

FINDINGS OF THE SUMMARY REPORT ON THE 2004 RESULTS OF INTEGRATED ENVIRONMENTAL MONITORING IN THE AREA SUBJECT TO IMPACT OF THE DEEP-WATER NAVIGATION ROUTE

1. The Integrated Environmental Monitoring Programme has been developed and introduced quite quickly, to encompass various types of monitoring and observations, such as regular observations, integrated surveys and special surveillance activities. Generally, this Integrated Monitoring Programme meets existing monitoring standards, in particular those that relate to the monitoring of transboundary water bodies, in terms of scope, monitored media and parameters, and monitoring frequencies.

2. Since March through December, 2004, the Danube Hydrometeorological Observatory carried out additional intensive measurements of flow discharges in the Ochakiv, Starostambulsky, and Bystre Branches, in order to obtain factual data on flow distribution in this part of the Danube Delta. The following (preliminary) conclusions can be made on the basis of this data:

- There has been no indication of increase in flow discharges due to dredging activities in the Bystre Branch;
- In 2004, the downward trend in flow discharges in the Ochakiv and Starostambulsky Branches (downstream of Bystre Branch) remained.

3. The sandbar deepening in the mouth section of the Bystre Branch has created the conditions conducive for upward invasion of seawater into the river. The boundaries separating freshwater, mixed-water and seawater zones are very dynamic, being dependant upon freshwater discharge rates in the mouth section, wind direction and speed (provided that the mouth section morphometry remains stable). Water quality measurements, conducted by the Danube Early-Warning and Monitoring Centre at the Odessa Oblast State Department of Environment and Natural Resources in the course of construction activity, indicate that salinity levels varied between 0.48‰ to 1.75 ‰ in the surface layer, and 9.24‰ to 9.57‰ in the bottom layer at that period.

The hydrological field survey (autumn 2004) involved a suite of relevant measurements in the mouth section of the Bystre Branch, designed to identify and characterize the saline-water wedge. On two occasions, the whole channel of the Bystre Branch was filled with fresh water, therefore no measurements were carried out upstream. On two other occasions, elevated salinity levels were recorded in the bottom layer (13.2 and 14.8‰), at a strong counter-current (up to 1.2 m/s). No saline-water wedge was detected in the upstream section (at 2 km in the first case, and 1 km in the second case). During the autumn survey, the tongue-shaped area of transformed river water extended from the Bystre Branch mouth to the dredging

spoils storage site (located at 8 km from the coast), showing the difference of 7‰ in salinity levels compared to the adjacent monitoring stations located at 3 km to the north and south.

4. The hydrological monitoring in the Danube Delta should be continued, and monitoring programme expanded in order to examine the dynamic processes in the seaward edge of Delta, the sandbar deformation in the Bystre Branch, the rate of sedimentation in the navigating cut, and the seawater invasion in the Bystre Branch; and assess the intensity of transport of suspended solids and bottom sediments from the dredging spoils dump to the adjacent areas of the sea at various hydrometeorological conditions.

5. During the second half of 2004, the Integrated Monitoring Programme involved intensive water quality measurements at 8 stationary stations representing 8 work sites (a suite of control measurements of chemical parameters), and additional water quality measurements were carried out at 32 sampling locations during the integrated water quality survey. This survey covered the whole area of the Danube Delta within Ukraine (including major river branches), and the outer delta. As part of this effort, over 4200 determinations were made on various aspects of water quality. The levels of pollutants in bottom sediments (heavy metals and oil products) were measured at the control stations and sampling locations included into the survey, so over 200 determinations were made in this respect.

6. The monitoring data indicate that the dredging activity, conducted according to a specially designed technology in the sandbar section, has led to an increase in concentrations of suspended solids (SS) only *within an insignificant area*. In the mouth section of the Bystre Branch, mean concentrations of suspended solids (taking into account the results of control measurements taken at the time of dredging activity) in the surface layer were at about 53 mg/l (with maximum concentration being at 318 mg/l). In the bottom layer, mean SS concentrations were at about 133 mg/l (with a maximum at 358 mg/l). The control measurements, taken in the course of construction activity (sandbar and rift clearance) by the Danube Monitoring and Early-Warning Centre, indicate that the SS concentrations were lower by 3-5-fold at 1 km to the left and right from a dredging site. The survey results provided by the Odessa Branch of the Institute of Marine Biology show that the margin of decrease in SS concentrations at a distance of 1.0 km was nearly 10-fold. It should be noted that the construction site is located within the avalanche sedimentation zone, where various physical and chemical processes enhance the rapid deposition of suspended solids and their transformation into the bottom sediments. Moreover, higher concentrations of suspended solids in the sandbar section of the Danube Delta represent an aggregate result of the SS transport with river flow and dredging activity in the area of seaward access channel.

7. In terms of the majority of monitored parameters and monitoring locations, water quality in the study area in the second half of 2004 could be described as 'very clean'

to 'clean' waters, corresponding to Classes I-II of Water Quality Classification adopted within the framework of the Trans-National Monitoring Network (TNMN) Programme for the Danube. The only, and regular, exception, is pH, which is due to the natural factors (elevated pH levels are characteristic for the mouth section of the Danube). As regards other monitored parameters, 90% of determinations show that water generally corresponds to Water Quality Class III (i.e. 'moderately polluted' water). Elevated contents of chlorides, measured at the mouth section of the Bystre Branch, were apparently caused by the saline water invasions into the Bystre Branch. On relatively frequent occasions, the levels of COD and nutrients were also within the limits set for Water Quality Class III.

8. Virtually all mean concentrations of contaminants recorded in the Danube-Reni section in the second half of 2004 were not higher than their respective average historical values. Relatively higher concentrations of some contaminants (COD, BOD₅, some heavy metals) in surface water layer, sampled in the second half of 2004 in the Kilia Branch (near Vilkovo) and Bystre Branch (mouth section) as part of the Integrated Monitoring Programme, were largely within the range of relevant historical values measured prior to the commencement of the project. The only exception were suspended solids, whose inputs in the mouth section of the Bystre Branch were significantly higher in 2004 as compared to the historical monitoring data, being apparently attributed to the dredging activity. However, as was previously noted in paragraph 6, this effect on water quality was limited to a rather small area.

9. During the dredging activity, the concentrations of phosphorus, nitrogen and silicon compounds, recorded in the sandbar section of the Bystre Branch, were well short of their respective background levels measured at the stationary monitoring stations. No significant changes in concentrations of oxygen and soluble organic substances have been recorded over the monitoring period.

Elevated concentrations of organic substances in the porous waters were recorded at the majority of sampling locations. High levels of organic substances (up to 25.5 mgO/l) were recorded near the Bystre Branch mouth, within the avalanche sedimentation zone, where the content of ammonium nitrogen also appeared to be highest. The survey results confirmed that bottom sediments currently represent a factor enhancing the process of eutrophication.

10. In the context of water quality standards set in Ukraine for water bodies used for fisheries, the most striking exceedances were measured during the dredging activity and in the immediate vicinity to the dredging sites. In these areas, both mean and maximum measured values of virtually all monitoring variables exceeded the temporary guideline levels (maximum admissible concentration (MAC) values) set for water bodies used for fisheries. However, actual concentrations of some pollutants were either well short of their respective background values, or showed exceedances only within a very limited area.

Monitoring results indicate that concentrations of oil products (OP) appeared to be persistently higher than their guidelines MAC levels. The average margin of exceedance was by 1.4-fold in the surface layer, and by 1.3-fold in the bottom layer of the river. While monitoring results show a slight downward trend in oil products in the surface layer as compared to the survey results collected in 1993–1997, it appears that their concentrations have remained at the same level in the bottom layer.

As regards heavy metals, while the recorded levels of Fe, Mn, Cu, and Zn were above the national guideline (i.e. temporary MAC limits set for fisheries), they were about equal to the background levels and, in the majority of cases, *well below the respective water quality targets* set for these parameters by the Danube Commission.

11. A suite of biotests conducted as part of the survey programme for water and bottom sediment samples showed that none of the samples taken contained toxic substances at concentrations capable to produce acute toxic effect.

12. As part of the 2004 integrated field survey, river mollusks were sampled in order to examine the bioaccumulation of heavy metals and arsenic. The concentrations found were either close to (Pb, Cr), or well below (Zn, Ni, Cu, As) mean values measured during the 2001 International Field Survey of the Danube River.

13. The review of historical monitoring data on concentrations of persistent organic contaminants provides a picture of large-scale long-term contamination of the Danube with persistent chlorinated organic pesticides (lindane, DDT) and atrazine. The historical data on chlorinated organic pesticides suggest that transboundary transport is likely to be the strongest contributor of these substances in the Ukrainian part of the Danube Delta. This finding is graphically illustrated by the October–November 2004 field survey results: bottom sediments sampled in the Reni-Vilkovo section showed a gradual decrease in concentrations of chlorinated organic compounds towards the Kilia Arm mouth of the Danube. It should be noted that these results showed good comparability with the results of the 2001 Joint Danube Survey (JDS-2001). The levels of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) in the bottom sediments were well below the official guidelines.

In the Bystre Branch, the *Anadonta Woodiana* mollusks were sampled to analyse the bioaccumulation rate of chlorinated organic pesticides (n,n-DDT metabolites and γ -HCH). The recorded levels of chlorinated organic pesticides and their metabolites ranged between 7 to 19 $\mu\text{g}/\text{kg}$, being close to the levels recorded in other sections of the Danube River during the 2001 Joint Danube Survey. The analysis of PCBs and PAHs in molluscs showed that the content of these toxic substances was well below existing safety guidelines (the sum of PCBs at 0.023-0.045 mg/kg , the sum of PAHs at 0.015-0.027 mg/kg).

14. Generally, the monitoring results produced as part of the 2004 Integrated Monitoring Programme indicate that dredging activity had produced certain local effect on the quality of aquatic environment. Changes in water quality, recorded in certain river sections near the dredging site in the course of monitoring programme, need to be examined/assessed in more detail at further stages of the Programme.

15. The results of biological monitoring and rapid tests held as part of the Programme in order to assess the biotic index indicate that there have been no significant changes in the community structure and pollution levels in the Danube since the commencement of operation of the Danube-Black Sea Navigation Route. The only exception relates to the dredging sites in the Bystre Branch, where invertebrate fauna was found to have depleted significantly within a limited area (immediately in the locations of dredging activity), and the community structure of bottom species has been disturbed.

16. No abnormalities were found in the distribution of radionuclides in water and bottom sediments. Inputs of man-made radionuclides from a nuclear reactor located in Romania, and dredging activities in the Bystre Branch have not had any effect on the radioecological state of the Lower Danube within Ukraine. Therefore the scope of future radioecological monitoring can be significantly reduced.

17. The data on water and bottom sediment quality collected in the course of 'marine' component of the Integrated Field Survey for the estuarine section of the Danube (including the navigation channel route) indicate that the variations in water quality in autumn period were mainly caused by natural factors and processes (river flow, river/marine water mixing, and hydrobiological processes).

18. The results of 'marine' component of the Autumn 2004 Integrated Field Survey show that the levels of nitrogen and phosphorus (in mineral and organic forms) were near or equal to the historical values recorded in the estuarine section over the past decade, though a slight downward trend in organic phosphorus was recorded.

19. Historically, the macrozoobenthic communities inhabiting the Danube Estuary featured the upward trend in quantitative parameters (population and biomass) from spring to autumn. In autumn 2004, the average biomass of benthos decreased by 7% relative to the spring level. The lowest values of benthic biomass were recorded in the location of dredging spoils dump (5 g/m^2). In the area where the impact of deep-water navigation route is considered to be highest, the survival rate of mussels is at about 30% of their initial population.

Generally, the state of macrozoobenthos in the Black Sea near the Danube Estuary was considered as satisfactory in November 2004, except the dredging site and spoils dump.

20. The analysis of fish samples taken for research purpose prior to and during the reopening of the deep-water navigation route shows that there was no significant impact on the commercial fish fauna inhabiting the outer delta of the Bystre Branch.

21. The following conclusions can be made based on the monitoring of flora and fauna species in the area of the Danube Biosphere Reserve during the reopening of the Danube-Black Sea Navigation Route:

- No significant changes have occurred in the vegetation cover in the nearest proximity to the construction site (Ptichiya Spit). The constructed dam provided better protection against the storm impact on the eastern part of the Ptichiya Spit, while the emerging shrub vegetation will enhance the development of vegetation cover similar to that of coastal spits.
- The nesting bird community inhabiting the Bystre Branch area comprises ground-nesting plover birds (especially speckled tern and river tern), dwelling on the Ptichiya Spit. In 2004, the population and structure of nesting-bird community of the Ptichiya Spit (currently representing key nesting area for bird colonies in the Danube Biosphere Reserve) remained the same as in the previous year. This is attributed both to a highly conservative nesting pattern of bird colonies, and the same levels of nesting capacity of the Ptichiya Spit in the years under examination.
- However, the level of disturbance increased significantly during the dredging activity in the sandbar section of the Bystre Branch. According to the DBR experts, this resulted in a dramatic reduction (by 9-15-fold) in successful reproduction rates in 2004, especially in the immediate vicinity to the navigation route, where this rate dropped to zero level. Specific reductions were as follows: from historically recorded 50-70% to 3-5% in 2004 in speckled tern (as the major colonial species in the outer delta), and from 60-80% to 7-10% in 2004 in river tern (the second major species).
- In the Bystre Branch area, the post-nesting community showed an increase in proportion accounted for by cormorant birds (from 35.0% in 2003 to 48.4% in 2004), due to their greater tolerance to noise and increase in area available for their rest, and a decrease in proportion of waterfowl species (duck and geese) showing lower tolerance to noise (from 27.7 to 19.6%, respectively). The seasonal patterns showed an increase in proportion accounted for by pelicans, herons, and sandpipers (from 0.4, 0.4 and 1.4% in 2003 to 0.9, 0.8 and 3.5% in 2004, respectively). This is apparently attributed to the intensive silting of water body isolated by the Ptichiya Spit, resulting in a temporary improvement of habitat conditions for these species.

22. Generally, the 2004 monitoring results show that actually observed trends in the environment quality, caused by the channel reopening activity, were well within, or

often below, the forecasted changes. The Integrated Environmental Monitoring Programme should constitute a mandatory component of the second phase of the channel reopening and its operation. The implementation of the Integrated Monitoring Programme should be continued in 2005-2006, while the 2004 monitoring results provide a good basis for adjustments in monitoring programme in order to improve its effectiveness and cost-efficiency.