On the assessment of the environmental ecological state in coastal cities

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Abstract. Engineering and environmental support of safe urban space is an important scientific and practical task, since it is based on the consideration of the territorial natural factors, the introduction of design and planning solutions for the urban and suburban areas’ development, the use of environmentally friendly materials in construction and operation. It is especially important to conduct the research on environmental risks in coastal areas of the cities that have recreational facilities. The goals and objectives of the research are to clarify the features of the city plans’ impact on the formation of the main environmental territorial problems (the level of the environmental components’ pollution, landscape changes, waste management) and evaluate the current environmental status using the example of Yalta to develop the environmental engineering recommendations for their solution. In the process of systematic selection of grounds and soils in the main functional areas (resort-recreational, residential, transport-industrial, agricultural and nature reserve), several categories of pollution were identified: conditionally clean territories, weak pollution of the territories, average pollution of the territories, dangerous pollution of the territories. Based on the field studies and their engineering processing, eight zones of environmental risk were identified within the territory of the Big Yalta: a waste landfill near the village Gaspra; the mouth of the Vodopadnaya river and the adjacent water area of the Yalta city beach; channel, floodplain and wellhead parts of the river. The fast and adjacent waters of the Yalta Passenger Seaport; the mouth of the river Avunda and the adjacent waters of the beaches of the village Gurzuf and YRC “Artek”. As a result of the study, the dependences of the ecological situation formation in the coastal urban areas on the various urban areas planning decisions features (for example, Big Yalta).

Introduction
The ecological state of the urban areas is characterized by varying the degrees of the crisis phenomena manifestation. In small cities that do not have industrial specialization, environmental problems are veiled and associated with the negative impact on the environment of mainly living objects, polluting materials, as well as building systems without taking into account their territorial features.

The development of foreign scientists (Jacobs D. [1], Forman, Frederick, T. Yigitcanlar; D. Dizdaroglu [2] and a number of other) and domestic scientists (E. Shcherbina, E. Gorbenkova, A. Mottaeva, N. Kalinina [3, 4] Ilyichev V., Kolchunov V., Bakaeva N., Kobeleva S. [5, 6]) should be noted on the problems of the sustainable development and biosphere compatibility of urbanized territories with the environment.
In the Crimea territory until the 2000s, almost all the cities lacked the master plans for reconstruction and development, as well as the long-term plans for the territorial development. The most significant problems for the ecological state of the cities were not considered: optimization of the water disposal system, primarily storm water, waste landfills, transport highways.

The ecological state of the peninsula was studied by various scientists (Bagrov N.V., Bokov V.A., Lushchik A.V., Goryachkin Yu.N., Vetrova N.M. [7, 8, 9], Tsytsarina E.A. [10]), although the situation constantly requires the environmental parameters clarification to develop the real and effective measures to ensure the environmental safety.

The goals and objectives of the research are to clarify the features of the city plans influence on the main environmental problems’ formation of the territory (the level of the environmental components pollution, landscape changes, waste management) and assess the current environmental status using the example of Yalta to develop the environmental engineering recommendations for their solution.

Materials and methods

When conducting the comprehensive environmental studies on the peninsula (for example, Yalta) in the process of systematic testing of grounds and soils in the main functional areas (resort-recreational, residential, transport-industrial, agricultural and nature reserve), the experts identified several categories of polluting materials and zones according to the degree of pollution: relatively clean territories, weak pollution of territories, average pollution of territories, dangerous pollution of territories.

The work is based on an approach that allows us to classify the study area according to the degree of environmental disadvantage, and to determine the procedure for the phased assessment of the ecological condition of the given territory. The ecological condition of the territory is assessed by a combination of criteria and the environmental pollution indicators: atmospheric air, water and soil. Total chemical pollution (Zc) characterizes the chemical pollution degree of the studied territories and allows to establish the presence of several pollution categories within the same study territory.

The criteria used and the indicators for assessing the ecological situation of the territory take into account: the collection of materials based on standard and generally accepted methods with mandatory statistical data processing; analysis of data in laboratories that have passed state certification and received a certificate; materials in the form of reports with a mandatory cartographic application.

To assess the ecological state of the territories, the indicators of integrated ecological and geochemical assessment of the territory were used using the ranks of environmental and geochemical assessment V.T. Trofimova and D.G. Zilinga, T.A. Baraboshkina [11]:

This indicator is calculated by the formula:

$$Z_c = \sum K_k - (n - 1)$$ (1)

where $C_i$ – is the toxic element concentration at the test point;
$C_b$ – is the normal geochemical background value for the soils of the Crimean Mountains;
n – is the number of considered anomalous elements forming a technogenic anomaly.

The authors distinguish the following categories of pollution of soils and soils with toxic elements:

| territory | pollution degree | $Z_c$ |
|-----------|------------------|-------|
| minimum   | low              | $Z_c<8$ |
|           | moderate         | $Z_c=8-19$ |
|           | moderately dangerous | $Z_c=20-32$ |
|           | dangerous        | $Z_c=32-64$ |
|           | extremely        | $Z_c>65$ |
|           | dangerous (maximum) | $Z_c>128$ |

During the research, the authors identified the functional zones and main sources of the anthropogenic stresses affecting the environment state for the territory of Big Yalta (Table 1).

| Table 1. Functional zones, subzones and main sources of load in Yalta |
| Zone         | Functional                                                                 | Loads sources                                                                 |
|-------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Residential | Very old building                                                           | 1-2 storey buildings                                                         |
|             |                                                                             | 3-4 storey buildings                                                         |
| Old building|                                                                             | 1-3 storey buildings                                                         |
|             |                                                                             | 4-5 storey buildings                                                         |
| New building|                                                                             | 5-16 storey buildings                                                        |
| Green spaces|                                                                             | Parks and gardens                                                            |
|             |                                                                             | Gardens and gardens                                                          |
| Industrial  | Enterprises with powerful technology process                                 | Reinforced concrete plants, asphalt-concrete plants                           |
|             |                                                                             | Food industry enterprises                                                     |
|             | Semi-dry process plants                                                     | Textile and food industry enterprises                                          |
| Communal   | Warehouses                                                                  | Logistics Warehouses                                                         |
| warehouse   |                                                                             | Warehouses for trade, general, specialized                                   |
|             |                                                                             | Warehouses for storing fruits and                                             |
|             | Utility enterprises                                                          | Landfills for household and industrial waste                                 |
|             |                                                                             | Laundry factories, dry cleaners, saunas                                       |
|             |                                                                             | Vehicle service companies                                                     |
|             |                                                                             | Fuel and lubricant warehouses, gas                                            |
| External    | Ground transportation                                                       | Highways, stations, parking lots                                              |
| transport   |                                                                             | Port Facilities and Marine Stations                                           |
|             | Water transport                                                              |                                                                              |
|             | Other                                                                       | Water-carrying service lines                                                 |
|             |                                                                             | Water Sewer Stormy Sewer Faecal                                              |
|             | Water-containing service lines                                              | Ponds                                                                        |
|             | Technogenic changes in topography (-)                                        | Storage reservoirs                                                            |
|             |                                                                             | Road embankments, land filling                                                |
|             |                                                                             | Dams                                                                         |
|             |                                                                             | Soil dumps                                                                    |
|             |                                                                             | Industrial dumps                                                              |
|             |                                                                             | City dumps                                                                    |
|             | Technogenic changes in topography (-)                                        | Road recesses                                                                 |
|             |                                                                             | Territory cutout                                                              |
|             |                                                                             | Ingulf Ravines                                                                |
|             |                                                                             | Mines                                                                         |
The conditionally clean territories (Zc<8) include the vast majority of lands of specially protected natural areas (SPNA): Yalta Mountain Forest Reserve, which is part of the Big Yalta territory of the Crimean Reserve, land on the territory of the Cape Martyan Natural Reserve and other large parks, monuments of landscape art, as well as natural nature reserves (Mount Koshka, Baydar Gate, etc.).

The introduction of the category - conditionally clean territory - is due to the fact that in the protected areas of the southern coast of the peninsula, in the absence of the soils’ chemical pollution, household waste is polluted along the hiking trails, on viewing platforms, etc. It is difficult to account for severe electromagnetic pollution, the influence of which cannot even be completely excluded, even in the protected areas.

Low pollution (Zc=8-19) is typical for agricultural and recreational areas. In agricultural areas, the main contribution to total chemical pollution is made by the use of chemical fertilizers, agricultural machinery and vehicles. Soil pollution is intensified in the suburban areas along the highways, near industrial and municipal storage facilities.

For many sanatorium-resorts and recreational (forest parks) zones west of Simeiz, the significant areas of relatively clean territories have been established with the transition to the slightly polluted in settlements.

Weak pollution was also noted in the areas of conflagration and buildings in the area of the nature reserve fund, on the streets of Gurzuf, Alupka, Simeiz, along the local roads connecting separate sections of settlements or new buildings, the embankment and a number of narrow streets of Old Yalta, Chekhovo district, Polekurovsky park et al., the area around the Sevastopol highway near the village of Opolznevy.

Average pollution of the territories (Zc=20-32) is recorded in the residential and transport-industrial zone, primarily in the cities of Yalta, Alupka, Miskhor, Simeiz, around the South Coast Highways - at a distance of 60 and 160 m on each side, with a traffic flow of up to 2200 cars / hour. The content of lead and dust in the streets of Kievskaia, Moskovskaya, Marshak was recorded up to 3 maximum permissible concentrations (MPC), elevated levels of chromium, zinc and nickel, etc. were noted in several gas stations (gas stations).

Dangerous pollution of the territories (soils, technogenic surface deposits) is recorded in industrial zones and at enterprises (Darsan - Zc=19-111, territories of placement of mortar-concrete units, reinforced concrete structures - Zc=21-64, asphalt concrete plant - Zc=26-108).

**Discussions and Results**

On the Big Yalta coastal territory, in the process of economic and recreational activities, the zones of environmental risk and the emerging environmental crisis arose, when the scale of the geological areas’ geochemical pollution - the lithosphere (ground, soil), hydrosphere (surface, underground and coastal sea waters), atmosphere (air basin), biosphere (degradation and destruction of vegetation) and (or) active processes of destruction (shambles) of the territory (landslides, landslips, river and air erosion, marine abrasion, when native and man-made karst, mining during the laying of various communications, the accumulation of household and industrial waste) exceeded the existing sanitary and hygienic standards and tolerances, and the geo-ecological state of the territory is characterized by a loss of self-regulation and self-cleaning ability.

According to the results of the authors’ research, the following sections of the Big Yalta territory can be assigned to ecological risk zones (Figure 1).

1. Solid Waste Landfill Near Gaspra.
The bulk hill of waste rises above the surrounding area to a height of 60 m. Below the relief, bogging areas that have arisen as a result of the leaching of contaminated leachate water to the surface from the body of the landfill are observed. A landslide has been formed in the area of the landfill, which is in an unstable stress state, which can be “discharged” by displacing the ground masses and the body of the landfill down the slope. This is especially possible with seismic events.

The Gasprinsky landfill is actively affecting the environment. The main agent of influence on surface and underground waters is leachate, on the atmosphere - biogas, as well as waste combustion products. The range of the landfill impact on the environment is hundreds of meters along the perimeter and several kilometers down the slope, including the possibility of the filtrate getting into the sea due to the discharge of surface runoff water, as well as the submarine unloading of groundwater polluted by the filtrate.

2. The mouth of the river. Waterfall and adjacent water area of the Yalta city beach.

Elevated levels of nitrates and nitrites are recorded in river water, and a high level of bacterial contamination with Escherichia coli in sea water (hundreds of times higher sanitary standards at the peak of the holiday season). In this zone, sanitary services periodically detect cholera vibrio (usually in late summer - early fall). The coefficient of ecological sustainability of the Vodopadnaya river ecosystem has negative values, which indicates the environmental instability of the river ecosystem, the lack of the effective sanitation in the catchment area. Within the city territory, the river has been turned into a sewage collector, where untreated or poorly treated communal sewage flows.

3. Channel, floodplain and wellhead parts of the river. The fast and adjacent waters of the Yalta Passenger Seaport.

The territory is overloaded with motor transport and trade complexes, including the city market. The Bystraya river has negative values of the calculated coefficient of environmental sustainability. The elevated levels of nitrates and nitrites are found in river water, and because of the organics’ abundance, the high values of chemical oxygen consumption are noted.

In summer, during the peak hours, the content of pollutants from vehicles in the surface layer of the atmosphere reaches critical values. The width of the air pollution zone along the highways on the Kievskaya and Moskovskaya streets at rush hours at a flow of 1600-1700 cars / hour reaches CO 60m, by NO2 – 160 m, capturing the residential areas. There is only one point for monitoring atmospheric air pollution in Yalta - in the area of the Spartak cinema theater (Marshak-Lomonosov Street).

Figure 1. Map-scheme of environmental risk zones of the Big Yalta territory

4. The mouth of the Avunda river and the adjacent waters of the beaches of Gurzuf and the “Artek International Children’s Center”.

The ecosystem of the mouth of the Avunda river is ecologically unstable, i.e. the river has been turned into a collector - a ditch for untreated municipal sewage. In summer, the seawater is
characterized by high bacterial contamination, especially near the sewage treatment plant sewer. Significant bacterial contamination is also recorded in the sea water of the beaches of the “Artek International Children’s Center”.

5. The highways Yuzhnoberezhnoe and Sevastopol highway and the objects of their infrastructure (gas stations).

The width of the active air pollution zone around the highways has reached 120-150m; the storm runoff enriched with oil products (up to 2-3 maximum permissible concentration) is discharged along the slope in the settlements’ territory (the cities of Yalta, Alupka, Gaspra, Gurzuf, etc.).

At the gas stations, car washes, tanks for collecting the spilled oil products are equipped (up to 26 maximum concentration limits in the dust on their territory), but there are no treatment facilities at all, after accumulation of flush water they are dumped down the slope.

6. The zones of industrial enterprises located within the settlements’ boundaries (industrial zone Darsan, RBU, ZhBK, asphalt concrete plant).

The maximum geochemical total pollution of the territories with heavy metals was noted in emissions into the air and in dust at work sites. (Zc>111-128), from high and surface sources come in values that exceed the maximum permissible concentrations (formaldehyde, benzo-pyrene, ethylbenzene, benzo-flour-ethane – >20 chemicals and compounds). The sanitary protection zones for many facilities should be 1000m.

7. Landslides, erosion and abrasion zones within the boundaries of the cities and settlements and in the zone of prospective development.

8. Coastal zone.

Two aspects deserve special attention: pollution of the bathing area (depth 2-5-10m), pollution of sea water in the release zone without treatment or only with mechanical treatment (sanatoriums of the urban-type village of Gurzuf, urban-type village of Miskhor and others west of Cape Ai-Todor) at a distance of 150-180 - 280-500m.

The coastal zone pollution of the sea and beaches is noted for Simeiz, Miskhor. Unorganized parking lots in the urban-type Koreiz village - by the Cableway in Ai-Petri make a significant contribution to stormwater pollution.

Summary

The studies have revealed that risk and the emerging environmental crisis arose in the territory of Yalta in the process of economic and environmental activity growth. Yalta is a vivid example of a resort-type agglomeration of a linear type, the historical center of which, in accordance with the existing administrative structure.

Currently, the planning structure of Big Yalta in the process of many years of the development has practically been formed. However, due to the intensive construction of sanatorium-resort and recreational facilities, as well as spontaneously arising sections of individual construction, individual settlements merged into a single urbanized strip. This phenomenon has significantly degraded the quality of the environment.

As a result of the study, the dependences of the ecological situation formation in the urban areas on the features of various urban areas’ planning decisions (for example, Yalta) are confirmed. A number of environmental problems can be overcome through the implementation of engineering measures (reconstruction of the wastewater collection, treatment system and stormwater discharge of all flows discharged into the sea), which ensure a reduction in the technogenic load on the environment. But individual problems should be considered from the perspective of adjusting the master plans for development to gradually stabilize the environmental parameters.

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