

# Наукові повідомлення

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## SPATIAL ORGANIZATION OF TOURIST ATTRACTION NETWORK OF KRYVORIZHZHIA

Technogenic tourism, as a relatively young trend in tourism, begins to play a significant role in Kryvbas, one of the oldest industrial regions in Ukraine. It has preserved the industrial heritage of the previous industrial and technological structure. Considering the considerable length and the total area of Kryvbas, classical methods of spatial research, in particular, the model of spatial optimization of access areas of Thiessen-Voronoi, can be effectively applied to studying, in particular, its tourist resources.

In our case, 48 points that correspond to certain tourist attractions form a network with different levels of transport access. The basis was the digital map of Kryvbas, made in MapInfoProf environment in previous author's works. Next, with the special option of MapInfoProf, Voronoi polygons were developed which became the tool for further spatial analysis. Actually, the results of such analysis allowed to clarify the recreational and technogenic zoning of Kryvbas, as well as to study main laws of spatial organization of tourist attraction network of the region.

Peculiarities of the modern spatial organization of tourist attraction network of Kryvorizhzhia encourage the conclusion on the presence of two major regions of the development of technogenic tourism within Kryvyi Rih. The first region is more developed Central-Southern with higher density and smaller average area of Voronoi polygons. The second one is the Northern with smaller number and larger average area of Voronoi polygons, as well as one that is more promising for the development of technogenic tourism. The results of the study will be useful in planning routes for tourist logistics.

**Keywords:** tourist, technogenic, route, logistics, polygon, Voronoi, zoning.

### *Дарья Шиян, Тетяна Казакова, Сергей Сосько. ПРОСТОРОВА ОРГАНІЗАЦІЯ МЕРЕЖІ ТУРИСТИЧНИХ ОБ'ЄКТІВ КРИВОРІЗЖЯ*

До сьогодні туристичні об'єкти Криворіжжя досліджувались багатьма географами, але переважно у туризмознавчому аспекті. Зважаючи на доволі значну площу і оригінальну конфігурацію Кривбасу як старопромислового регіону виникає проблема формування мережі туристичних об'єктів, а, відтак, дослідження її просторової організації. Для цього в роботі вперше застосовані такі методи просторового аналізу як полігони Вороного. Результати такого аналізу дозволили уточнити рекреаційно-техногенне районування Кривбасу, а також дослідити головні закономірності просторової організації мережі туристичних об'єктів регіону. Результати дослідження будуть корисними при плануванні маршрутів в межах туристичної логістики.

**Ключові слова:** туристичний, техногенний, маршрут, логістика, полігон, Вороной, районування.

### *Дарья Шиян, Татьяна Казакова, Сергей Сосько. ПРОСТРАНСТВЕННАЯ ОРГАНИЗАЦИЯ СЕТИ ТУРИСТИЧЕСКИХ ОБЪЕКТОВ КРИВОРОЖЬЯ*

До сегодняшнего дня туристические объекты Криворожья исследовались многими географами, но преимущественно в туризмозведческом аспекте. Учитывая довольно большую площадь и оригинальную конфигурацию Кривбасса как старопромышленного региона, возникает проблема формирования сети туристических объектов, и, таким образом, исследования ее пространственной организации. Для этого в работе впервые использован такой метод пространственного анализа как полигоны Вороного. Результаты этого анализа позволили уточнить рекреационно-техногенное районирование Кривбасса, а также исследовать главные закономерности пространственной организации сети туристических объектов региона. Результаты исследования будут полезными при планировании маршрутов при осуществлении туристической логистики.

**Ключевые слова:** туристический, техногенный, маршрут, логистика, полигон, Вороной, районирование.

**Problem statement.** The spatial organization of the Ukrainian economy has unique features, due to the complicated history of the development of the domestic economy. It is noteworthy that branches of modern specialization (in particular, export one) which were formed at the end of the 19th century and today define the face of our state in the international geographical division of labor. Thus, the coal and metallurgical complex of Donbas and Prydniprovia forms about 40% of the Ukrainian exports [3] and these regions have been supporting such specialization for more than a century. At the same time, with the development of the market economy, opening borders after the collapse of the former great state, the Ukrainian economy gradually diversified, in particular due to the development of branches of manufacturing industry, services, small and medium businesses and tourism. Spaciously “overlapped” old traditional industries, these new ones create unique combinations of mines and kindergartens, waste hens and hospitals, dumps and recreation areas. In some 10-15 years, in our eyes, these new industries, aimed at maintaining the viability of our cities, are increasingly gaining in living space. How harmonious these combinations can be is a complicated and little studied issue. The authors have repeatedly studied these issues in their previous publications [10, 19].

**Review of recent publications.** Although industrial heritage tourism (or industrial tourism) is not a new phenomenon, it has acquired increasing importance as part of the cultural offering presented by a growing number of destinations. In fact, it can be a source of profitable differentiation for them, taking advantage of particular past and present industrial resources to generate potentially distinctive and memorable experiences [23, 25].

There are some works deal with a problem, accentually for old industry regions [6, 16].

Industrial or technological tourism is designed to “revive” the regions of old industrial development. In particular, giant industrial facilities in mining and industrial regions can cause significant interest to tourists with individual needs [2, 22, 24, 26, 27].

Among domestic scientists, the issue of tourism development both on the basis of natural and man-made landscapes is insufficiently studied [12, 13]. As for the use of tourism in the industrial heritage, such works belong mainly to the authors [6].

Another aspect of the novelty of our study is the use of GIS technologies (spatial analysis) and any other types of modeling for tourism research. The following works can be found [1, 4, 15].

Despite its industrial functions, Kryvyi Rig has become a powerful branch of production and consumption of services and consumer goods from the traditional mining and metallurgical center that is quite natural for the market economy. In our eyes and with our participation, the widespread development of market relations gradually reformatted the effect of factors of placing the economy in the direction of the predominance of consumer factor [20]. Achievements of the old production and technological structure are of interest to tourists today that is reflected in activities of local authorities [14].

Despite the results of previous studies of tourist resources of Kryvbas, the problem of their territorial organization and, moreover, the use optimization is not studied enough and, therefore, requires study. Moreover, the logistics of tourist services are gradually becoming more important [18].

Considering the considerable length and the total area of Kryvbas, classical methods of spatial research, in particular, the model of spatial optimization of access areas of Thiessen-Voronoi, can be effectively applied to studying, in particular, its tourist resources. The main aspect of the novelty of our research is almost complete lack of scientific works on the logistics of tourist services in the old industrial regions where technogenic tourism is actively developing [8]. The main assumption (hypothesis) of our study is the possibility of logistic optimization of tourist flows specified on separate recreational and man-made subareas of Kryvbas (Fig. 1).

**Statement of basic materials.** The development of tourism industry occurs in the presence of certain resources. Each type of tourism must have its own resource base. Therefore, the analysis and assessment of resourcefulness of the territory for the development of a particular type of tourism is to determine: 1) tourism content; 2) corresponding natural and social objects to the content; 3) territorial structure of natural objects of tourism – regional approach; 4) object and subject of assessment; 5) criteria and indicators of assessment; 6) methods of evaluation using point scales. Provision with resources for the development of technogenic tourism has already been investigated including appropriate zoning [7].

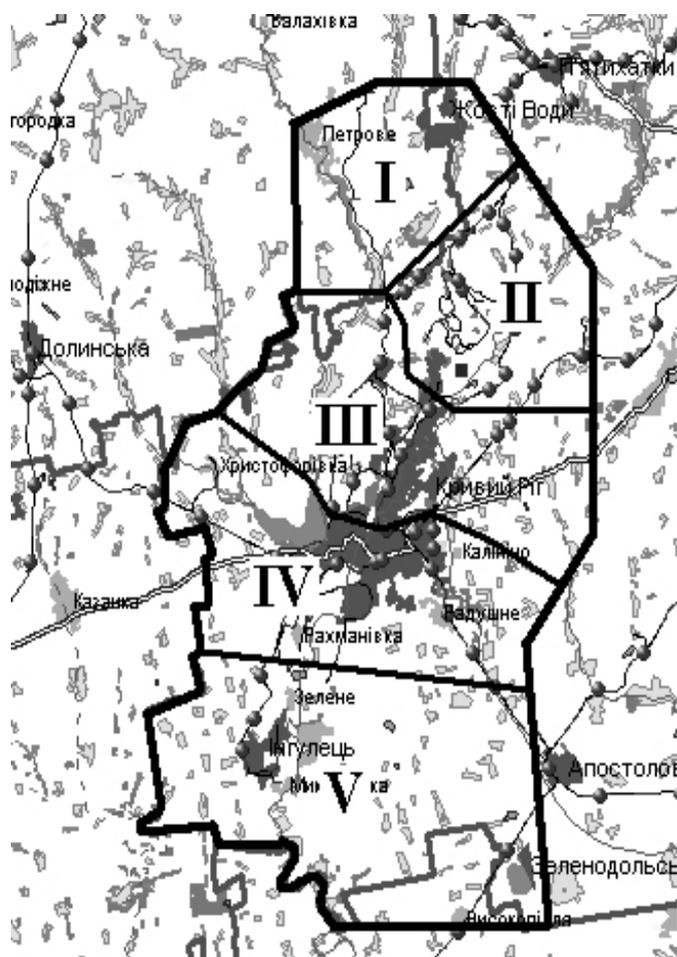
It must be agreed with Denisik G.I., who notes that Krivbass is the most unique region in terms of the recruitment and territorial structure of industrial anthropogenic landscapes [5]. Indeed, a relatively small area of Kryvorizhzhya (4.1 thousand km<sup>2</sup>) formed the most diverse groups of anthropogenic landscapes. The region is a contemporary landscape unique – here almost all known varieties of industrial landscapes of Ukraine are spatially united. It is estimated that within the limits of the city of Kryvyi Rih, which is the residential and industrial core of the region, the most widespread are residential (34.1%), industrial (31.9%) and transport (15.0%) anthropogenic landscapes.

Anthropogenic landscapes of Kryvbas are investigated from the 1960's. To date, the classification of anthropogenic landscapes has been developed, their zoning and compilation maps have been carried out. For the purposes of development of technogenic tourism the classification of industrial landscapes of Kryvbas is of greatest importance. So Kryvbas owns all the most attractive industrial landscapes on the territory of Ukraine.

Kryvyi Rih recreational and technogenic subdistrict is characterized by the most complete combination of industrial landscapes of all kinds. The city of Kryvy Rih is provided with a developed hotel industry, several travel agencies and agencies, a transport system of local, domestic and international level (airport Lozovatka). In the estimation of the regional assessment of resource-based technogenic tourism, the heterogeneity of the provision of specific objects of the Kryvy Rih recreational

and man-made micro-districts is determined. Each of the microdistricts is characterized by the presence of: 1) significant areas of mining and industrial landscapes (quarries, dumps, sludge, mine failures); 2) interesting in terms of production technology (ore dressing, iron ore

extraction and granite, pig iron, steel, heavy machinery production, etc.); 3) territorial integrity - the compactness of the placement of individual industrial enterprises; 4) raw material homogeneity of production facilities.



**Fig. 1. Recreational and technogenic zoning of Kryvbas (Kazakova, 2006). Recreational and technogenic sub-regions: I. Petrovsky; II. North; III. Central; IV. South; V. Inguletsky**

Territorial heterogeneity of the structure of locating production facilities and associated industrial anthropogenic landscapes made it possible to divide Kryvyi Rih sub district into 5 micro districts (Fig. 1).

*Petrovsky RT sub-regions.* Somewhat distant from the city of Krivoy Rog. It is located predominantly in the Petrovsky district of Kirovograd region, where open-source deposits of magnetite quartzite are being developed and, therefore, a young mining and quarrying complex of Central Mining and Processing Plant is being developed near the village Petrovo. The complex is represented by two quarries: quarry No. 3 (Petrovsky deposit, developed since 1977), quarry number 4 (Artemivske deposit) is located near the village Yesipivka Petrivsky district. The development of this facility began in January 1985.

It is expedient, from the point of view of the territorial compactness, to include the industrial center of Zhovti Vody, where the main production is also metallurgical, in the sub-regions. Historical and industrial in-

terest are the old pre-revolutionary surface developments of iron ores in the area with Gannivka, where until 1917 worked Zhovtorichinsky mines. An extremely interesting target for TT is the Eastern Mining and Processing Plant, which is Europe's largest producer of natural uranium. The production of sulfuric acid, both technical and improved, is also interesting for the Eastern GOK. The plant is the largest producer in Ukraine.

*Northern RT sub-regions.* In its composition Northern Iron Ore Mining Company is one of the largest mining companies in Europe. The main types of technological activities are the extraction and enrichment of magnetite iron ores, the production of lignite and iron ore concentrate. The main objects are Ternivske and Ganivske ore managements (2 large quarries up to 365 m deep, several significant dumps with an area of over 1000 hectares each), crushing and concentrating factories number 1 and number 2, shops for the production of niches № 1 and № 2, a mining and transport workshop with a fleet of large-tonnage cars (100-120 tons), a slag

economy workshop with a huge gutter size of over 1000 hectares.

Also located on the territory of the sub-regions are: a closed underground mine (Pershotravnevyi), an operating mine of the Kryvorizh Iron Ore Plant with dumps, modernized operating mine Central GOK (age 70), working Kolomoyevsky granite quarry with a dump, failing mine shafts of mines them, old pre-revolutionary and pre-war iron ore quarries.

*Central RT sub-regions.* The main resource base is represented by mining and metallurgical enterprises, the leading of which is Central GOK with its structural subdivisions. There are 2 iron-ore quarries with numerous dumps. Quarry No. 1 (depth 300 m, length 4,1 km) is the main supplier of crude ore for processing and enrichment at the plant. The history of the career began in 1957 when the first cubic meters of the mountain mass were lifted. Quarry No. 2 is preserved and is now covered with open-pit rock quarry No. 1, since it was intended for the extraction of oxidized quartzites, the enrichment of which today has become unprofitable. Shlama Storage - one of the largest in Kryvbass. The "tailings" (recycling wastes) of the enrichment of iron quartzites are transported here. Its size reaches 1793 hectares. In order to prevent leakage of highly mineralized water to underground waters and the river Ingulets, a drainage system unique in its size is constructed at 16.3 km (with 9 drainage pumping stations). Also, the structural units of mineral processing of CGOK are characterized by high attractiveness: crushing, concentrating (iron ore concentrate with iron content is 67% - the highest indicator among the Krivbass and Ukraine's GOK) and the planting of the factory.

In addition to the man-made objects of the CGOK in the territory of the Central RT of the sub-regions, there are working mines of the CJSC - them. R. Luxemburg with a failure zone and old mining, "Zhovtneva", them. "Bolshevik" with dumps and pre-revolutionary promotional objects, "Rodina" with a failure zone and an old quarry (from 1886). The mine "Sukhaya Balka" is represented by the existing mines "Jubileinaya" and them. "Frunze" with faulty zones and dumps. Within the microregion of the existing "Artem-1" mine, OJSC "Mittal Steel Kryviy Rih" has a working mine of "Artem-1" with failure and mooring zones and its own iron ore quarry and a closed mine. A separate place is the closed "October" granite quarry with dumps and lakes, which formed from underground and atmospheric waters and used by the population in rest.

Among the enterprises of other complexes, the following may be of particular interest to tehnogenyqe tourism (TT): 1) Kryvy Rih Central Mining Equipment Mining Plant - is engaged in the production of parts and assemblies of quarry excavators, crushing plants, ore grinders, conveyors, slurry pumps, agglomeration equipment and other mining equipment; 2) Kryvy Rih silicate plant, which manufactures bricks, ceramic tiles, concrete products, wall blocks, concrete pavement slabs; 3) "Polstar" and Open Society "Krivorozhskij sewing factory" "Start" - enterprises of light industry, producing clothes of wide assortment; 4) "Kryvorizhlib" (products - bread products, cakes); "Kryvorizhskiy combine of bread products" - the main producer and supplier of flour to

bread enterprises of Kryvorizhyya; 5) Joint-Stock Company Electrozavod for the production of the complex distribution device KRUV-6B, electrical equipment for mines, electric appliances of a wide range, electric furnaces for baking bread, etc.; 6) Diesel Plant - produces a crane and performs major overhaul of heavy-duty vehicles for the GOK; 7) Joint-stock company «Veretenno-woolly-ward factory» - the enterprise of light industry which makes yarn from synthetic fibers.

*Southern RT sub-regions* is characterized equally both in mining and in factory landscapes. One of the most powerful mining and metallurgical combines of Europe "Mittal Steel Kryviy Rih" with coking plant and iron-ore "Novokryvorizh GOK" is the district-forming enterprise. This is a unique enterprise with a full metallurgical cycle. The plant was founded since 1934. The main products of the plant now are reinforcing rolled steel wire rolled wire, as well as related products - gaseous and liquid nitrogen, gaseous argon, benzene, gaseous and liquid oxygen, coke, neon-helium mixtures, ammonium sulfate, blast furnace slag. The structural subdivisions of the plant are blast furnace and coke production, rolling production, sludge management, etc.

Novokryvorizh mining and concentrating complex "Mittal Steel Kryviy Rih" production - agglomerate and iron ore concentrate. Interest for TT is typical of the mining and metallurgical combines structural units: 1) 3 quarries (No. 1 - closed, № 2 and № 3 - are being developed) and dumps of ore management; 2) slime economy with 2 hydrotransitions - "Mirolyubivsky" and "United"; 3) crushing and concentrating factories. Closed RU "Dzerzhinsky" with several mines ("Saksagan", "Giant-Deep") and a deep quarry, own enrichment factory and a small drainage.

"Southern Mining and Processing Plant". Has specialization in extraction and enrichment of ferruginous magnetite quartzites of the "Skeletavsky" deposit with the production of iron ore concentrate and blast furnace sinter. In the structure of the plant there are several interesting objects for TT: 1) mining management in the quarry-giant (310 m deep and 3 km in diameter) several tall dumps 2) Mining and transport shop with automobile and railroad delivery of ore and rocks (length of tracks at the plant is truly an invaluable figure - 352 km); 3) slag economy with 3 large storages - "Voykivsky", "Hrusovatsky" and "United" (total area 603 ha and the length of the pulp conduits for the provision of sludge more than 60 km); 4) crushing and concentrating complex with 2 crushing and 2 concentrating factories. The concomitant products on the South GOK are sand from the dumping crushing rock, crushed stone.

A number of prerevolutionary mines, from which the remains of mining, 100-year-old quarries and dumps.

For TT to machine-building enterprises, three plants are best suited. The first - "Kryvy Rih turbine plant Konstar" - is engaged in the production of gas turbine equipment and drive gas turbine engines. "Kryvorizhgirmash" is an enterprise producing mining equipment - drilling and auxiliary machinery for mining, as well as equipment for the tunneling of drilling bitumen. The range of products of the plant includes: drilling machines, drilling equipment, underground equipment for drilling in mines, perforators, machines for loading

and moving mountain mass, bucket mine loader, trolleys and pushers, piston pneumatic motors, and others. The third one is "KryvorizNDPI Research Institute". On it you can get acquainted with the production of equipment and spare parts for the mining and processing complex, foundry casting, the production of metal constructions of any complexity, the production of conveyors and screens, the development of combines for rock breeding, etc.

The construction branch of the Southern RT sub-region is represented by the most powerful in its field of the state enterprise "Kryvyi Rih Cement". Created in 1951. It is the only enterprise in Ukraine that uses the Japanese dry method of cement production. The plant produces high-grade cement, portland cement, sulfate-resistant slag-portland cement.

Other enterprises: 1) «Krivorozhsky smirnyky plant» production of dry earth pigments - iron meric, mummy, hollow, talc; paint and varnish products - oil paints, liquid ruby rubbers, enamels, soils, water-dispersion paints, bituminous varnishes; 2) enterprises of the footwear industry of light industry - Ukrainian-Polish LLC "Mikels-Ukraine" and subsidiary company "Rainford" LLC "Yunist" for the production of special footwear, model men's and women's shoes; 3) OJSC Krivoy Rog Bakery No. 1 with baking bread, biscuits, confectionery.

Separately from the city is the "Khristoforovsky plant" of refractory blocks and concrete - near the city of Kryviy Rih in the same name Krivoy Rog district of Dnipropetrovsk region.

*Ingulets RT sub-region* is characterized by predominance of mining and metallurgical objects. The main district-forming enterprise is Inguletsky GOK: a large (350 m deep) quarry with a capacity of 70 million tons / year, 3 complex large waste, 3 concentrating factories for the production of iron ore concentrate (63.9% iron content), crushing a factory with 4 stages of crushing and a huge tailing pond in the valley of Ingulets. Former RU Ingulets is represented by a failure zone, old prerevolutionary mines, closed by small quarries with accompanying dumps ("Visnyk"). In Ingultsi, a joint Ukrainian-French food industry enterprise "Nadezhda" is interested in the production of baking yeast.

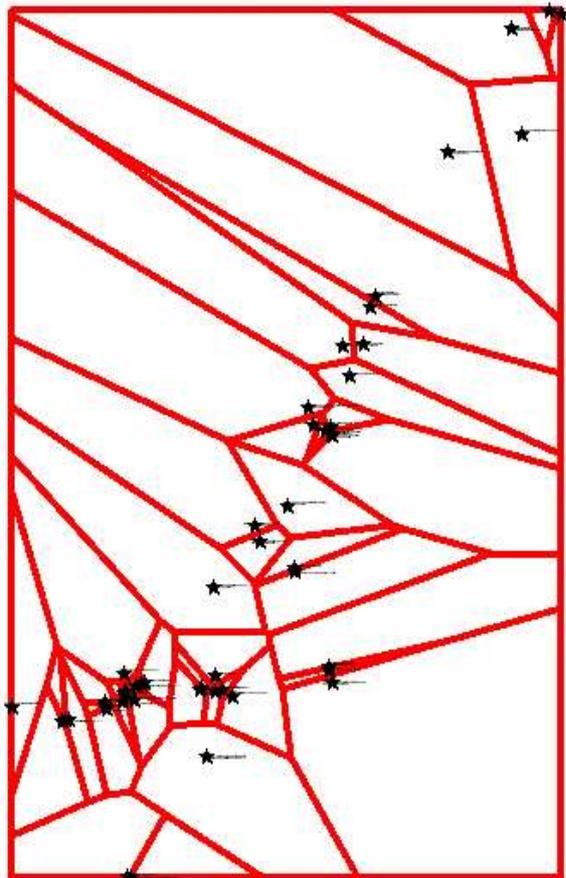
The sub-region includes Kryvorizskaya power station in Zelenodolsk (Apostolic district of the Dnipropetrovsk region), as this enterprise produces electric current and provides it to the city of Kryviy Rih. The inclusion of the "KRTES" diversifies the resource base for TT tours in the neighborhood and in the Kryvyi Rig region in the subarea as a whole. Also, in Zelenodolsk, for TT can be attracted to "Plant Continent", which is engaged in the production of galvanized wire.

Table 1

## List of tourist attractions in Kryvorizhzhia [29]

№	Attraction name	№	Attraction name	№	Attraction name
1	Botanical Garden	17	Orthodox-Pokrovsky Monastery	33	Catholic temple "Assumption of the Blessed Virgin Mary"
2	Museum of Mining Techniques	18	Museum of Military and Labor Glory "Rodina Mine"	34	Monument to "Muse of Creativity"
3	Petliakova Square the center of the old town of Terny	19	Geological Sight of Nature "Amphibolites"	35	Museum of Southern Enrichment Plant
4	Ternov Museum of Local Lore	20	Memorial "Memory Clock"	36	Karachuniv granite quarry
5	Former railway bridge of Chervona flat-bottom valley	21	Holy Transfiguration Cathedral	37	Geological Sight "Rocks МОДРy"
6	Memorable sign-stele for heroes "Underground workers"	22	Geological Sight of Nature "Slate Rocks"	38	Boat station
7	Train station Rokuvata	23	95 kvartal of Kryvyi Rig	39	Park named after F. Mershavtsev
8	Musical fountain	24	Monument to liberators of Kryvyi Rig	40	Geological Park in the open air
9	Monument to the dead miners	25	Monument to Cossack Rig	41	Monument to St. Nicholas the Wonderworker
10	Management of PJSC "ІІГЗК"	26	St. George bell tower	42	Kryvyi Rig Museum of Local Lore
11	Orthodox St. Volodymyr's Monastery	27	Flower clock	43	Theater of Drama and Muses of Comedy named after T.G. Shevchenko
12	Theater "Academy of Movement"	28	3D video gallery of Kryvyi Rig Museum of Local Lore	44	Sculpture "Friend"
13	Kryvyi Rig School of Seafarers	29	Kryvyi Rig State Circus	45	Memorial sign to the victims of the Holodomor
14	Monument to Afghan Warriors	30	Museum of Metallurgical Combine of PJSC "ArcelorMittal Kryvyi Rig"	46	Kryvyi Rig Synagogue
15	Memorable sign for defenders of Kresiv dam	31	Building of the station "Kryvyi Rig-Golovny"	46	Geological Museum KTY
16	Dam of Kresiv Reservoir	32	Monument "Railway Train"	48	First Urban Botanical Garden

Since the time of this zoning, certain changes have occurred in the concept of technogenic tourism, as well as in practical approaches to the use of tourist resources of the region. In particular, activating tourist flows in Kryvbas, as well as increasing curiosity of local residents to visit local attractions, encouraged tour operators to saturate tourist routes not only with traditional objects of industrial heritage (quarries, dumps, sludge dumps, mines, steel making enterprises, pipes, mechanical engi-



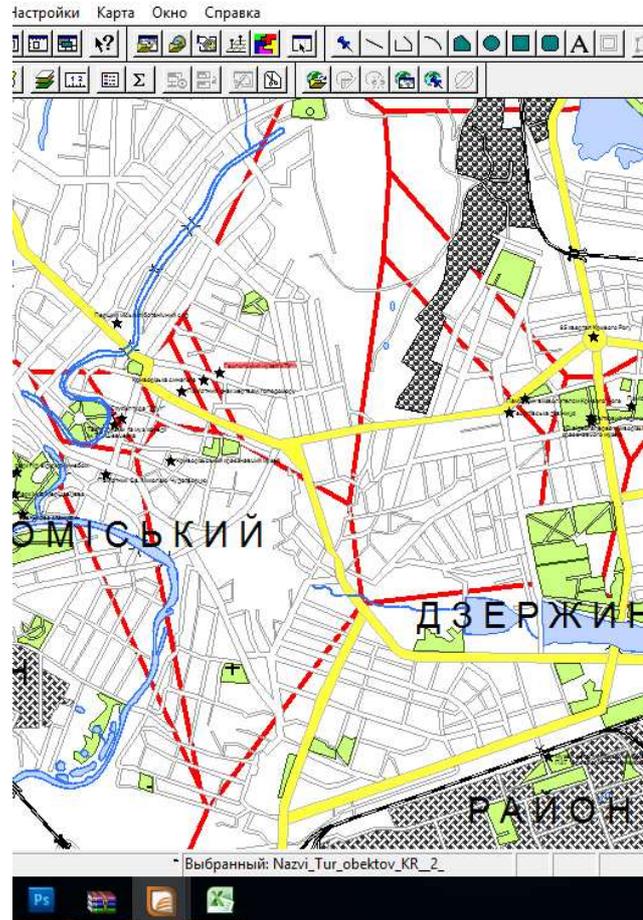
**Fig. 2. General scheme of Voronoi polygons throughout the city of Kryvyi Rih**

Methodological approaches to such optimization may include both traditional methods for systematizing information, in particular, databases and the latest ones, such as geographic information systems. Traditional methods, such as creation of geographic databases of environmental tourism objects, have already been used by authors in previous publications [9, 21].

In general, tourist logistics of large spaces always requires some optimization, which in the list of possibilities of modern GIS is embodied in the tools of the spatial analysis. Among them, we chose Voronoi polygons which represent the areas formed on a given set of points in such way that the distance from any point to the given point is less than to any other point of the whole set. The construction of Voronoi polygons takes place in such way that each area contains only one point. Boundaries of Voronoi polygons are the segments of perpendiculars

neering products, etc.) but also those that have the historical and cultural importance.

In particular, today, in Kryvyi Rih there are 48 tourist attractions that are actively involved in tourism (Table 1). Given the rather significant list of attractions and a significant area of the entire region in Table 1, there is a need to take into account the spatial heterogeneity of the network of tourist attractions. First of all, this is necessary to optimize the planning of various tours.



**Fig. 3. Fragment of the scheme of Voronoi polygons in inner-city areas with the highest density of tourist attractions**

set up to the sides of triangle sides in the Delaunay triangulation which can be constructed with respect to the same point set. Voronoi polygons option in MapInfoProf GIS allows you to build such polygons from the specified list of points. At the same time, points and polygons can be located on both the same and on different layers. According to the authors of MapInfoProf software, this operation may be useful in cases where it is necessary to show areas of impact around service centers with the help of polygons. As a result, the researcher gets areas that are as close as possible to the point of interest. In this case, Voronoi polygons can be created on the original layer or to choose points on one layer and received Voronoi polygons placed on the other.

In our case, 48 points that correspond to certain tourist attractions form a network with different levels of transport access. The basis is the digital map of Kryvbas

done in MapInfoProf [17] and contains 8 main layers of the topographic basis. Then, fields of the database are created in the new layer corresponding to the list and names of individual tourist attractions. After choosing all attractions within the layer, Voronoi polygons were constructed on their basis with the special option MapInfoProf (Fig. 2, 3).

**Conclusions.** Old-industrial regions of Ukraine, such as Kryvbas, are at the stage of rebirth. But unlike Donbass, it takes place in a peaceful evolutionary way. With the exception of the industrial powerful logistic and cultural and tourist potential, modern Kryvbas can become an attractive region for the development of modern types of tourism.

1. Given the large area and length of the region to analyze its tourist potential, classical methods of spatial analysis such as zoning and optimization, such as the construction of Tissen-Voronoi landfills, can be effectively applied. These methods were implemented in GIS MapInfoProf.

2. The combined analysis of created layers in MapInfoProf and zoning schemes (Fig.1) made it possible to state the following:

- The largest spatial density of tourist attractions (22 out of 48) is observed in the Central (III) and Southern (IV) recreational and man-made sub districts. Thus, in the list of objects only 4 (Geological Sight “Rocks MODRu”, Karachuniv granite quarry, Geological Sight of Nature “Amphibolites” and Geological Sight of Nature “Slate Rocks”) are conditionally technogenic tourist attractions. The rest (the overwhelming majority) is historical-cultural, architectural and sacred heritage.

- In the same (III and IV) tourist technogenic sub districts the lowest values (in km) of relations between

the center and periphery of certain Voronoi polygons are observed which is explained by the density of residential buildings in the city and the largest density of roads (Fig. 3). Given that most of the hotel facilities are concentrated in the central districts of the city; this gives significant advantages to tour operators when organizing budget radial tours for short distances.

- Due to the relative “lack of capacity” for tourist attractions of the areas of I, II and V sub districts such as those where potential technogenic tourism attractions are located (ditches, quarries, mines, sludge and dumps) their territory requires more active tourist development. Regarding tourism logistics, these remote sub districts will require the organization of more “specialized” tours for motivated tourists.

3. Peculiarities of the modern spatial organization of the network of tourist attractions in Kryvorizhzhia, studied in our work, lead to the conclusion that there are two major regions of the development of technogenic tourism within the city of Kryvyi Rig. The first region is more developed Central-Southern with higher density and smaller average area of Voronoi polygons (in IV and V recreational and technogenic sub districts). The second one is the Northern with smaller number and larger average area of Voronoi polygons, as well as one that is more promising for the development of technogenic tourism (in I, II and III recreational and technogenic sub districts).

Application in spatial studies of the network of tourist attractions the method of Thiessen-Voronoi polygons can be useful for establishing general patterns of their spatial organization and, hence, for optimizing tourist flows of logistics.

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