Monitoring and Management of Visitor Flows in Recreational and Protected Areas
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# Interaction of Land and Water Ecosystems in Recreational and Protected Areas

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Abstract: The experience of monitoring and management of visitor flows is stored enough large for land ecosystems in recreational and protected areas. An estimation of influence of visiting flows and choice of optimum loadings for water ecosystems are connected to some difficulties. This difficulty is predetermined, first of all, by complexity of interaction of land and water ecosystems and by complexity of performance of monitoring of environment for such ecosystems. Interaction of water and land ecosystems we will consider on an example of the Dniester River Basin and coast of the Black Sea, which are popular recreational and protected areas.

## TOP DNIESTER BASIN. (FIG. 1A,B).

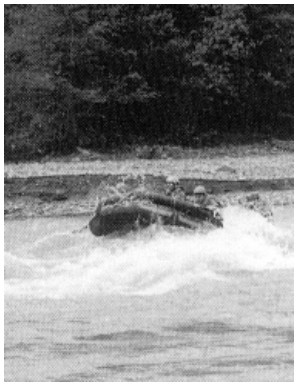

*Figure 1a. Top Dniester River Basin*

*Figure 1b. Top Dniester River Basin*

The Dniester Basin is located in west, southwest part of the Ukraine and east part of the Republic Moldova. Common catchment area of Dniester River Basin makes 72100 km2, from which 63030 km2 concerns to the Ukraine. Total length of the Dniester River is equal 1362 km, from which 705 km concerns territory of the Ukraine. Dniester divide usually into three parts: top (Ukraine), average and lower (Ukraine and Moldova) by character of river's valley, coastal landscapes, water conditions, biodiversity.

The Dniester River begins on northern slope of East Carpathians at height about 900 м and in the top part flows in the narrow canyon valley which is natural border between Carpathians and Podolsk Hills. The top part of the river has mountain character in all area.The high diversity of plant species, which have different age and origin, is a result of geographical location of Top Dniester Basin where three floristic region (Carpathians, Polissya and Podilsk) are mutual junction. Flora includes more than 1500 species of top plants and more than 700 species of vascular plants. The flora houses about 50 endemic and 70 rare species listed in the Red Data Book of Ukraine. The mountain and alpigenous elements of flora are most ancient extant from the tertiary period.

## AVERAGE DNIESTER RIVER BASIN

*Figure 2. Average Dniester River Basin*

The Basin of the Average Dniester covers partially-wooded and steppe natural zones. The most part of this territory, rich natural vegetative and animal complexes, was transformed in agrocenoses for last decades. The gradual extinction is marked for many kinds after destruction of steppe

areas, began degradation of steppe and meadow communities by pastures and by plough of soil. Strong influence on steppe and partially-wooded ecosystems have rendered drainage and pollution of natural reservoirs of this area. The natural communities and populations were kept as fragments on different parts of area that complicates a survival of many fauna and flora species. The vegetation is characterized by great diversity of species and plant alignments, among which forest, that make the base of the landscape and are the nature-functional of the partially-wooded. Oak, hornbeam-oak, nornbeam-oak-ash and beech phytoconose, peculiar steppe alignments, including feather grass, original grassland plants formed vegetation.

## LOWER DNIESTER BASIN

*Figure 3. Lower Dniester River Basin*

Two zone such as - wood and steppe take part in addition of a vegetative cover of territory of the Lower Dniester. The rarefied oak forest of the Mediterranean type from an oak fluffy and accompanied by retinue of the mediterranean-balkan species prevail in wood ecosystems. The prevalence of black soil specifies distribution of large open steppe spaces in the past which now are ploughed up. Many from kept until recently "islands" with steppe vegetation nowadays also are engaged by windbreak. Rare relic steppe of savanna type generated by the mediterranean - balkan species meet now in the kept steppe islands. Dniester River crosses a narrow strip by rich different grasss of feather-grass steppes. Here steppe zone is transformed into a cultural landscape, in which steppe vegetation and flora, as the natural resources, almost have disappeared. Deprived variants of steppes were kept as small islands contiguous to the agricultural areas and placed on unsuitable soils for agriculture. Not zone types of ecosystems: the valleys woods of the rivers, meadow, water-marsh, vegetation of the salted marshs meet in conditions of the Lower Dniester.

## PROTECTED TERRITORIES OF THE DNIESTER BASIN

The natural landscapes both biodiversity of flora and fauna anthropogenous loadings in the rivers basin last decades. The degradation process of landscapes and biodiversity cannot be stopped without creation of network of reserved territories in the river basin. Three natural reserves ”Rosztochya”, “Medobory”, “Horgany” and two national nature parks “Vyzhnytsky” and “Podilski Tovtry” are in Ukraine in the Dniester Basin and only in the top part of the basin. The reserves and national parks are absent in average and lower parts of Dniester Basin in territory of Ukraine. Three natural reserves ”Kodri”, “Jagorlik”, “Plual Faguluj” are in Moldova in the Averege Dniester (Fig.4).

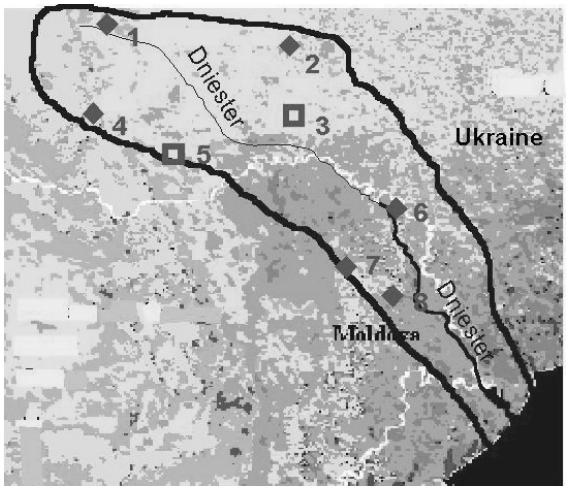


*Figure 4. Map of the distribution of natural reserves, national nature parks and Atmospherically-resistant Vegetation (ARVI) in the Dniester River Basin;*
*1-”Rosztochya”, 2-“Medobory”, 3-“Podilski Tovtry”, 4-“Horgany”,*
*5-“Vyzhnytsky”, 6-“Jagorlik”, 7-“Plual Faguluj”, 8-”Kodri”;*
*(red rhombs - natural reserves, red quadrates – national nature parks).*

Natural reserve and the national parks are absent in the lower part of the Dniester Basin. The amplified attention to the top and average sites of the Dniester Basin for preservation of biodiversity is defined by residing of bulk of rare species of fauna and flora in these areas. However use of the given criterion in an estimation of importance of different areas can have negative legs. The natural ecosystems in areas with a small amount of rare species remain without a due guard that reduces in reduction or even to vanishing species. Reserves and national parks is not present in the lower part of Dniester. This area is characterized by a rather low amount of rare species. Nevertheless there is a set of criteria which force to convert the special attention and on this area of Dniester River Basin.

The vormela, sturgeon, spoon-bill (recorded in the List of the Bern Convention) is species

registered now only in this part of the Basin (Fig. 5 a-c). The species of an ancient ecosystem of the Pontocaspian Sea and species from terrestrial ecosystems of tertiary phase were kept in ecosystems only of this part of the Basin. Dniester delta of together with deltas of Danube, Dnieper, Bug and deltas of the rivers of the Azov Sea form the marsh zone and zone of species ancient of the pontocaspian ecosystem.

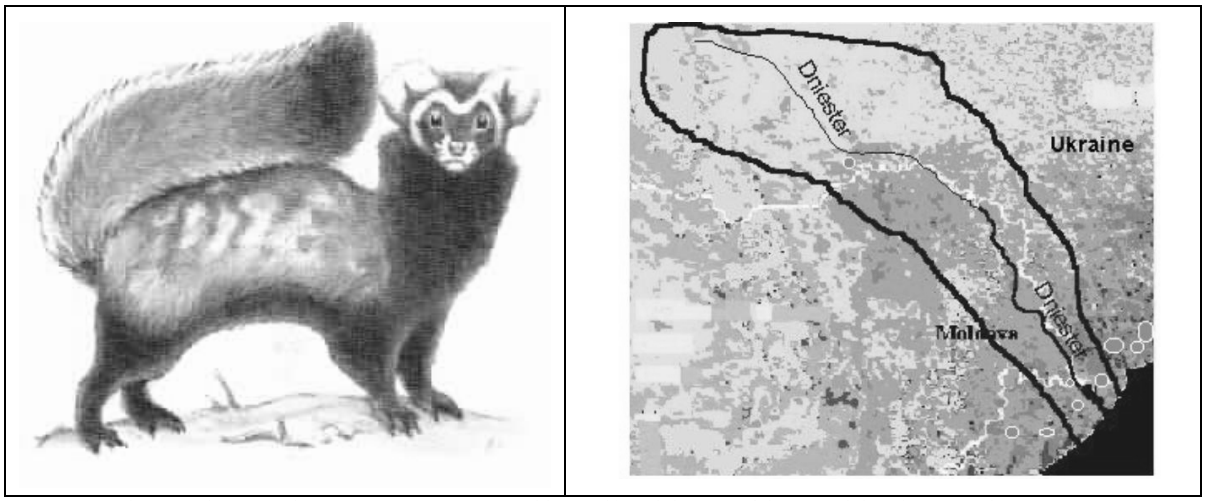


*Figure 5a. The vormela (Vormela peregusna peregusna, Guldensuedi) and the map of the spatial distribution in the Dnieter River Basin.*

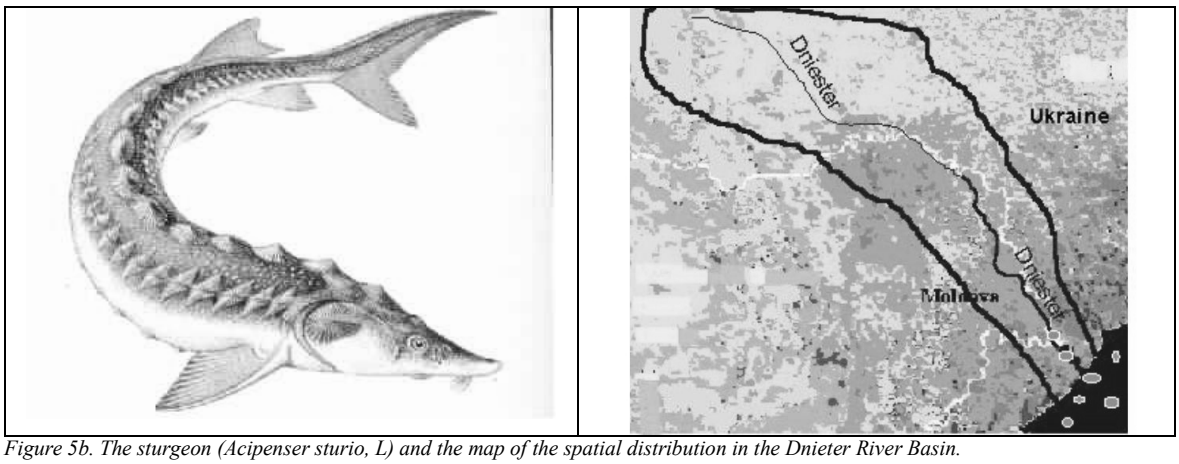


*Figure 5b. The sturgeon (Acipenser sturio, L) and the map of the spatial distribution in the Dnieter River Basin.*

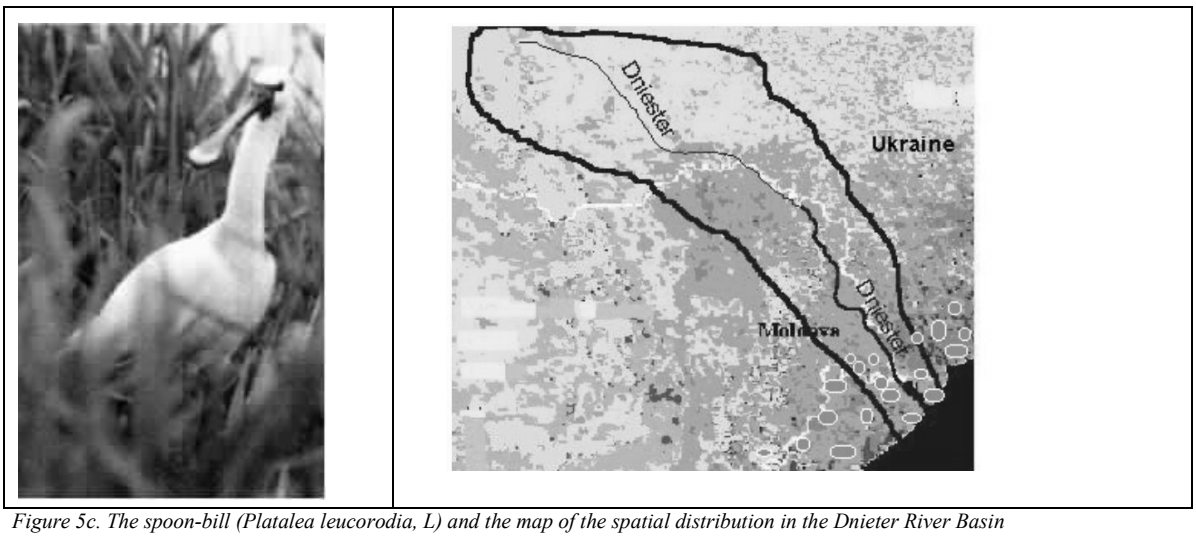


*Figure 5c. The spoon-bill (Platalea leucorodia, L) and the map of the spatial distribution in the Dnieter River Basin*

The high biological efficiency ensures steady functioning of terrestrial and water ecosystems. This site of the Dniester Basin is the important place of a nesting of marsh birds, rest and fattening on paths of migrations of a great many of species of migrant birds, place of a spawning both fattening of many river and anadrom fishes.

Therefore initiatives of the Ukrainian and Moldavian nature protection structures, scientific, public on creation of National Park "Lower-Dniester" in the lower part of the river basin is rather urgent. Obviously that the expansion and development of existing reserved territories of Ukraine and Moldova in the Dniester Basin in uniform reserved natural network is necessary.

The analysis of structures, the functioning of different populations and ecosystems of the Dniester River Basin specifies necessity of development of complex criteria for an estimation of condition of natural ecosystems for their guard, preservation of biodiversity and creation of natural ecological network for all the Basin as component of uniform of the European Ecological Network. The planning of tourist flows, as a rule, is based only on local estimations of possible stability of natural ecosystems without the account of large-scale ecological processes in region. Water ecosystems, besides direct influence of the campers (bathing, motor boats, collection of exotic organisms), have indirect loadings from adjoining industrial and agricultural areas. The recreational and protected territories of the Dniester River Basin are in environment of areas with intensive anthropogenous loading. The pollution are transported from these areas in recreational and protected areas of the river basin. Therefore choice of optimum loading from visiting flows for recreational and protected areas is necessary to carry out considering of anthropogenous loadings from adjoining areas.

The flow of the tourists is not summarized in scale of the basin, and its influence on all ecosystem of the basin is not analyzed. It is considered to the sufficient analysis of loadings on local protected territories. If the flow of the tourists is possible roughly to count in the lower part of the Dniester River, it is impossible to receive the clear information for area of the Lower Dniester. The definition of sufficiency of protected territories remains also by important problem for preservation of steady functioning of the large-scale ecosystem of the Dniester River Basin.

The terrestrial ecosystems and anthropogenous loadings of the River Basin influence not only on river but also sea ecosystems, on natural and recreational resources of sea coast. Four large rivers of Europe, namely the Danube, Dnieper, Dniester and Bug rivers, discharge their water and effluent into the Black Sea (Fig. 6). In addition the river plumes are turbid and carry a high load of suspended particles. The suspended sediment is colloidal and on its surface pollutants are absorbed. These include pollutants such as pesticides, hydrocarbon, heavy metals, organic matters and radioactive isotopes. By this mechanism the polluted river waters of the large rivers can be transferred to marine areas of Ukraine, Romania, Bulgaria and Turkey where they damage the natural ecosystem and worsen the condition for the recreational resources.

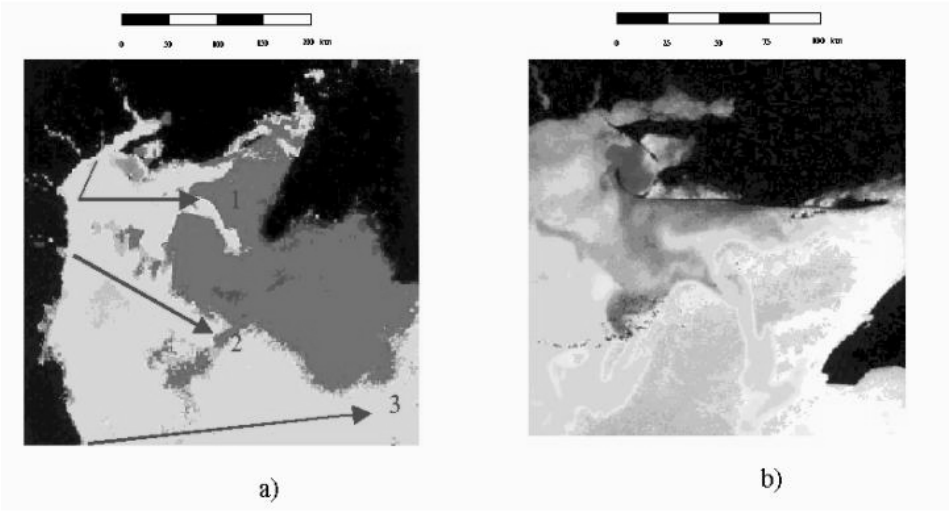


*Figure 6. Satellite observation (NOAA-AVHRR) showing water turbidity indicating the extent of river plumes (red = high concentrations; blue and purple = low concentrations) in the Black Sea. a) 1- Dnieper and Bug River plume, 2 – Dniester River plume, 3- Danube River plume (regional scale); b) Dnieper and Bug river plume (local scale).(From Shalovenkov, 2000)*

Such a dominant pollutant is the organic matter on the surface of the suspended particles. They result in eutrophication on the northwest shelf, sea coast in summer and autumn. This eutrophication generates major changes in condition for sea coast ecosystems and recreation. The flows of the tourists and vacationists are planned for the sea coast without the account of large-scale influence of the large rivers and scales of eutrophication. Not only the large-scale ecological processes are not considered at planning rest at sea coast, but also the comprehensively local ecological processes connected with development of a coastal infrastructure of rest are not taken into account.

The development of coastal infrastructures for rest is connected frequently to increase of household drains in water ecosystems. The pollution of water ecosystems by rain drainage practically is not considered, which are transferred by mud flows of rain from surface of land. Examples of the not taken into account for local pollution of coastal sea ecosystems will consider for two sanatoriums at coast of Crimea taking place near to protected natural areas.

## THE COASTAL AREA OF THE "DOLPHIN" SANATORIUM, SUDAK

*Figure 7. The coastal area of the "Dolphin" Sanatorium, Sudak*

Oil-hydrocarbon, asphalt-resinous substances, cadmium, chromium, polychlorbifenils, lead, zinc had the maximum accumulated concentration in coastal parts of water area with gradients from north rain drainage in beach zone of the «Dolphin» Sanatorium (Fig.8).

## THE COASTAL AREA OF THE "AI-DANILI" SANATORIUM, JALTA

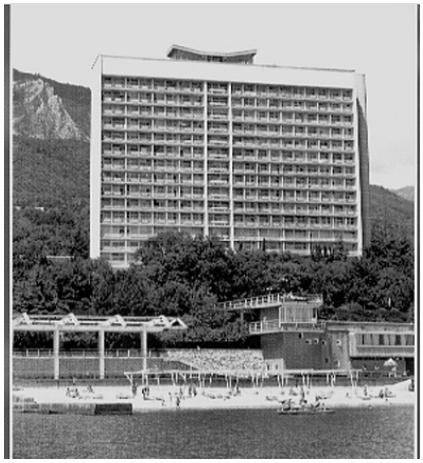

*Figure 9. The coastal area of the "Ai-Danili" Sanatorium, Jalta*

The basic source of pollution and accumulation of pollution is the coastal drain in northeast part of beach of the "Ai-Danili" Sanatorium The maximal accumulation concentration of oil-hydrocarbon, $\alpha+\gamma$ pesticides, zinc, lead, mercury, asphalt-resinous substances is registered in northeast part of this water area (Fig.10).

Spatial distribution of biomass of bottom animals is evidence of constant influence of rain waters with polluting substances in the condition of the coastal ecosystem for two sea water areas. (Fig. 11).

From the given results followed, that the basic coastal source of pollution for water areas are of the rain drains. It will well be coordinated by results of biological indication (fig. 11a,b) of the ecological condition of coastal ecosystems, and also to accumulation of polluting substances in bottom sediment (fig. 8 and 10). These pollution are distributed by coastal currents as well to the adjacent protected natural sea ecosystems.

The rain drains are caused short-term changes of ecological conditions in coastal sea ecosystems, worsen sanitary conditions of beach zones and can be sources of human diseases depending on volumes of rain fall, area of a drainage and hydrological conditions in the sea. The given factor is rather important also for taking into account at modeling and forecast of processes of interaction of terrestrial and sea ecosystems. The volumes of carry of pollutants depend on quantity of atmospheric precipitations, rain catchment area and development of coastal infrastructure.

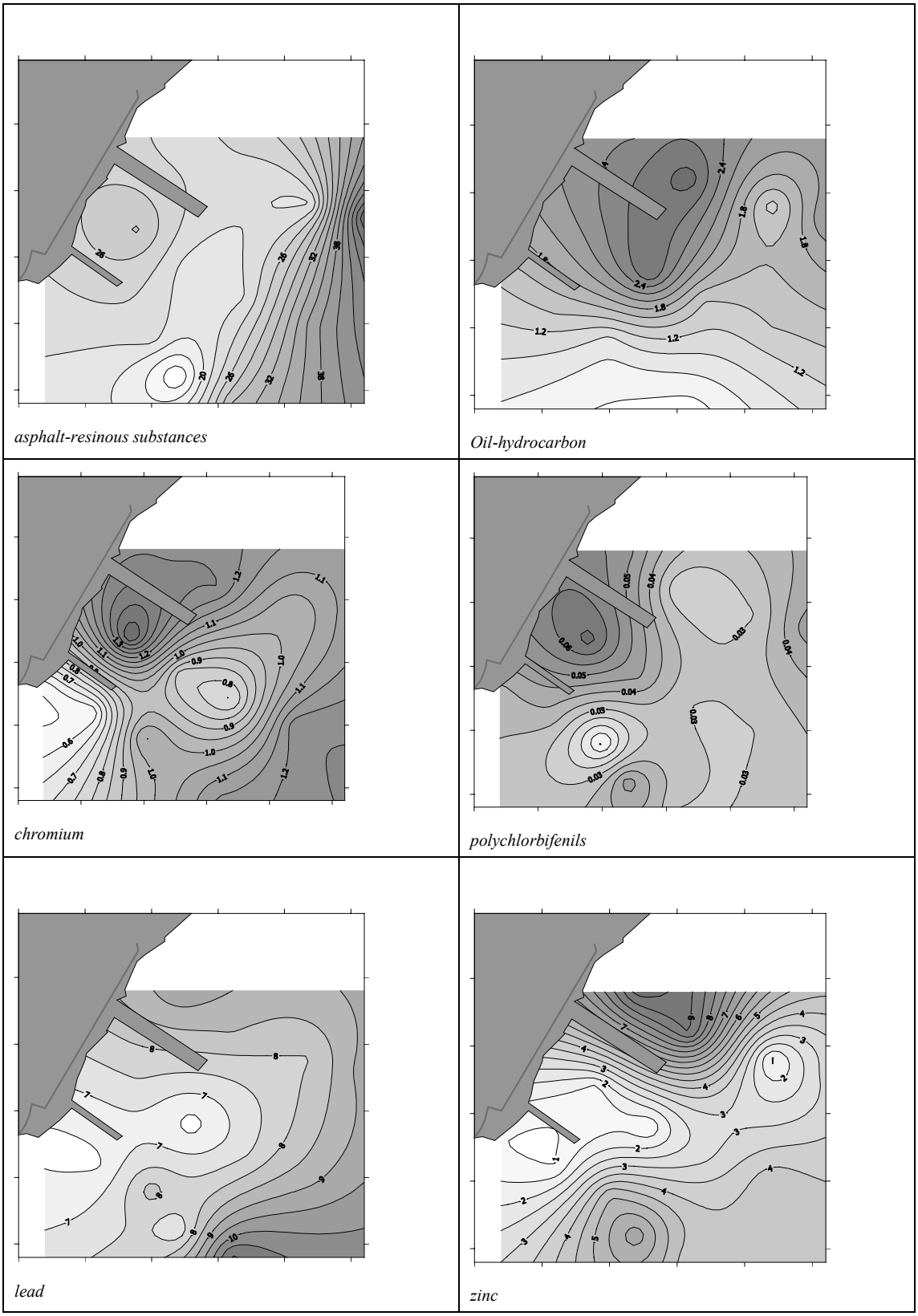


*Figure 8. Spatial distribution in bottom sediments of polluting substances(mg/kg) on example of chromium, zinc, lead, oil-hydrocarbon, asphalt-resinous substances incorporated in coastal area of the "Dolphin" Sanatorium.*

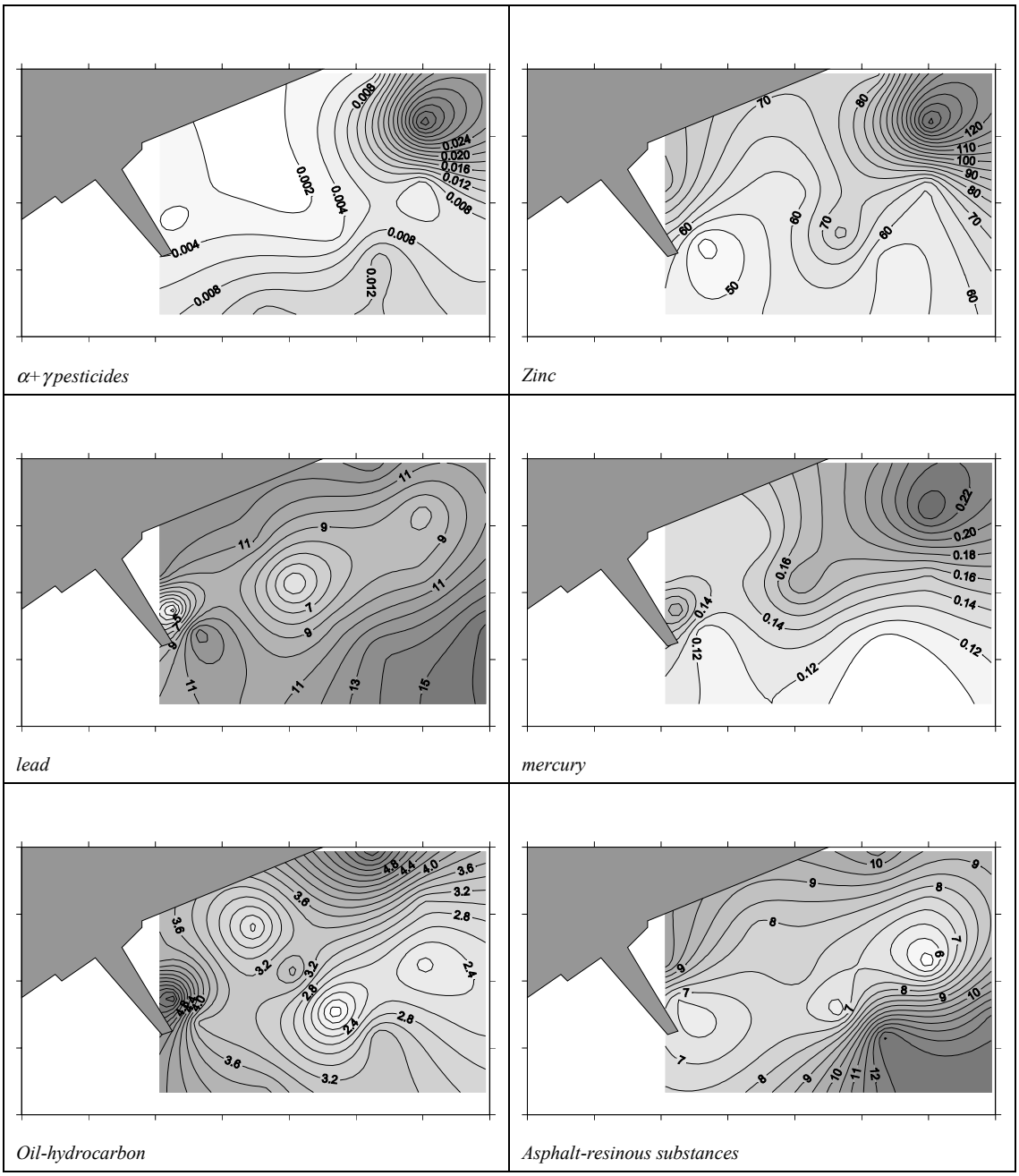


*Figure 10. Spatial distribution in bottom sediments of polluting substances(mg/kg) on example of α+γ pesticides, zinc, lead, mercury, oil-hydrocarbon, asphalt-resinous substances incorporated in coastal area of the "Ai-Danili" Sanatorium.*

## CONCLUSION

The water ecosystems of recreational and protected areas test anthropogenous loadings not only with contiguous of land territories, but also from all of catchment basin of river, lake, sea. Stability of natural populations, communities and ecosystems in recreational and protected areas depend not only from local, but also from large-scale (for example, regional) ecological processes. Therefore it is necessary to take into account total influence of many factors in choice of optimum visiting flows for support of ecosystems in steady condition. It requires the complex approach in management of visiting flows of camper and in development of computer Support Systems for recreational and protected areas.

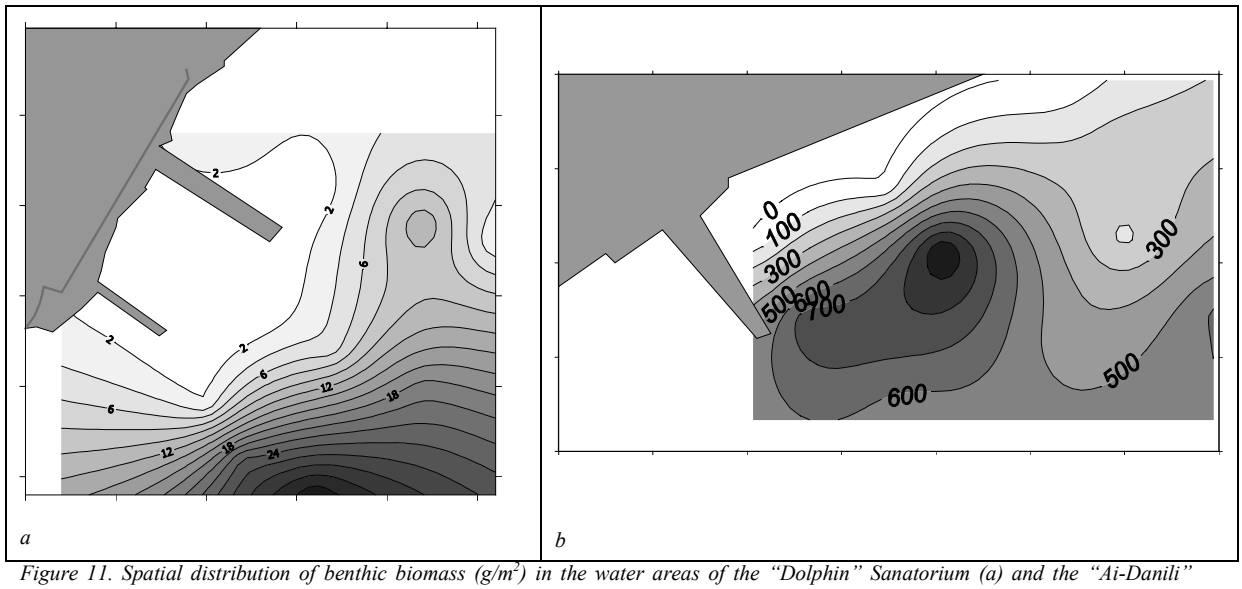


*Figure 11. Spatial distribution of benthic biomass (g/m$^2$) in the water areas of the "Dolphin" Sanatorium (a) and the "Ai-Danili" Sanatorium (b).*