the most problematic ones, such as Pavlodar-Ekibastuz, Karatau-Taraz, etc., shows, the construction of treatment facilities and the implementation of appropriate environmental measures constantly lags behind the commissioning of environmentally hazardous capacities. But even in the case of their synchronous construction, as shown by numerous examples and available studies on “coal”, “phosphorus” and other areas characteristic of the specialization of the TIC of Kazakhstan, the level of pollution of the surrounding territories with “residual” emissions is usually higher than the norm <sup>(1)</sup>. Prevention or mitigation of this just can be ensured by planning measures, including certain options for the planning structure of the settlement of these areas.

B. In many cases, as the analysis of some examples of current practice has shown, for example, in the Almaty TIC, it is not effective in terms of investment and the result obtained, it is not the fight against single sources of environmental pollution by individual enterprises, but their grouping and holding district-wide activities, a significant proportion which falls on planning measures (including the rational mutual placement of production and the population, the choice of optimal directions for the development of populated areas and zoning, the organization of various kinds of protective and buffer zones, etc.).

C. Today, the point of view is becoming generally accepted, according to which sectoral actions in relation to environmental protection are no longer enough. On the contrary, in its essence, this problem is typically intersectoral, in which intersectoral measures, especially planning ones, are becoming increasingly important <sup>(3)</sup>.

General scientific and methodological principles for the planning of settlements and the formation of settlement systems, taking into account natural and environmental factors, were formulated back in the last century in the “General Scheme of Settlement on the Territory of the USSR until 2000” <sup>(2)</sup>. It contained a theoretical concept of a complex territorial organization of production, settlement and environmental protection at all taxonomic levels.

Actual aspects of the problem are disclosed from various sides by such authors as Abilov A.Zh. <sup>(4)</sup>, Kosolapov O.V. <sup>(5)</sup>, Kochurov B.I. <sup>(6)</sup>, Kryukova N.A. <sup>(7)</sup>, Lipina S.A. <sup>(8)</sup>, Nekrasova M.A. <sup>(9)</sup>. The results of these studies are the scientific and methodological basis for specific developments in the field of district planning, planning and development of populated areas, which are carried out by design organizations for various regions of the country, including Kazakhstan. However, due to the fact that the acuteness of environmental problems has been recognized only recently, these works have not yet received sufficient coverage of many issues of the coordinated development of production and settlements, taking into account environmental balance. There are no studies devoted to assessing the natural and landscape conditions of the areas of accelerated development – the zones of formation of the TIC of Kazakhstan. In many respects, the very scheme of analysis of the ecological and urban planning conditions for the development of settlement in these areas is not clear; there is no classification of the zones of development of the TIC, which makes it possible to differentiate planning methods and forms of settlement depending on the characteristics of the ecological situation.

## **TERRITORIAL AND INDUSTRIAL COMPLEXES (TIC)**

One of the most effective forms of placement of productive forces in modern conditions of intensification of the economy are territorial production complexes (TICs). In the TIC as a specific territorial-intersectoral form of organization of production, ample opportunities open up for the rational solution of issues of technological

cooperation and combination, the integrated and efficient use of natural and labor resources, the creation of unified construction, repair and procurement bases, the development of engineering and technical infrastructure and the non-production sphere (4.4). At present, TIC is a planned, proportionally developing set of steadily interconnected objects of the sectors of the national economy, labor and natural resources, concentrated on a relatively limited and compact territory, which has a set and size of resources necessary for the country (republic) to solve major economic problems (4.51).

The development and implementation of programs for the formation of the TIC is carried out in accordance with the methodological instructions of government bodies. A comprehensive scientific justification for program-targeted TIC is given in the monograph by M.K. Bandman. In Kazakhstan, which is characterized by a concentrated-nodal nature of the distribution of raw materials, general economic and labor resources, a significant differentiation of natural conditions, with a relatively weak development of the territory and insufficient transport provision, this process is quite active <sup>(1)</sup>.

An analysis of materials on the prospective development of the productive forces of Kazakhstan, contained in the developments of government agencies, shows that by now in Kazakhstan there are TICs as already actively developing, including those of interstate importance (for example, Pavlodar-Ekibastuz, Karatau-Taraz, Mangyshlak), and TIC, the development of which is just beginning. An analysis of the current structure of industry and a comparison of the main indicators characterizing the importance of industries showed that the leading branches of specialization of the TIC of Kazakhstan are: fuel industry, energy (Pavlodar-Ekibastuz), non-ferrous metallurgy (Rudno-Altai, Dzhezkazgan-Zhaimem, industry (Karatau-Taraz), oil industry (Mangyshlak), that is, those industries that have the greatest impact on the environment.

The specific features of the Republic leave their mark on the nature of the formation of settlement in the development zones of the TIC: a vast territory (2.7 million sq. km); significant differentiation of natural landscape and socio-economic conditions of its individual parts; the local nature of the distribution of productive forces; relatively weak development of the territory and an underdeveloped transport network with a simultaneously developed structure of settlement in certain areas. In the Republic, the proportion of the population living in large, large and largest cities (with a population of 100-500 thousand and over 500 thousand people) is relatively high; it is 1.3 times higher than the average for the CIS. At the same time, the share of the population concentrated in the agglomerations formed around the cities of Almaty and Karaganda with a population of more than 500 thousand people is 3.6 times lower than the average. That is, Kazakhstan is characterized by an increased localization of the urban population around urban centers. Thus, the share of the urban population living in the zone of 2-hour accessibility of cities with a population of more than 100 thousand inhabitants is 1.3 times higher than the average for the CIS. A distinctive feature of rural settlement in the region is the concentration of the bulk of the rural population in enlarged settlements with a population of 1,000 to 5,000 people – 46.5%. At the same time, the share of the rural population living in the 2-hour accessibility zones of cities with a population of more than 100 thousand inhabitants is 1.2 times lower than in the CIS as a whole; in other words, rural settlement is characterized by greater dispersion.

Another specific feature that largely determines the nature of settlement in the TIC of Kazakhstan is the contradiction between the huge production and economic potential in certain parts of the Republic and the very low ability of the natural environment to perceive anthropogenic loads. In this regard, the development of cities and towns on a scale corresponding to the expansion of their city-forming base is already facing the need to overcome serious environmental and urban planning restrictions. This problem will become even more acute in the future, with the development of territorial production complexes to the scale envisaged in industry developments.

According to the production and economic structure, urban settlements developing in the zones of the TIC of Kazakhstan can be divided into the following main groups:

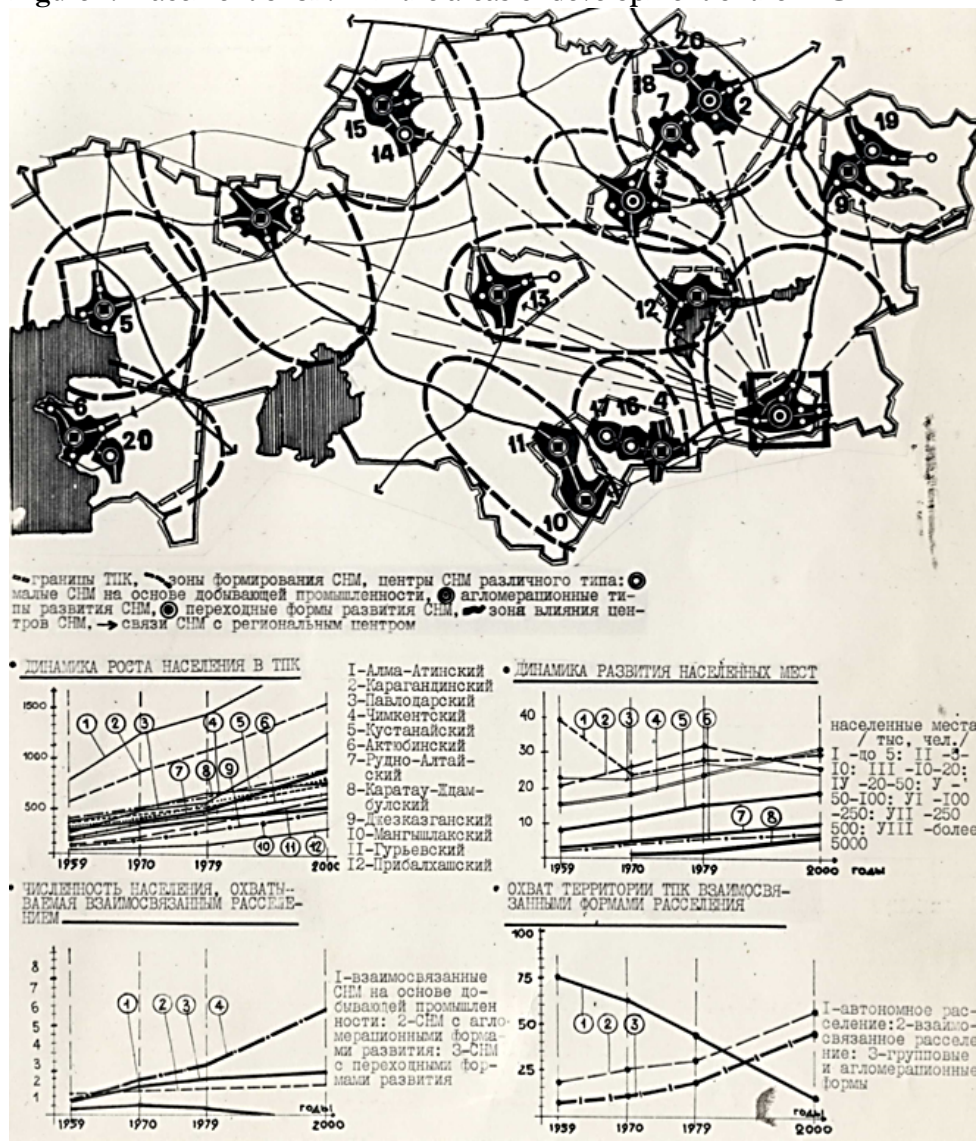
- cities developing mainly on the basis of the extractive industry (Zhaimem, Zhetygara, Shakhtinsk, etc.) - these are mainly small towns, urban-type settlements, shift camps of peripheral industrial centers;
- cities developing on the basis of mining and manufacturing industries (Karaganda, Kentau, Leninogorsk, Zyryanovsk, Taraz, etc.);
- cities developing on the basis of the manufacturing industry (Aktyubinsk, Balkhash, Semipalatinsk, Temirtau, Almaty, etc.).

According to the level of interconnectedness of cities and towns, or, in other words, according to the degree of their formation into systems of interconnected settlement of various types in the conditions of Kazakhstan, 3 types of systems can be distinguished (Figure 1).

First of all, a peculiar form of interconnected settlement is singled out, consisting of a set of small settlements developing on the basis of territorially close mining enterprises of the raw-material TIC. Such systems include

Zhezkazgan-Zhaireskaya, Kustanaiskaya, Balkhashskaya, etc. Interconnected systems of this type from the point of view of living conditions are distinguished by a number of disadvantages: the absence of a developed center with the necessary set of socio-cultural institutions and, accordingly, the weak development of inter-settlement ties; the distribution of production between populated areas is random in nature, while the choice of places of application in each of the populated areas is narrow. The priority of production tasks in general led to the lack of expression of zoning, which is all the more necessary here due to the widespread pollution of the territory from closely located enterprises, as well as the disordered planning structure of these systems.

Figure 1. Placement of SNM in the areas of development of the TIC



Source: drawing by the author

Another group is represented by systems of agglomeration type with expression - a multifunctional large city with a developed socio-cultural potential (Almaty, Karaganda). An analysis of their planning structure and the established links between settlements will allow us to consider that these concentric systems can be considered as actively developing group systems of settlements.

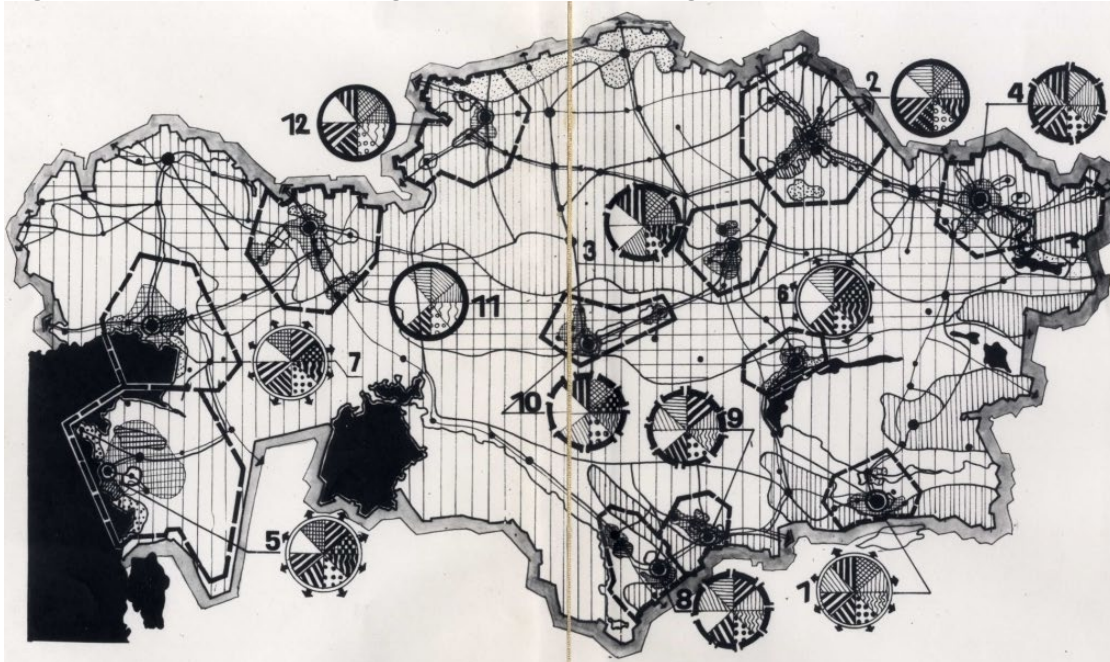
The third group, represented by 8 systems of interconnected settlement, can be considered as a transitional type - from a small settlement without a pronounced center and an undeveloped planning structure to developed systems of an agglomeration type. These systems are developing mainly on the basis of cities - regional centers, which are at the same time the cores of territorial production (Taraz, Ust-Kamenogorsk, Pavlodar, etc.).

## NATURAL AND LANDSCAPE CONDITIONS AND MAIN ECOLOGICAL AND TOWN-PLANNING PROBLEMS OF RESETTLEMENT

The ecological and urban planning orientation of the organization of resettlement and the development of populated areas on the basis of an interconnected analysis of the system “industrial and economic structure - planning structure of settlement - the natural environment” requires special attention to the last component - the analysis of natural and landscape conditions in the development zones of the TIC.

If in special physical and geographical, as well as in district planning works, the analysis of natural and landscape conditions, as a rule, is understood as a characteristic of natural and climatic features, engineering and geological features of the territory <sup>(2)</sup> and only minimal attention is paid in some cases to the analysis of specific characteristics that can be called environmental and urban conditions, then based on purposes of this work, it pays special attention to this aspect (Figures 2, 3).

**Figure 2. Comprehensive ecological and urban planning characteristics of development zones**



Source: drawing by the author

TIC of Kazakhstan (shown: favorable, relatively favorable, unfavorable; geochemical assessment of the territory: self-purification of the atmosphere, landscapes and surface waters - good, moderate, weak; deflationary risk - low, moderate, high; landscape resistance to physical stress - stable, relatively stable, unstable; biogeochemical endemias; natural foci of diseases; seismicity; borders of the TIC, centers of the TIC and industrial hubs; territories: negatively affected by anthropogenic loads, favorable for the development of industry and residential areas, requiring protection, requiring reclamation, suitable for recreation; natural zones - forest-steppe, steppe, semi-desert, mountainous regions) (Figure 3).

Ecological and urban conditions are understood as the interaction of natural and anthropogenic factors (mainly related to the development and functioning of populated areas), as a result of which a certain ecological situation develops in a given territory (hygienic conditions, the degree of disturbance of landscapes and its individual elements, the state of ecosystems and etc.) <sup>(1)</sup>.

**Figure 3. Types of landscapes**

a) “deep” anthropogenic intrusion into the natural landscape, with a limited possibility of reclamation; b) semi-desert landscape changed by hydromelioration; c) cultivated landscape requiring constant reproduction; d) relic foothill landscape requiring strict protection; e) limited-stable landscape, there is a danger of anthropogenic overload by uncontrolled grazing; f) unique foothill-mountain landscape in need of protection limited recreational due to deflationary phenomena; g) unique foothill-mountain landscape in need of protection limited recreational due to deflationary phenomena



Source: drawing by the author

The TICs released on the territory of the Republic are located in different climatic and landscape conditions, which determines the variety of responses of the natural environment to the emerging technogenic impact. The severity of the ecological situation within the TIC requires the identification of priority environmental problems both for individual components of nature and for landscapes as a whole. For this purpose, it is necessary not only to assess the degree of technogenic pressure on natural landscapes in areas of altered nature, but also to characterize the self-purification potential of various natural media (air, water, soil, vegetation) of the corresponding natural zones in which the studied TICs are located.

For a comprehensive characterization of the self-purification of the territory, all components of the natural environment from pollution by waste products of industrial activity, indicators of geochemical activity, expressed in a point assessment, can be used (2).

The geochemical activity of a territory is determined by the ability of the natural environment (its individual components and entire complexes) to withstand technogenic impacts arising from polluting emissions from industrial enterprises, agricultural, and household facilities. The natural properties of the natural environment determine the possible degree of neutralization of ingredients coming from outside (in solid, liquid, gaseous state) through

decomposition on the spot and due to the removal of transformation products outside the given territory by wind, water flows, and subsoil runoff.

To assess the impact of emissions evacuated into the atmosphere, it is necessary to consider the potential for self-purification of the atmosphere within the boundaries of the formed TIC. The above calculations of the estimated indicators of individual characteristics of environmental and urban conditions are made on the basis of an analysis of the materials of the Kazakh Hydrometeorological Service, the Ministry of Geology, the Ministry of Agriculture, regional basin inspections, regional SES and other departments and organizations responsible for nature management, as well as materials from Kazgiprograd, Kazgiprovodkhoz, Kazhydroproject.

The intensity of degradation with the possible entry of gaseous pollution into the atmosphere depends on the thermal resources of the territory. In general, these resources are significant for all TICs. Thus, the total solar radiation varies from 100 to 140 kcal/cm<sup>2</sup> per year, and the index of the sum of active temperatures, reflecting the rate of decay of man-made compounds in the warm season, varies from 2000 degrees in Pavlodar-Ekibastuz, Karaganda-Temirtau, Kustanai TIC to 5000 degrees in Shymkent-Kentau TIC. An additional source of oxidation of chemicals in the atmosphere is the energy of lightning discharges. Frequency of thunderstorms is 20-25 days per season in Aktobe-Alginsk and Kustanay TIC, and 15 days per season in Pavlodar-Ekibastuz TIC. In the foothills, thunderstorms intensify and in Karatau-Taraz, Shymken-Kentau, Almaty in TIC reach the maximum values for the territory of the Republic - 30 days per year. On the contrary, for Mangyshlak and Atyrau-Inderbor TIC thunderstorms are not significant (their number per season does not exceed 5 days). The wind regime of the territory is a factor contributing to the removal and dispersion, deconcentration of chemical compounds in the atmosphere. From this point of view, the territories of the Mangyshlak and Aktobe-Alga TIC are favorable (average annual wind speeds are 7-8 m/s). The rest of the TICs are characterized by annual wind speeds of less than 4 m/s.

The recurrence of calm situations and inversion phenomena serves as a negative characteristic of the atmosphere's self-purification potential. So, for Karaganda-Temirtau and Pavlodar-Ekibastuz, Zhezkazgan-Zhay-remsky TIC, the frequency of surface inversions is 40-60% with their thickness up to 0.6-0.8 km in winter, and not more than 0.4 km in summer. In all seasons, the frequency of wind speeds of 0-1 m/s does not exceed 20-25%, although there is a well-marked annual variation of weak winds. The repeatability of the wind speed of 0-4 m/s at a height of 500 m is 20-30%. Thus, equiprobable conditions are created both for the dispersion of impurities and for their accumulation. On the territory of Mangyshlak, Atyrau-Inderbor, Pribalkhash TIC, the greatest weakening of the wind near the ground and at altitude is observed in autumn. In addition, the general background of natural dust content in the air is increased in this area. Therefore, it is undesirable to place objects emitting a large amount of solid impurities in it.

Aktobe-Alga, Kustanai and Rudno-Altai TIC are characterized by weak winds and stable stratification. The repeatability of surface inversions can exceed 80% with their thickness of 1000 m and temperature difference up to 10 degrees. The frequency of low winds in winter near the ground and at a height of 500 m is 70% and 50%, respectively. In summer, it significantly decreases to 50-60% and to 25-30%. Air stagnation conditions are not uncommon throughout the year. These TICs are generally unfavorable in terms of dispersing industrial emissions and self-purification of the atmosphere.

In TIC located in mountainous landscapes (Almaty, Shymkent-Kentau, Karatau-Taraz), wind regimes caused by anticyclones have a well-defined annual course of weak winds with a maximum frequency of 90% in winter and a noticeable decrease to 40-60% in summer. The conditions of air stagnation in the entire thickness of the boundary layer, the presence of powerful and intense surface inversions, combined with long periods of weak winds, are 10-15 days a month, and in some places periods of up to 25-20 days are possible. Inversions are characterized by a thickness of more than 1000 m and a temperature difference of more than 10 degrees. In the warm half-year period, the frequency of weak winds is also significant, but less than in winter. Due to the peculiarities of the self-purification of the atmosphere in these TICs, it is undesirable to place large industrial facilities; in some cases, it is required to limit the growth of cities (Figure 4).

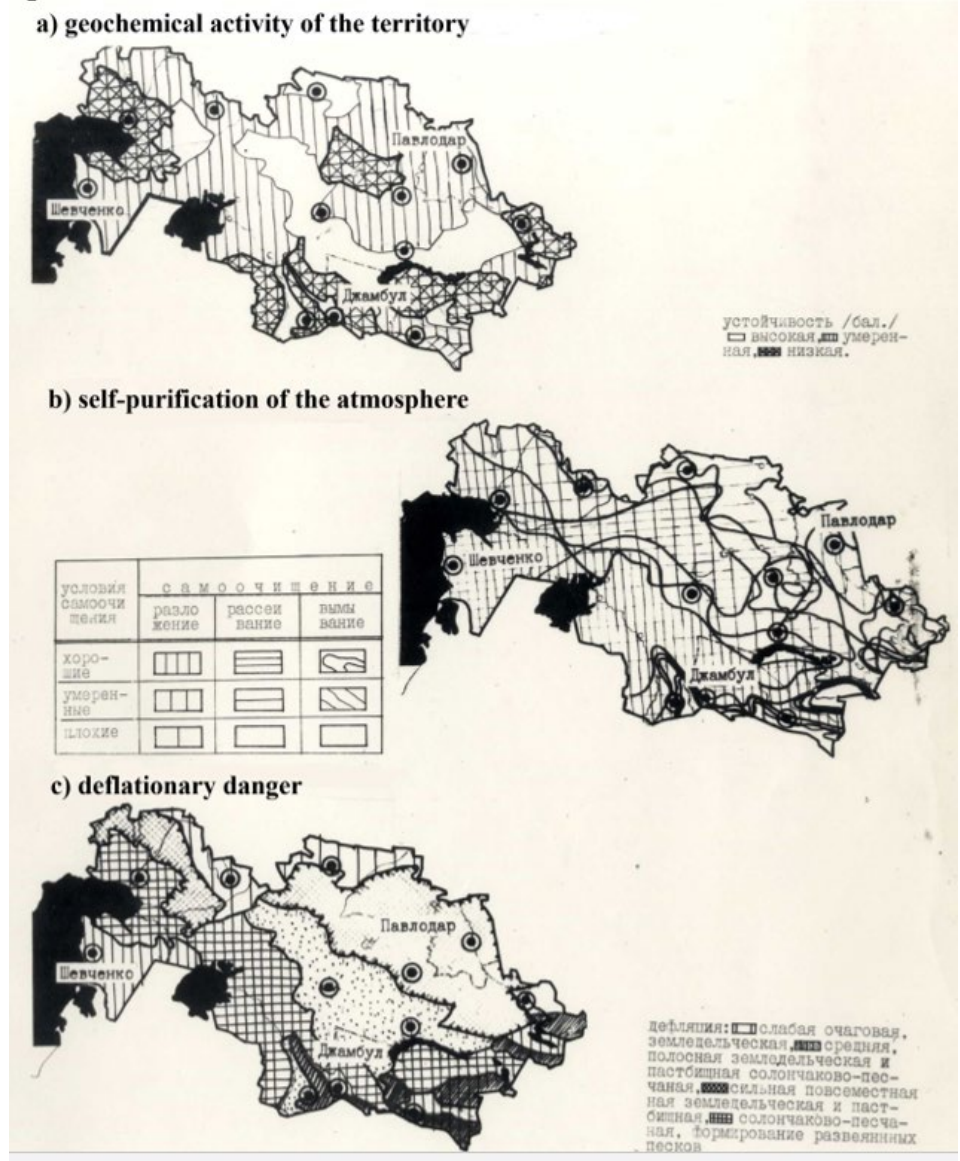
The self-purification of the atmosphere of the TIC from technogenic soluble substances with precipitation is generally very limited, with the exception of the TIC located in mountainous areas (the amount of precipitation per year is 600 mm or more). Karaganda-Temirtau, Kustanai, Aktobe-Alga TIC are in relatively favorable conditions (the amount of precipitation reaches 350-400 mm per year), especially in the spring, when the atmosphere is most likely to be freed from soluble pollutants. The insignificance of precipitation falling on the territory of the Mangyshlak, Atyrau-Inderbor, Pribalkhash TIC (up to 200 mm per year), and in a very short season of the year, cannot serve as a factor in the self-purification of the atmosphere from pollutants.

An important characteristic of the geochemical activity of the territory is the self-purification of surface waters from chemical compounds through dilution and removal. The intensity of the latter is related to the values of the average



annual runoff and flow rates. Self-purification of surface waters from water-soluble and suspended substances by means of removal occurs most intensively in mountainous areas - the average annual flow is from 100 to 1600 l / sec / sq. km. Almaty, Shymkent-Kentau, Rudno-Altai, Karatau-Taraz TIC have the most favorable conditions for the removal of pollutants (annual runoff from the territory ranges from 20 to 100 l / s / sq. km) with surface watercourses. In the flat conditions of the Karaganda-Temirtau, Pavlodar-Ekibastuz and Aktobe-Alga TIC, the runoff from the surface decreases to 10 l / sec / sq. km, although the flow in a few rivers is quite high (870 cubic meters / sec on the Irtysh river 58 cubic meters / sec - Nura River) and they are of great transit importance. The TIC of arid regions (Mangyshlak, Atyrau-Inderbor, etc.) is characterized by temporary streams with a short spring runoff (up to 1-2 l / sec per sq. km), which do not play a significant role in self-purification of the territory. The lack of removal of soluble ingredients leads to their local conservation in the endorheic areas of the semi-desert and desert zone. The possibility of contamination of surface waters with various compounds also depends on the acidity index of river waters.

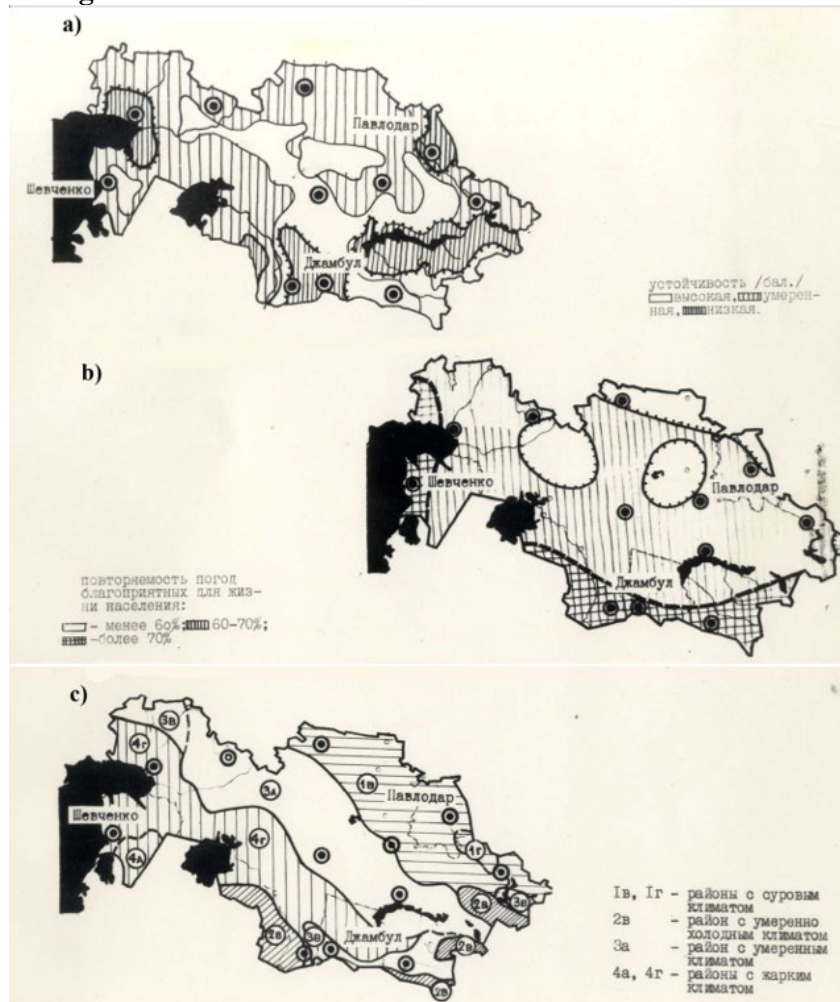
Figure 4. Geochemical activity of the territory, self-purification of the atmosphere, deflationary danger



Source: drawing by the author

The surface waters of all TICs contain few organic substances, which leads to an insignificant migration ability of heavy metals if they enter river waters.

Figure 5. Resilience of the territory to physical stress, repeatability of weather favorable for life, climatic zoning a) resilience of the territory to physical stress; b) the frequency of weather favorable for life; c) climatic zoning



Source: drawing by the author

The most comprehensive characteristic of geochemical activity is the ability of landscapes in the TIC to self-purify or their resistance to pollution <sup>(3)</sup>. Landscapes differ both in the intensity of decomposition of incoming substances (due to humification and mineralization) and in the degree of probability of removal of metabolic products by surface and subsoil runoff. In general, the processes of decomposition of substances prevail over the removal, with the exception of mountainous areas. Differentiation of self-purification was carried out not only by zonal affiliation, but also by the occupied hypsometric level (plain and mountainous territories), to reflect which appropriate correction factors were introduced.

The landscapes of the TIC of the forest-steppe and steppe zones (Kostanay, Aktobe-Alga, Pavlodar-Ekibastuz, Karaganda-Temirtau) are distinguished by a relatively high rate of decomposition of mineral and organic substances in soils and relatively favorable conditions for the migration of alien elements. If the intensity of decomposition of organic matter in the landscapes of the forest-steppe zone is taken as 1.0, then in the steppe complexes it will be 1.1-1.2 (automorphic landscapes with chernozem and chestnut soils under forb-feather grass and soddy-grass associations). Moderate drainage of the floodplain of large rivers (Tobol, Ural, Irtysh), the development of a ravine-gully network contributes to the removal of technogenic substances with surface runoff outside the territory (especially in spring). Poorly drained areas and terraces of river valleys, as well as depressions and ancient hollows of runoff with complexes of meadow and steppe solonets developed here complicate and slow down the processes of self-purification of the

territory, serve as preservatives for ingredients. The probability of purification by dispersion of pollutants is relatively low due to the small (compared to the mountainous zone) amount of precipitation - up to 350 mm.

For TIC belonging to the semi-desert and desert zone (Zhezkazgan-Zhairesky, Atyrau-Inderborsky, Mangyshlaksy, Pribalkhashsky), a corresponding increase in the intensity of decomposition of substances in soils is characteristic, with a sufficiently high intensity of decomposition of substances in the atmosphere. Thus, the rate of disappearance of possible foreign substances will be 1.4-1.6 under conditions of sparse vegetation (wormwood-saltwort associations).

With negligible watering, drying up rivers (Assa and others), and general salinity of soils and soils, zonal soils (brown and gray-brown) are common in combination with soils of solonetz and solonetz-saline soils. In depressions between hills, in dry ancient valley and lake depressions, vast fields of solonchaks and takyr-like solonetz were formed. All this indicates the presence of conditions for the evaporation concentration of technogenic substances, which can lead to pollution and degradation of landscapes. Especially dangerous is the entry into landscapes of wastes containing molybdenum, vanadium, uranium, selenium, since they are very mobile in this soil environment. In addition, due to the aridity of the climate, a relative accumulation of substances in soils on the so-called evaporation barriers is possible, and in the desert zone the intensity of this process is 2-3 times higher than in the steppe <sup>(1)</sup>.

The landscapes of the TIC of mountain regions and piedmont plains (Almatinsky, Rudno-Altai, etc.) differ from their plain counterparts in better self-purification conditions due to greater watering and moisture, which reflects the intensification of migration processes of various flows of substances in mobile media and the relative weakening of mineralization and salinization processes. Here, the intensity of decomposition of pollutants in the air and their removal by water flows is very high. The stability of the natural environment to physical stress is determined by the ability of natural complexes to restore their functions after the removal of stress, that is, a period of relaxation, as well as the productivity of biocenoses <sup>(2)</sup>. According to this indicator, the Aktobe-Alga, Pavlodar-Ekibastuz and Kustanai TICs have the best conditions, the landscapes of which have a significant biomass (up to 25 q/ha), a high rate of biological circulation (Figure 5).

The landscapes of mountain meadows and forests, although they are distinguished by significant reserves of biomass, but the development of denudation processes on the slopes, in the event of vegetation removal, does not allow them to be classified as sustainable (Rudno-Altai TIC, Almaty TIC, etc.). Undoubtedly, the natural complexes of the TIC, formed in severe arid desert zones with sparse vegetation and slow biological circulation, should be considered unstable to physical stress (Mangyshlak, Pribalkhash, etc.). The resistance of natural complexes to deflation is determined by the ability to withstand the dispersing effect of the wind, which primarily depends on the nature of the vegetation cover and the properties of the soil cover. On the other hand, the frequency of dangerous deflationary wind speeds and the number of dust storms determine the deflationary danger of a given territory<sup>(4,5,6,7,8,9,10)</sup>.

According to the above indicators for the purposes of this work, all TIC can be conditionally evaluated on a three-point system. The favorable group included Kustanai and Aktobe-Alga, where weak focal agricultural deflation is possible. The situation in the Mangyshlak, Atyrau-Inderbor TIC may turn out to be the most dangerous, since scattered sands are formed here and, therefore, solonchak-sand deflation is likely. In the intensively developed lands of the Karaganda-Temirtau TIC, Pavlodar-Ekibastuz TIC, deflation can develop to a large extent everywhere, and often due to overgrazing. In the rest of the TIC, wind erosion will manifest itself in some cavernous areas as a strong disturbance of the vegetation cover due to pasture depression.

## **PRINCIPLES AND SCHEMES FOR OPTIMIZING THE FUNCTIONAL AND PLANNING STRUCTURE OF SETTLEMENT**

Based on the analysis of the totality of parameters of the geochemical activity of the territories of the TIC - self-purification of the atmosphere, surface waters, landscapes, resistance to physical stress, deflationary danger, ranked according to three degrees of favorableness, the overall ecological potential of individual TICs was revealed, and the factor of occurrence of natural focal infections or biochemical endemias was considered as lowering the degree of favorableness of the territory. A comprehensive assessment of the environmental conditions of the TIC also included an analysis of the possibility of the occurrence of natural focal diseases and biochemical endemias, as factors that complicate and worsen the ecological situation. Despite the unequal significance of the assessment factors, in general, the indicators taken reflected the specific environmental conditions of the TIC.

The Aktobe-Alga, Pavlodar-Ekibastuz, Kustanai TICs have a high ecological potential (the score of the final environmental assessment is 13-16). However, the modern development of industrial production makes significant adjustments to the environmental situation, which makes it highly desirable, for example, to stabilize the development of production capacities in the Pavlodar-Ekibastuz TIC as a whole. Low environmental resources in most of the TIC

of Kazakhstan (environmental score 11, 12), which determines, given the high level of technogenic pressure on natural complexes, limiting the development of industries that have harmful emissions into the atmosphere and water (especially the Karaganda-Temirtau and Karatau-Taraz TIC). Mangyshlak, Atyrau-Inderbor, Pribalkhash, Almaty TIC are inferior to all previous ones in ecological terms (total score 8 - 10). This indicates that on their territory one should not, without extreme necessity, allow the placement of large industrial facilities that “produce” a large amount of non-recyclable waste.

On the other hand, the economic development plans related to the national economic needs, in almost any option for the formation of the production and economic structure of the WPK of Kazakhstan, provide for a certain volume of increasing production, including environmentally unfavorable. This determines the special importance of the functional and planning organization of settlement in the development zones of the TIC, the development of planning methods and techniques that would reduce the severity of adverse environmental consequences.

The main attention to environmental issues, which have been observed in recent years when making economic decisions on the development of the distribution of productive forces, are increasingly reflected both in the practice of urban planning and in the methodological principles developed for general plans of cities, schemes and regional planning projects. Thus, the issues of protection and improvement of the natural environment in the design of settlement systems have been given much attention in the guidelines published in recent years by the Central Research Institute of Urban Planning on the development of a number of sections of schemes and projects of district planning. They propose a number of methods that ensure that environmental and urban planning requirements are taken into account both at the analytical stage in a comprehensive assessment of the territory, and at the design and construction stages - in the development of functional zoning of the territory, as well as in the development of a special section devoted to environmental and urban planning measures for the protection natural environment.

The implementation of these sections in the schemes and projects of the district planning contributes to a more comprehensive approach to the organization of resettlement, not only in conjunction with production, economic and social factors, but also directly take into account environmental and urban planning restrictions. At the same time, the proposals developed in these documents can only be considered as fundamental, rather general principles that require further deepening, taking into account specific environmental and urban planning situations in the “production - resettlement - nature” system in relation to the characteristics of regions of various types. In this case, the peculiarity lies in the fact that the promising settlement areas considered in the study - Mangyshlak, Pavlodar-Ekibastuz and Karatau-Taraz are not in an “average” situation, for which there are a number of recommendations, but are very similar in ecological and urban planning, in relation to areas with specific features that require a special approach in solving resettlement issues.

The requirements that define such an approach can be formulated as follows:

- when determining the planning structure of settlement systems in the development zones of the considered TIC, environmental and urban planning factors should be considered as the main leading conditions that determine all possible alternatives, which, in turn, necessitates the development of a special methodology for compiling and selecting settlement options in them;
- when choosing the optimal variant of the prospective planning structure of settlement in the area of development of the considered TIC, one of the main urban planning tasks that have to be solved here is to overcome the contradiction between the increased vulnerability of the natural environment, on the one hand, and the large scales characteristic of such types of TIC and the constant increase in volumes environmentally hazardous industries;
- when developing planning ecological and urban planning methods for the functional planning organization of the territory of settlement areas, careful consideration of local natural and climatic features becomes essential;
- with increased attention to environmental and urban planning aspects in the development zones of the considered TIC as the main factor in organizing settlement in them, the formation of the optimal structure of the TIC should be based on the consideration and evaluation of complex options for the functional planning structure, representing a holistic design solution that should cover the structural elements of different rank and their spatial connections (planning centers and axes, functional zones, buffer territories, etc.).

Based on these requirements, in this paper an attempt is made to modernize and concretize the general principles developed at TsNIIP urban planning for taking into account environmental and urban planning factors in the schemes and projects of district planning, in relation to the task of forming a functional planning structure for promising settlement in the specific conditions of intensively developing TIC with large volumes environmentally unfriendly production. The solution of this problem prompted the author of the study to develop a special methodology that includes five blocks, which are considered as successive stages of modeling the settlement of the TIC (Figure 6).

Block I - Development of goals for the formation of promising settlement and criteria for its assessment in difficult environmental and urban development conditions for the development of the TIC: establishing environmental and urban planning goals for the formation and development of interconnected settlement; development of a system of indicators and criteria for assessing the formation and development of settlement systems associated with particularly difficult environmental and urban conditions.

Block II - Comprehensive ecological and urban planning characteristics of settlement areas in the development zones of the TIC: formation of a system of factors influencing the ecological and urban planning conditions of settlement; identification of active and critical factors that determine the prospective ecological and urban development situation in the settlement area; identification and evaluation of ecological and urban planning restrictions on the development of interconnected settlement.

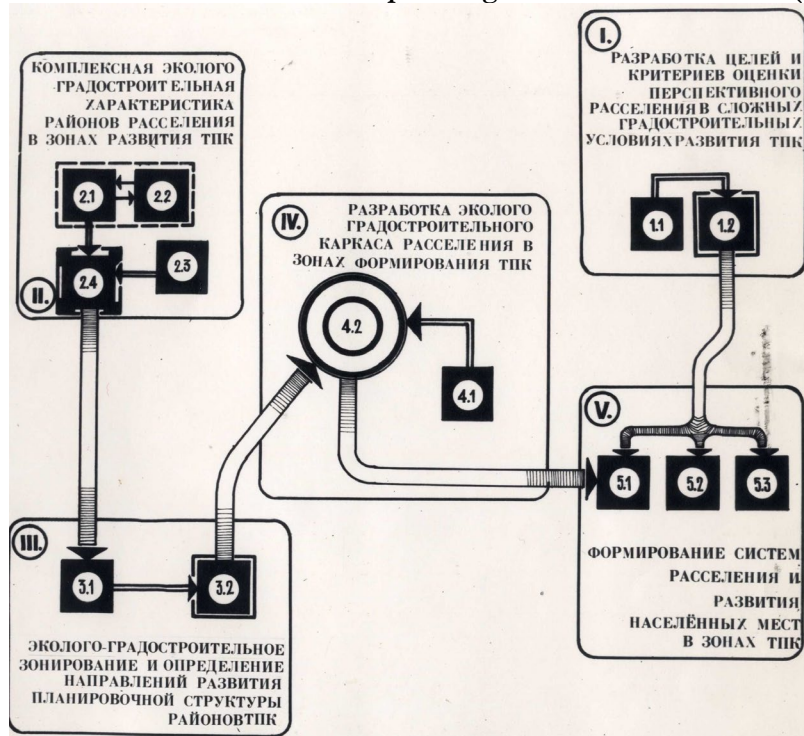
Block III - Ecological and urban planning zoning and determination of directions for the development of the planning structure of the TIC districts: a comprehensive analysis of the conditions for the prospective urban development of the TPK zones; development of ecological and urban zoning and identification of territories with different modes of use.

Block IV - Development of an ecological and urban planning framework for settlement in the zones of the formation of the TIC: determination of requirements for the development of an ecological and urban planning framework; formation of an ecological and urban planning framework, taking into account the zoning of the territory, the natural landscape and planning conditions of the settlement areas.

Block V - Formation of settlement systems and development of settlements in the zones of the TIC: development and evaluation of options for resettlement in the development zones of the TIC; identification of features of the functional and planning structure of group systems of populated areas; planning development of settlements.

In accordance with the sequence established in the general methodological scheme, the results of the analysis are presented below.

**Figure 6. Methodological block diagram of the analysis of ecological and urban conditions and the choice of a variant of the functional and planning structure of settlement (drawing by the author).**



Source: drawing by the author

References: I.1. - establishment of ecological and urban planning goals for the formation and development of interconnected settlement; I.2. - development of a system of indicators and criteria for assessing the formation and development of settlement systems; II.1 - formation of a system of factors influencing the ecological and urban conditions of settlement; II.2. – identification of active and critical factors that determine the prospective

environmental and urban development situation in the settlement area; II.3. – assessment of environmental and urban planning constraints on the development of interconnected settlement; II.4. – Identification and assessment of ecological and urban planning restrictions of interconnected settlement; III.1. - a comprehensive analysis of the conditions for the prospective urban development of the TPK zones; III.2. - development of ecological and urban planning zoning and identification of territories with different modes of use; IV.1. – determination of requirements for the development of an ecological and urban framework; IV.2. - the formation of an ecological and urban planning framework, taking into account the zoning of the territory, the natural landscape and planning conditions of the settlement areas; V.1. – development and evaluation of settlement options in the development zones of the WPK; V.2. - identification of features of the functional and planning structure of group systems of populated areas; V.3. – planning development of settlements.

## CONCLUSION

An important ecological and urban planning prerequisite for solving the problems of resettlement in the TIC is the formation of an ecological and urban planning framework in them – a system of interconnected, most environmentally active elements of the natural landscape. It is shown that the ecological and town-planning framework of the territory of the WPK acts as an important part of the architectural and planning structure of the TPK settlement system, including plotter (natural parks, reserves, forests of the first group, etc.), linear (rivers and their floodplains, protective forest plantations, water protection forests and etc.) and point elements (green zones of populated areas, individual protected objects of wildlife and inanimate nature, etc.).

For Pavlodar-Ekibastuz TIC (type I), it is most expedient to develop an ecological and urban planning framework in the form of sufficiently powerful axes (floodplain of the Irtysh river, canal section) of ecological activity and intersecting secondary axes (Shiderty river valley, landscaped highways, etc.). For the Karatau-Taraz TIC (type II), such a framework is most acceptable, having a mesh structure (three longitudinal axes of ecological activity with several “bridges”). For the Mangyshlak TIC (type III), the ecological and town-planning frame of settlement can be formed in the form of green areas around the largest settlements. The characteristics of the quantitative parameters of ecological and urban planning analysis depend on the conditions for the balance of the natural and anthropogenic environment in a given territory, on the ratio of urbanized, agricultural and open spaces. The optimal ratio of such territories in Pavlodar-Ekibastuz, Karatau-Taraz and Mangyshlak TIC, respectively, is (in%): 22:61:17; 5:87:8 and 2:1:97.

Depending on the specific conditions for the development of the TIC within them, it is possible to form either subregional settlement systems (Pavlodar, Mangyshlak, Kustanai, Taraz, etc.), or several separate GSNMs (Balkhash, Atyrau, Aktobe, etc.). As the centers of these systems, it is advisable to develop the existing largest cities in the cores of the WPK, the lower limit of the population in which should be 200-250 thousand people, and the zone of influence - 250-300 km. In the cores and individual industrial districts of the WPK, it is expedient to form GSNM, the population of the city centers of which can be within the following limits: in large GSNM at least 500 thousand people, in medium GOSM - from 70 thousand to 500 thousand people, in small GOSM - from 20 thousand to 70 thousand people. Accordingly, the radii of the zones of influence of the GPS will be: large 60-80 km, medium - 40-60 km, small - 30-40 km. The development of experimental options for resettlement and their subsequent evaluation showed that, according to environmental and urban planning criteria, the following is expedient.

For the Pavlodar-Ekibastuz TIC, the formation of a new planning wasp along the river. Irtysh with the strengthening of transport links between the cities of Pavlodar and Irtyshsk. The development of the latter should proceed at an accelerated pace in order to create a second sub-center - a counterbalance to the cities of Pavlodar and Ekibastuz, the development of which should be restrained. For the Karatau-Taraz TIC, the preservation of the basically existing settlement structure while limiting the growth of the cities of Taraz, Karatau and Zhanatas and the predominant development of other cities in the zones of influence of these centers. For the Mangyshlak TIC, the predominant development of settlements in areas with the most favorable environmental and urban conditions along the coastal strip, the creation of a new city on the basis of a promising oil field on the Buzachi Peninsula, as well as a more active use of the rotational method of developing the deep territories of the TIC. When developing master plans for cities and urban-type settlements that are part of the GSNM in the zones of formation of the WPK, the following should be taken into account.

Urban settlements (steppe zones, located in relatively favorable natural conditions with the presence of natural water areas, forests, etc.) should have a semi-closed planning structure with the city center entering the coastal zone, where it is necessary to develop a forest park belt that performs recreational and windproof functions. In areas of the steppe

zone with relatively sparse vegetation, the absence of natural water areas and flat relief, the planning structure of urban settlements should be closed, and the forest park zone, having limited development, should perform wind-shelter functions as much as possible. In the cities of the desert and semi-desert zone, located on the sea coast in conditions of a hard uncomfortable wind regime, the planning structure should be compact and closed in relation to the coastal strip. Cities located in the foothill-desert zone should have a dissected planning structure, opening onto the river axis. The study of possible ways to form a functional and planning structure of the settlement system, taking into account the ecological and urban conditions in the zones of formation of the TIC of Kazakhstan, allows us to formulate specific practical recommendations for drawing up schemes and projects of district planning, as well as master plans for cities. The introduction of these recommendations into design with the subsequent implementation of project proposals in commercial construction can provide significant social, environmental and economic efficiency of design solutions. The social effect is achieved as a result of improving working conditions, life and recreation of the population, hygienic living conditions. The ecological effect is determined by measures to increase the ecological potential of the areas of formation of the TIC, contributing to the increase in the resistance of the natural environment to anthropogenic pressures, and the preservation of the gene pool of plants and animals. The economic effect can be obtained by preventing environmental damage, increasing labor productivity and the general working capacity of the population as a result of improving living conditions. The most fundamental conclusions and proposals of the study, due to their sufficient universality, can be used to address the issues of prospective resettlement in other regions of the country, including those with natural conditions that are different from Kazakhstan, but similar in nature to the development of the TIC in them - in Central Asia.

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