

Specificity of the Impact of Contemporary Urban Planning on the Ecological State of Cities

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Abstract – One of the factors in the formation of the ecological state of a city is the planning scheme of development, reflecting the features of the functional division of city space. At the same time, ensuring environmentally safe urban space involves solving the engineering problem of layout adjusting (optimization, modernization), taking into account the natural factors (terrain, landscape, climate zone) and the economic specialization of the territory. In this context, comprehensive environmental studies should be carried out, the main objective of which is to identify patterns of formation and manifestation of violations of environmentally safe environmental parameters (pollution of soil, air, water, including underground and above-ground sources, sea) in order to overcome or reduce negative processes in the present or in the future. The geoecological mapping of environmental risks in different areas of the city based on the seaside recreational area – Feodosia.

Keywords – *ecological state; characteristics; functional areas; a seaside city.*

I. INTRODUCTION

The ecological state of urban areas is characterized by different degrees of manifestation of crisis phenomena. In specialized industrial cities, the environmental situation may be critical due to the threats of a particular industry. In small cities, which do not have industrial specialization, environmental problems are veiled and associated with a negative impact on the environment, mainly by road transport. Clear planning and project requirements for concerning the ecological quality of building and reconstruction of urban areas appeared only at the end of the 20th century. The works of foreign scientists (Jacobs D. [1], Forman [2], Frederick [3] and many others) and domestic scientists (Illichev V., Kolchunov V., Bakaeva N. [4,

5], Kobeleva S. [6], Afonina M. [7]) on the problems of sustainable development and biospheric compatibility of urbanized areas with the environment should be noted.

It is difficult to find an example of a rational planning of a city with a population of more than 100.000 people on the Crimea territory, as the cities were built and rebuilt haphazardly, and each historical period gave its requirements. Until the 2000s, almost all the cities of the Crimea had no site plans for reconstruction and development and long-term plans for the territorial development of the cities. The most significant problems for the ecological state of the cities were not considered: optimization of the water disposal system, primarily stormwater, MSW (municipal solid waste), transport highways.

For a long time, the natural environment withstood this load without visible facts of degradation, but the processes of anthropogenic impact began to appear more actively and it was necessary to study all the features of the formation of violations of the ecological state and the development of the measures for stabilizing and overcoming them. The research of the ecological situation on the Peninsula were conducted by various scholars (Bagrov N.V., Bokov V.A., Lushchik A.V. [8], Goryachkin Yu.N. [9], Vetrova N.M. [10, 11], Tsytsarina E.A. [12])

The objectives of the research are: to clarify the features of the influence of the city planning schemes on the formation of the main environmental problems (the level of pollution components of the environment, landscape change, waste management) and to assess the current environmental state of Feodosia in order to develop environmental and engineering recommendations for their solution.

II. METHODS AND MATERIALS

The method of geochemical mapping was used when conducting the environmental studies on the peninsula (based on the example of Feodosia) in order to identify the spatial pattern of allocation centres of pollution. The soil cover is a natural accumulator of chemical elements, which leads to a noticeable increase of a gross content of trace elements in it with prolonged exposure to external sources of pollution. The sequence of work was testing the soil, conducting the analysis of it, comparing the results with the background meanings and conducting the maps with allocation centres of pollution.

The samples were taken from the upper and most informative soil horizon (0.5-10 cm). Testing at this point was carried out by the "envelope" method in accordance with the requirements of AUSS (all-Union State Standard) (165 samples in total).

The selected soil samples were analyzed by spectral method (atomic-emissive): 37 chemical elements: copper, lead, cobalt, nickel, molybdenum, zinc, chromium, vanadium, titanium, tin, magnesium, manganese, barium, beryllium, niobium, zirconium, gallium, lanthanum, cerium, yttrium, ytterbium, silver, bismuth, germanium, selenium, strontium, lithium, phosphorus, arsenic, antimony, aluminum, iron, calcium, silicon, sodium, tungsten, cadmium.

The samples of water of the seaside zone, storm drain, water of the Baybuga river, separate streams in the city are selected and analyzed. The mobile forms Cu, Pb, Cr, Zn, Cd (I and II hazard class), petroleum products in the soils were determined in the laboratory Ministry of Ecology of Republic of Crimea.

III. RESULTS

Feodosia is located in the southeast of Crimea on the coast of the Feodosia gulf and on the slopes of the spurs of the Tepe-Oba ridge. The ridge, which is 288.2 m high above sea level, closes the Main ridge of the Crimean mountains from the East. Towards the sea the ridge Tepe-Oba ends with St. Ilya cape (abs. mark – 115.0 m). The number of inhabitants of Feodosia is 115,5 thousand people, the length of the coastline is 35 km.

Feodosia is the center of the eastern Crimea, rich in mineral springs, therapeutic mud, there are wide beaches in the city and beyond it (stretching for 15 km). The city is not only a resort, but also an industrial center with an extensive network of roads, a branch of railways, a sea trading port, a large oil depot and more than 30 industrial enterprises.

The modern building of Feodosia was formed in the second half of the 20th century and was carried out rather haphazardly. Among large enterprises only a mechanical factory, hosiery and tobacco factories, fish enterprises, a bakery and some others worked in the city at the beginning of the 70s of the 20th century. Prospects of development of Feodosia are defined in "Site Plan of the Development of Municipal Corporation by the city District of Feodosiya".

In the study of the environmental problems, the influence of planning features was taken into account by identification of the existing functional zonation of the city. Functional planning zonation is determined by the historical development of the

city. It is a combined multi-time construction of residential neighborhoods mixed with industrial zones and highways.

The researchers identified the following functional areas: the resort recreational area; the resort residential area; the production residential area; the production area. Moreover, they compiled a map of functional zonation (Fig. 1).

The resort recreational area is located along the Feodosia gulf from the sea port to the Golden Sands, including the promenade (the railway tracks are there). There are sanatoriums, hotels, parks, museums, concert halls, centers of public service in this area. The area is quite green, there are the city beaches on the sea border. The width of the zone is 25 – 40 – 60 m, length is up to 4.5 km.

The resort residential zone is a fundamentally new type of functional zones – it is the territory of residential units for the joint residence of the local and the tourists (the principles of formation, parameters and requirements for the construction of recreational housing are set out in the section "Proposals for the Transformation of the Housing Fund for Organizing Recreational Residential Development"). The territory of public buildings is also included in the resort residential area also.

This zone includes such areas of the city, as Quarantine, Forstadt, Morsad and Center located in the south-eastern part of the city, in which religious sites, hospitals, clinics, markets, narrow boulevards (the Admiral boulevard) are placed in addition to residential buildings (buildings of different floors with narrow streets, alleys) – it is mainly the old historical part of the city.

Residential zones consist of several zones that were built in different periods of time, some of them are unit enterprises.

The residential production areas are located irregularly around the residential areas and built in different periods of time, each of them has industrial productions, some of them were closed in the 1990s. The area size of the enterprises is up to 1 km². The linear and the western zones with a width of 100-250 m: in addition to housing in a narrow lane placed Food Factory, Hosiery Factory, other factories, such as: Optical Factory, Mechanical Factory, Brick Factory, "Agroelektroremont" Factory, the boiler-house, DCS (Distributed Control System) "Krymremstroytrest", "Stroymaterialy", two ATEs (Auto-Transport Enterprise), wholesalers, garages (place size is up to 0.5 km²).

Production areas: the territory provided for the placement of industrial enterprises and municipal and warehouse facilities, construction organizations, special facilities, facilities and structures of external transport, motor transport enterprises, garages, engineering infrastructure facilities related to meeting the needs of tourists and the local population.

The total area of all industrial enterprises, warehouses, transport and communication organizations is about 30% of the city territory.

The production areas in the planning structure of the city is represented by three large industrial enterprises (Fig. 1): Feodosia commercial seaport; the bulk plant; The "Stroydetal" Factory (currently is closed – there is a grain terminal in its

place) and two industrial communal zones: the North-West area, consisting of the enterprises: meat-packing plant, “Stroyaterialy”, the furniture factory, the coal warehouse and a number of other warehouses (the area size is 1.2 km²) and the South-West area is bounded on the east by the Kerch highway, with a length of 1.7 km and a width of 250-450 m, included in the residential zone to the south (strip 100-250 m wide, 600 m long). It is composed of PDZ (power distribution zone), OGM base, “SP Elektromontazh”, warehouses, garages, trade houses, LTD “Ostrov”, the Instrument-making Plant.

For more than 200 years, the city has been experiencing and accumulating environmental problems. Unregulated growth of the city is typical for the entire period of its development. These problems are particularly acute at the present time.

The researchers identified the following features of the ecological state in different zones of Feodosia.

The system of drainage of the storm and sewage water is formed by planned elevation and slope of the surface of the study territory towards the sea in all the study areas. It is noted that the pumping stations (there are 18 of them in the city) that pumping the storm water to the waste treatment facilities are worn out by 50%, the untreated water is discharged through the beams into the Baybuga river and directly into the seaside zone, they are partially drained through the beaches.

The pipes of deep-water sewage discharge after treatment, laid along the bottom of the bay at a distance of 400 m from the coast, are in unsatisfactory condition. Among the main biogenic elements, the predominance of unstable nitrite form of nitrogen over nitrate (mainly in the summer period - in June) is determined, as well as the predominance of the content of phosphate phosphorus (the mineral phosphate) over organic was revealed, which indicates the increase in biogenic pollution and the corresponding intensification of the processes of organic matter destruction.

TABLE I. CONTENT OF TOXIC CHEMICAL ELEMENTS AND THEIR CONCENTRATION RATIOS IN SOILS AND SUBSOILS OF FEODOSIA

Elements	The Content of Elements mg/kg		Concentration Coefficient		Efficiency Rates = Ci/Efficiency Rates	
	Min	max	K _k ^{min}	K _k ^{max}	min	max
Lead	20	800	1	40	< 1	26,67
Copper	10	400	0,41	16,32	< 1	4,2
Zinc	40	4000	0,43	43,48	1,17	1,90
Antimony	32	1000			6,96	217,39
Molybdenum	0,63	4,0	0,42	2,67	< 1	2,0
Strontium	320	1000	80,34	251,06	0,5	1,60
Phosphorus	500	2000	0,64	2,55	0,5	2,0
Chromium	20	200	0,24	2,38	0,2	2,0
Vanadium	6,3	120	0,06	0,90	0,42	8,0

According to the surface lithochemical survey carried out on the territory of Feodosia, the anomalies of toxic elements of I, II, III hazard classes were established. The soil-geochemical anomalies of lead, zinc, antimony, molybdenum, strontium have the greatest development.

The anomalies of Pb, Zn, Cu, P, Cr and others are installed sporadically in all the study area, i.e. along the railway, near the port, on the Chelnokov, Voykov, Garnaev, Starshinov streets,

along the Simferopol highway, in areas of the bulk plant, the old waste treatment facilities, SDW landfill. Lead content in these anomalies ranges from 30 to 100 mg/kg. The local anomalies with lead content from 100 to 300 mg/kg were also found:

- along the railway;
- the bulk plant area;
- in the area of SDW landfill;
- along Simferopol highway;
- on the territory of industrial enterprises.

In parts of the old waste treatment facilities, SDW landfill, seaport there are local anomalies with the lead content of 300 to 500 mg/kg. CPDC of the lead varies from 1 to 30 and reaches 26.7.

In the examined areas 3 areas of contamination are identified:

1. The weak pollution ($Z_c = < 8$). Conditionally clean territories include the recreational resorts (The Black Sea Promenade) as well as the resort residential and residential areas;
2. The average degree of pollution ($Z_c = 8-16$) is typical for the residential and industrial areas where industrial enterprises are located;
3. The moderately hazardous pollution ($Z_c = 16-32$). The maximum degree of pollution is characterized by the territory of the Feodosia commercial sea port, Feodosia enterprise for the provision of oil-products and the central station generating power plant.

The analysis of the overall picture of soil contamination with chemical elements allows to estimate the investigated area from hygienic positions.

Local anomalies with the copper content of 32-70 mg/kg are found in the port area and along the main streets of the city. There are also anomalies with a higher content of zinc, antimony (bulk plant – 250 mg/kg, old waste treatment facilities – 150-200 mg/kg, 250 mg/kg, the area of solid waste – 120-400 mg/kg).

Copper concentration coefficients vary from 0.4 to 16.3, the efficiency rates reach 4, zinc – 0.4-43.5 mg/kg, the efficiency rates – 0.15-1.2.

The analysis of the groundwater conditions takes into account the characteristics of the territory: depth, topography, geological structure, as well as the level of urbanization and the planning of development. Taking into account the high groundwater level, the swampiness of the western border of the city (beyond the Kerch highway) is by the slope of the relief eastward towards the sea. Feodosia bulk plant, the largest enterprise on the coast of Crimea, deserves special attention in terms of the impact of groundwater pollution. The enterprise works since 1899, in the 70s it was reconstructed, waste treatment facilities were built, the new pump station was constructed, the unique technological complex was created. Transshipment of oil products is carried out by sea and train and there is an impact on the environment – the groundwater and

the soils are covered with oil in the form of a slick with a capacity of 2-3 cm to 40-50 cm and the strip of 25-30 m. the appearance of oil on the surface of the groundwater is due to the leaks.

The results of the analysis of the seawater in the seaside zone on the enterprise "Stroydetal" territory (sample 14) show that the oil products are 0.044 mg/dm³.

The technogenic deposits along the railway line were examined and the oil products were identified. The samples were taken in the area of 10 m², the sampling depth is 0.2 m. The place of selection is the area of the railway crossing through the Kerch highway, Aivazovskaya station, the crossing of the railway lines in the area of Galereinaya street. The content of non-polar hydrocarbons (oil products) is 980,3-1928,0 mg/kg.

A significant part of the service facilities of the resort area, estate residential development and green areas for public use are located in the lower part with absolute marks from 0.2 m to 0.6 m. Such low marks and close occurrence of the groundwater require a number of engineering measures: filling the territory of the landscaped and newly developed areas; alluvion of the territory of at least 0.5 m above the estimated horizon of high waters, taking into account the height of the wave during wind surge.

The strip of equipped beaches is included into the zone of sanitary protection of the sea or the coastal strip. The border of the coastal strip runs along the edge of the public resort embankment, where surface runoff is collected from the entire projected area.

IV. CONCLUSION

The study revealed that in the territory of Feodosia the zones of environmental risk and the emerging environmental crisis were found in the process of economic activity: the geochemical pollution of geological spheres (soils, subsoils), hydrospheres (the surface, underground and coastal sea water), atmospheres (air basin), biospheres (degradation and destruction of plants), active processes of destruction (abrasion) of the beaches, ill-conceived construction of the city (industrial enterprises are located in the residential areas), the layout of underground utilities without reclamation of the territory, accumulation of household and industrial waste in various parts of the city, non-compliance with the sanitary protection zones between industrial facilities, residential buildings and recreation areas.

According to the research, the following areas of Feodosia can be attributed to the zones of environmental risk:

1. *The zones of industrial enterprises.* Large industrial facilities, such as Bulk Plant, Commercial Sea Port and the grain terminal are located in a close proximity to the residential areas and hotels, the distance between them is 30-40-60 m.

2. *The seaside zone.* Special attention is given to two aspects: the pollution of the bathing area (the depth is 2-5-10 m), the sea water pollution in the discharge area without cleaning along the beams (because the pumping stations are not working), down to the sea in the east direction:

Intensively polluted water in the Baybuga river, the color of it is dark gray, muddy, the bottom is not visible.

3. *The channel, floodplain and the mouth of the Baybuga river.*

Since the territory is overloaded with man-made objects, including the city market, the Baybuga river has negative rates of the calculated coefficient of environmental sustainability. Increased nitrate and nitrite concentrations were found in the river water, and high COD rates were observed due to the abundance of organic matter. At the mouth of the river and in the sea water a high content of E. coli was found.

4. *Discharge of wastewater after waste treatment facilities in the sea at a distance of 400 m from the coast in the area of the north cape of Saint Ilya.*

It is necessary to repair or replace completely the system of pipes through which the waste water after the waste treatment facilities is discharged into the sea. The pipes rusted directly 4-5 m from the coast, and the water begins to flow almost in 1m from the coast and possibly throughout the 400 m.

5. *Kerch highway, Simferopol highway and their infrastructure (gas stations).*

The width of the zone of active air pollution around the highways is 100-120 m; storm water, enriched with oil products (up to 2-3 MPC – maximal permissible concentration) is discharged down the slope into the city. At the gas stations, the car washes are equipped with tanks for collecting spilled oil products (up to 26 MPC in the dust in their territory), but there are no waste treatment facilities, so after the accumulation of the wash water they are discharged down into the Blizhniye Kamyski.

The study confirmed the dependence of the formation of the environmental situation in the urban areas from the features of planning decisions of different areas of urban development (for example, Feodosia). A number of environmental problems can be overcome by the implementation of engineering measures (reconstruction of the system of collection and treatment of the waste and storm water of all flows that are discharged into the sea) in order to reduce the anthropogenic load on the environment. But some problems should be considered from the perspective of adjusting the site plans of development for the gradual stabilization of the environmental parameters of the environment.

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