

**Ministry of Ecology and Natural Resources of Ukraine**  
**Research Institution "Ukrainian Scientific Research Institute of Ecological  
Problems" (USRIEP)**

**ANNOTATED CONSOLIDATED FINAL REPORT**  
**ON SCIENTIFIC RESEARCH**

**Complex environmental monitoring under exploitation of the deep water  
fairway Danube-Black Sea under the period of 2016-2017. Territory of the sea  
access canal.**

**2017**

## INTRODUCTION

In 2004 in order to evaluate the impact of works on resumption and exploitation of deep water fairway the complex environmental monitoring program (hereafter the program) aimed on elimination of the uncertainties in the assessments of effects on the environment was developed and implemented.

Due to the fact of dynamic progress of ecological processes in the Danube Delta and possible changes of the scale of human impacts including the volume of operational works on support of DWF there is a need of reviewing and adjusting of the work program taking into account the results of stationary observations, control measurements, field research and etc. This induces the acceptance of the Program each year with the introduction of the necessary adjustments. According to the Program (Annex A) and in compliance with the Terms of Reference to the contract number 410 / 1.1 / 158-B-ФДЛ-16 from 07.08.2016 the works were carried out during the reporting period.

For work performance the main executor (USRIEP Ministry of Ecology and Natural Resources of Ukraine) have been involved the following organizations: Danube Hydrometeorological Observatory (DHMO), Odessa Centre State Enterprise South Scientific Institute of Fisheries and Oceanography (SSIFO), Governmental Enterprise «CHERNOMORNIIPROEKT» , Danube Biosphere Reserve National Academy of Sciences of Ukraine (DBR), Governmental Institution "Institute of Marine Biology, National Academy of Sciences of Ukraine" (IMB).

Monitoring program includes following main types of the works in 2016:

- Conduction and processing of the results of regular hydrological and hydro-chemical monitoring on the points of baseline environmental studies and on the area of possible impact on the environment of the deep water fairway Danube-Black Sea;
- Conduction and processing of the results of control measurements of water quality and bottom sediments during dredging in the sea access canal (SAC) DWF and in the area of marine soil dump;
- Assessment of cumulative impacts of navigation on the state of surface and water ecosystems;
- Assessment of water areas that are used to fish spawning and nesting of birds and their nutrition;
- Carrying out of comprehensive expeditionary surveys of water quality and state of the components of environment. Complex expeditionary surveys include hydrological, hydrochemical and hydrobiological study of marine part of the DWF and coastal ecosystems in the territory of the DBR;

- Monitoring of fish fauna, assessment of the negative impact on fishery resources under exploitation of the deep water fairway Danube-Black Sea;
- Quarterly calculations of damage caused to aquatic environment and fish stocks and the size of compensation payments, assessment of residual volume capacity of soil of the disposal area (sea, etc.);
- Preliminary calculations of damage caused to the components of the environmental as a result of operational works on the route of sea access canal of DWF Danube-Black Sea and for the storage of exclude soil on 2017;
- Monitoring of plant and animal communities of coastline and wetlands of the Danube Biosphere Reserve under exploitation of DWF Danube-Black Sea;
- prognosis evaluation of possible effects of stopping of dredging in the Ukrainian part of the delta on the environment while preserving artificial redistribution of runoff in favor of the Romanian system of the estuaries of Danube;
- Analysis and generalization of the results of observations, development of the forecast of changes of environment; assessment of a possible transboundary impact of the operational dredging works and navigation;
- Development of recommendations on the prevention and minimization of the effects of DWF exploitation on the environment including the transboundary context.

Annotated report contains compressed information on the actual implementation of the program of works and basic results of research on the monitoring directions.

## **1. The actual implementation of the program and the scope of works**

For reporting period according to the Program expeditionary surveys of riverbed site of the Danube were held. During the scientific expeditions and on the stationary hydrological observation posts the observations of the hydrological characteristics of the delta watercourses were carried out.

During 2016, as in previous years, were carried out monthly systematic studies of hydro-chemical indicators of water of the Ukrainian part of Danube. samples were taken and analyzed in 17 points of observation by Danube Hydrometeorological Observatory. Regular observation of hydro-chemical indicators of water is one of the main monitoring direction of Ukrainian part of the Danube. In 2016 were selected and analyzed 153 water samples and performed 4302 determination of elements of hydrochemical indices of water.

Hydrobiological studies of the Danube in 2016 performed the experts of USRIEP. The study included the selection and processing of samples of phytoplankton and

zooplankton, water and bottom sediments to study seasonal state of biological communities, content of photosynthetic pigments of phytoplankton algae and bottom sediment (BS). During the period of expeditionary researches were selected 129 samples of water and bottom sediments on hydrobiological and hydrochemical (heavy metals) analysis.

Expeditionary surveys of seashore were conducted under the control observations during the hydrotechnical works. The collection and compilation of hydrological and hydro-chemical data on the bars part and the adjacent water areas on 12 stations in August and on 12 stations in October - November were performed. Each station performs complex hydrological, hydrochemical and hydrobiological activities; meteorological observations.

The 98 measurements of hydrological indicators were performed and selected 48 water samples for determining the hydro-physical and hydro-chemical parameters on 18 indicators, 23 soil samples for determining the particle size distribution and content of pollutants. The analytical works on the state of water and sediment parameters were held in certified laboratories.

Hydrobiological investigations of seashore included study of the seasonal state of groups phyto-zooplankton, macrozoobenthos, meiobenthos and phytoperiphyton. In 2016 162 hydrobiological samples (phytoplankton - 48 samples zooplankton - 24, benthos - 46 and fitoperyfiton - 44 samples) were selected and processed. determination of the state of fish feed base was performed.

Ichthyological monitoring works were carried out according to the Program. The analysis of statistical data on the fishing of anadromous and nonmigratory species in the Danube river and the collection and processing of the materials that characterize the state of fish populations were performed (SSIFO). On the territory of DBR in the framework of complex environmental monitoring were conducted observations of the state of plant communities of coastline and wetlands, macrozoobenthos of freshwater and brackish-water bays and creeks on the territory of the DBR, herpetofauna and rare fish fauna as well as bird and theriological surveys in the area of DWF and Ermakov island.

Studies of ecological processes in the Danube Delta and the coastal part of the sea with the use of remote monitoring were conducted. The data on the dynamics of riverbed processes and suspended solids in the Danube Delta and the Black Sea coastal area are obtained by the materials of satellite imagery.

In the 2016 The assessment of the impact of dredging on the water environment and fish fauna was performed; quarterly calculations the compensation payments were conducted (SSIFO, «CHERNOMORNIIPROEKT» ).

The following types of works were carried out: the analysis of the the actual volume of soil storage, which is excavated during dredging operation under resumption of DWF

"Danube - Black Sea", the assessment of the residual volume capacity of soil of the dump; the study of the further possibility of its use under dredging in the marine part of the DWF "Danube - Black Sea" (CHERNOMORNIIPROEKT).

Preliminary calculations of damage caused to the components of the environment as a result of operational works on the route of sea access canal of DWF Danube-Black Sea and for the storage of exclude soil on 2017 were carried out.

The program of the complex environmental monitoring under exploitation of the DWF Danube - Black Sea in 2016 has been fully implemented.

## **2. Hydrological and hydrochemical studies of the Danube (DHMO, USRIEP).**

In 2016 according to the Program of complex environmental monitoring and the technical project for the sub-contract with USRIEP by the Danube Hydrometeorological Observatory were performed regular hydrological and hydro-chemical investigations in operating conditions of deep water fairway (DWF) "Danube - Black Sea".

The hydrological monitoring program included daily monitoring of the level and temperature of water. These observations were carried out on eleven stationary posts in five of which, moreover was carried out daily monitoring on turbidity. also have been taken expedition to study the spatial and temporal variability of water flow and sediment of the Danube and its delta branches.

Hydrochemical observations in accordance with the requirements of technical task were carried out on Danube and on the branches of the Kiliya delta. The number of stations on the Danube River and delta branches in 2016 amounted 17. Processing of samples involves the execution of analyzes on certain ingredients directly in selected samples on board, as well as in stationary laboratory of the Danube Hydrometeorological Observatory.

### **The results of hydrological monitoring**

The average annual water level in 2016 at the top of the Danube Delta was higher than average long-term. The maximum water levels observed in March and don't reached dangerous marks. Minimum level observed since the beginning of the year (Fig.2.1).

The maximum water discharge at the top of the Danube Delta amounted to 12,800 cubic meters. m / s and had availability of 10%, which corresponds to the average frequency of once in 10 years.



Fig. 2.1. Chart of the course of the daily water levels of Danube, ГП-I Reni

Analysis of measurements of water discharge for the period 2005-2016 indicates that currently at the top of the Danube Delta is preserved long-term trend of decreasing of water content of Kiliya branches system which is related with the transboundary impacts of large hydrotechnical works in the Romanian part of the Delta.

### **The results of regular and expeditionary hydrochemical observations**

Changes of the hydrochemical regime of delta part of the Danube to a large extent depended on the parameters of the hydrological regime - water content and temperature, atmospheric precipitation and melting of snow are the reasons of entering of suspended solids and some chemical pollutants from surface runoff.

The content of dissolved oxygen, on which depend all chemical and biological self-purification processes in the river was fairly high throughout the year, decrease was observed in the summer. It is noted inverse correlation of oxygen in the water with temperature. Violations of norms are not observed, the lowest oxygen content was observed in July and August 0.90 - 0.88 maximum admissible concentration for fishery slightly better compared with last year.

Excess of quality standards for pollution for cultural and social water usage (MAC c/s) and for fishery water usage (MAC f.) observed starting from the cross-border area (observation point - R01 Danube River 71 miles above Reni). In this section of the river is systematically observed a significant excess of maximum permissible concentration of suspended solids, COD, iron, phenols.

The mediated results of observations on section of the river, both on separate seasons and for the whole year do not exceed the above standards of metal content both in the water and in the sediments.

The waters of the Danube delta, as well as in previous years above permitted contaminated with suspended solids, organic substances, nitrites, and metals. Above permitted contamination of the river water by hydrochemical parameters of pollution and pollution of sediment by metals has been observed for the cross-border area (observations point R01 Of the Danube, 71 miles).

### **3. Assessment of the ecological status of the Danube by hydrobiological and hydrochemical parameters (USRIEP).**

Investigations of the state of hydrobiological groups were held in summer (August) and autumn - winter (November) periods in 2016. Samples were selected on the track of deep water fairway Danube - Black Sea and were measure the water temperature and transparency by Secchi disk. During the period of the research expeditions were selected 129 samples of water and sediment for hydrobiological and hydrochemical analysis.

#### **The results of hydrobiological research.**

During the analysis of 24 algal samples collected during expeditions in August and November 2016 in the studied river stations of Danube was found 170 species and intraspecific taxon from 8 groups of freshwater phytoplankton (Annex B). Separately during selections in summer and late-autumn in 2016 were marked 140 and 115 taxonomic units respectively.

The analysis of samples of zooplankton showed that river groups in 2016 marked by very low rates of species diversity and quantitative development.

During research the benthic fauna was presented at different periods from 8 to 19 species of invertebrates.

Density and biomass of benthic aquatic organisms in points of research ranged widely: from 125 ind / m<sup>2</sup> to 8500 ind / m<sup>2</sup> and 2250 mg / m<sup>2</sup> to - 52750 mg / m<sup>2</sup>, the maximum of quantitative indicators of development of benthic were observed in below Kiliya. Reducing of the basic indicators of aquatic organisms connected with the feature of the ecological state of the pond at the time of the research.

Obtained data in 2016 during sampling of the chlorophyll "a" of phytoplankton on average conforms to oligo-mesotrophic waters. Summarizing the research results in 2016 may be noted that in general there is no significant violations in the state of the ecosystem of the Danube by biological parameters.

Environmental assessment of water quality of Ukrainian part of the Danube (hydrochemical indicators)

Environmental assessment of surface water quality of Ukrainian part of the Danube Delta was carried out on the basis of methodologies of environmental assessment of surface water quality for the relevant categories and information provided by the monitoring subjects under works to control dredging DWF "Danube-Black Sea" in 2016.

The calculation results of environmental indices are the follows.

The worst water quality is marked by Trophy-saprobiological block of indicators. No significant differences in water quality between separate points by an average annual estimate were found. Compared to previous years the overall environmental assessment of the Ukrainian part of the Danube practically unchanged.

Compared to 2015 was observed insignificant improvement in the environmental index in all points of observation for the average levels of indicators.

#### **4. Control monitoring during operation deep water fairway Danube-Black Sea (the sea side) (IMB)**

In 2016 on the monitoring program of the fairway on the coast of the Danube were carried out 2 expeditions in August and October-November. Expedition works were conducted in the autumn in 2 stages: the first stage of October 26-31, the second stage of November 8-13. This situation has been caused by adverse weather conditions. Scheme of the stations is given below.

In the macrozoobenthos of Danube sea region in 2016 registered 51 taxon. In the period from September to October 2016 as a part of phytoperiphyton community at the site of Ust-Danube have been recorded 12 species in September and 11 in October, and near the Byistryiy mouth - 11 species in September and 12 in October species.

The analysis of interannual dynamics of the categories of ecological status of the Danube delta in the period of 2004-2016 based on the state of phytoperiphyton shows that within a safe period, which observed after an abnormally on climate 2010 the 2016 characterized by lowest absolute value of morphofunctional fitoindikator. The water quality was within the range of the category of "good".

#### **5. Ichthyological monitoring results (SSIFO)**

Ichthyologic studies in 2015 were carried out as part of the complex monitoring of the exploitation of deep water fairway (DWF) Danube-Black Sea at the mouth according technical specifications and contract between USRIEP and SSIFO and "Program ...".

Scientific research work was carried out according to standard methods of hydrobiological and ichthyological studies adopted in the system of State fishery Agency and NAS. The works on program were conducted within the framework of the joint



monitoring points of SSIFO and the Danube Biosphere Reserve involving fishing organizations in the region, either on its own UDC SSIFO and DBR.

The following basic parameters of commercial species populations were studied:

- Sexual, size-weight composition;
- The growth rate of different age groups;
- Status of the gonads, fertility and efficiency of spawning;
- Changes in the number of populations of commercial fish species.

The results of the carried out works indicate the following.

In general water management and hydrological state of water bodies of Danube River watershed in 2016 was satisfactory. This fact favorably affected on the spawning migration of anadromous fish.

The intensity of the fish moving of the Danube herring in the River in 2016 can be called as high in comparison with the 2014 and 2015 years.

The obtained data indicate on unfavourable state of sturgeon species in the Danube. Natural reproduction of beluga and sterlet in the Danube is maintained at a relatively higher level than the stellate sturgeon and, especially, the Russian sturgeon.

The low number of producers of anadromous sturgeon calling at the river to spawn, testifies the doldrums of populations. The situation with the reproduction of the Danube herd of Russian sturgeon can be evaluated as poor, but occurrence of such situation is not related to the works on the resumption and exploitation DWF Danube - Black Sea.

The direct influence of soil development and the dumping on the fish fauna is relatively small.

Dredging works on support of the DWF have a limited impact by areas of work on fish fauna and had no cross-border impact.

## **6. Monitoring of terrestrial and coastal ecosystems on the territory of the Danube Biosphere Reserve (DBR)**

Monitoring of plant and animal communities of the coastline and flowing of the Danube Biosphere Reserve (DBR further) during exploitation of deep water fairway Danube - Black Sea in 2016 took place in accordance with the terms of reference and programs.

To the structure of the monitoring which is carried out by the DBR employees, have been included observations on the species protected by various international conventions and listed in the Red Book of Ukraine. In connection with the approval in 2009 of the

New Edition of the Red Book of Ukraine, these species were under the supplementary attention during the work.

Significant attention was paid to the invasive species due to the fact that they are spread primarily thanks to the existing traffic flows.

The composition of the flora of the reserve in 2016 did not change and consists of 1562 species.

The most important and rare meadow communities are newly formed coastal areas. These areas are the most valuable for speciation. However in the composition of their phytocenoses observed the increase in the number and density of adventitious species. Invasive species require constant monitoring.

The main factors of influence on the flora and vegetation of the reserve in 2016 were climate, hydrological and anthropogenic.

No washouts of shoreline of the channel along the estuaries Starostambulskoe and Byistryiy happened.

Protective dam built in the recess estuary Byistryiy leads to changes in morphostructures of the coastal part of the Stambulskiy island and to changes in the composition of sand-littoral vegetation.

In comparison with the previous years the number of macrozoobenthos in the bars part of the Vostochniy branch rose by almost 5 times (7570 ind / M<sup>2</sup>, biomass -.. 6 (up to 98.7 g / m<sup>2</sup>) it is happened because of the extreme outbreak of amphipods *Pontogammarus maeoticus* and molluscs).

In June and July 2016 among existing young sturgeon that migrate to the sea, attended exclusively young beluga and sterlet length of 12-18 cm. The young of second sturgeon species was not observed. However, the species composition of the catch changed at the end of July. Young of Beluga has ceased to be caught, but beginnings caught the young stellate sturgeon in length from 13 to 18 cm. Sometimes the catches have been marked hybrid of sturgeon and stellate sturgeon a length of 12 to 26 cm.

During 2016 there was no significant effect of exploitation of the DWF Danube - Black Sea to the representatives of the rare fish fauna in the study area. There were no effects of the impact, directly, of navigation (pollution, wave phenomena and others.). Direct effects of DWF in estuary Byistryiy of the migrations in spring and autumn 2016 have been identified.

During the investigations in 2016 a substantial direct effect of the DWF Danube-Black Sea on theriofauna of the DBR also not has been found.

**7. The analysis of channel processes and suspended solids in the Danube Delta and the coastal area of the Black Sea based on satellite images**

## Selection of satellite images.

In 2016 for the analysis of dynamics of suspended solids and change of the coastline the pictures from space mashin Landsat 8 were involved in the course of work and analyzed and supplemented of images database. With 46 available images of the study area made by the of KA Landsat 8 were selected and processed 13 satellite images of the Danube estuary by the criteria of quality. A feature of 2016 was the presence of clouds and fog on most pictures of the first half of the year, making impossible further processing and interpretation of these pictures.

## The dynamics of coastlines

Analysis of satellite images allowed to investigate spatial and temporal changes in the coastline. For analysis we used a combination of long, medium and a near infrared channel that equalizes fototon of water surface and makes it more contrast relative to the land surface. During the comparative visual analysis of images of the most significant changes in the coastline in areas Gulf Taranov, Ptichiy Island and the islands of Novaya Zemlya were allocated (Figs. 7.1-7.3).

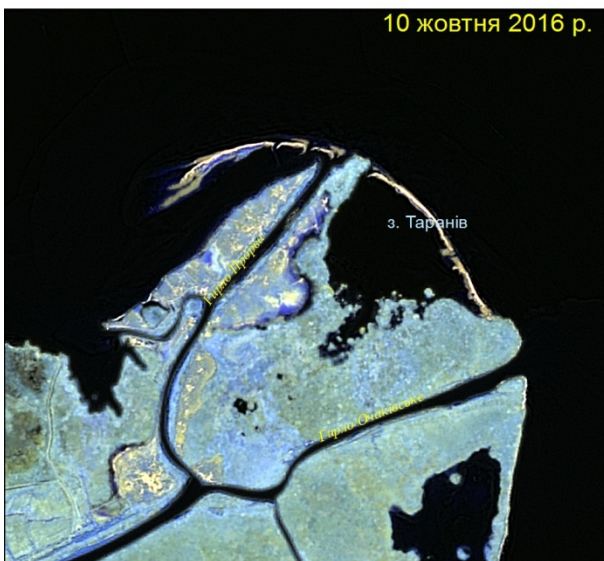
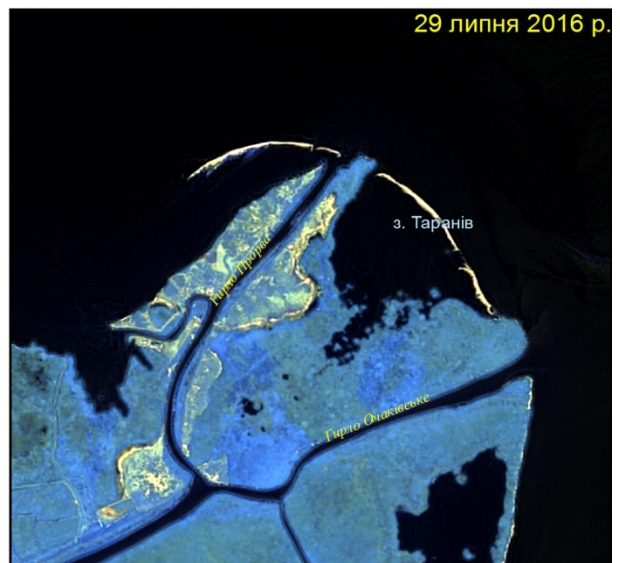
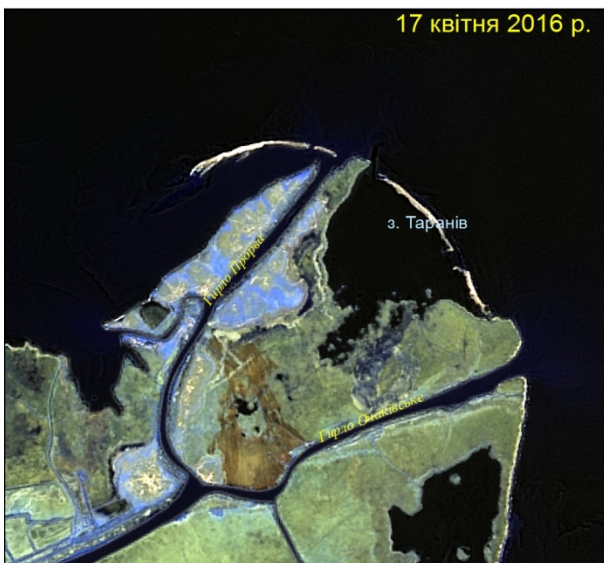
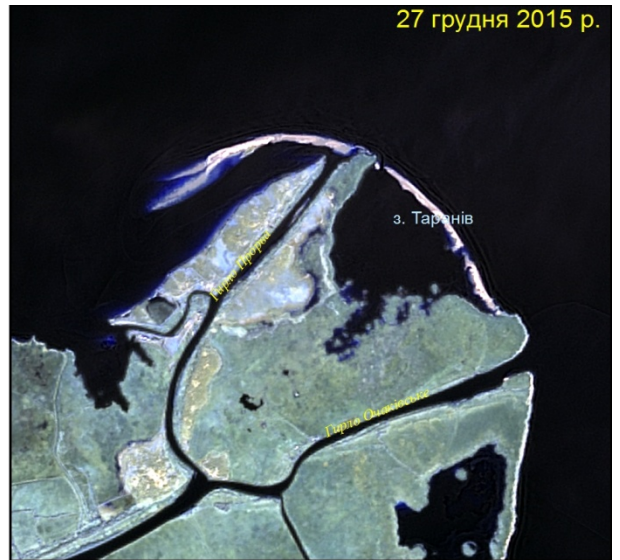
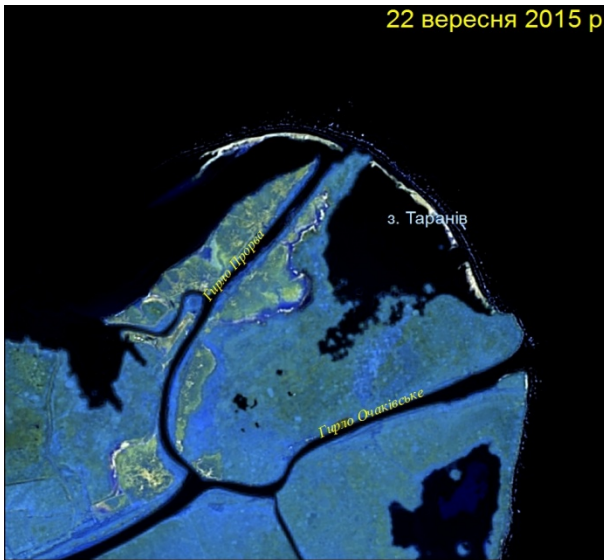


Fig. 7.1. Changing of the coastline and marine sand bars in the Gulf Taranov

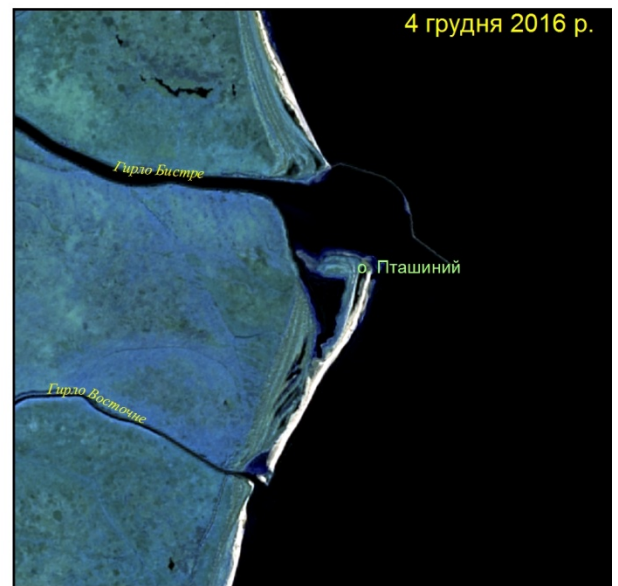
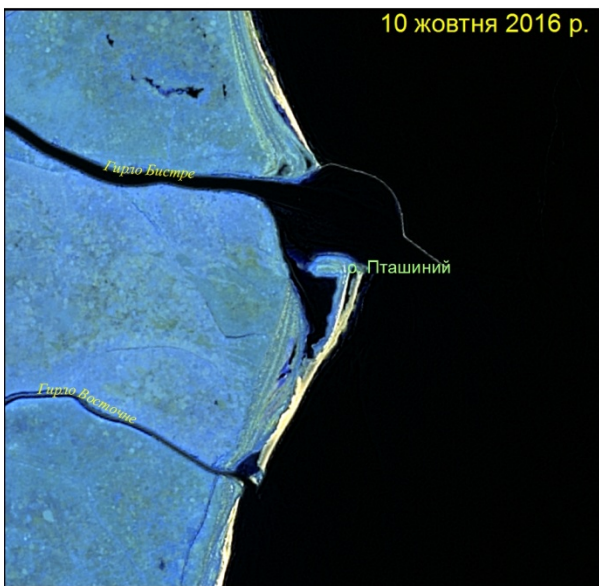
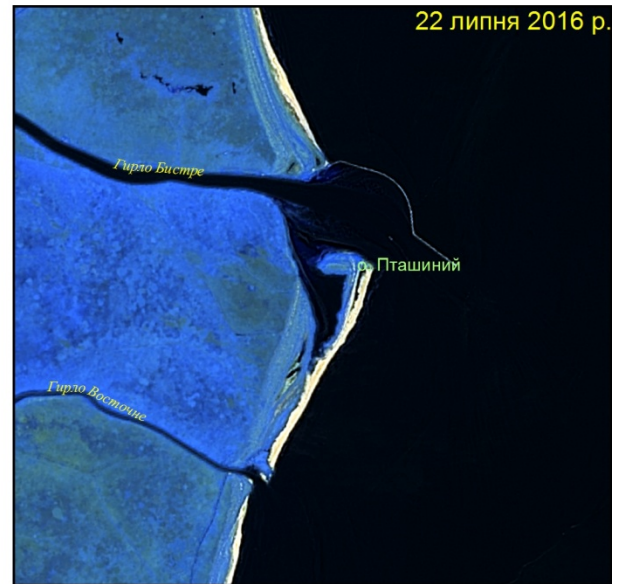
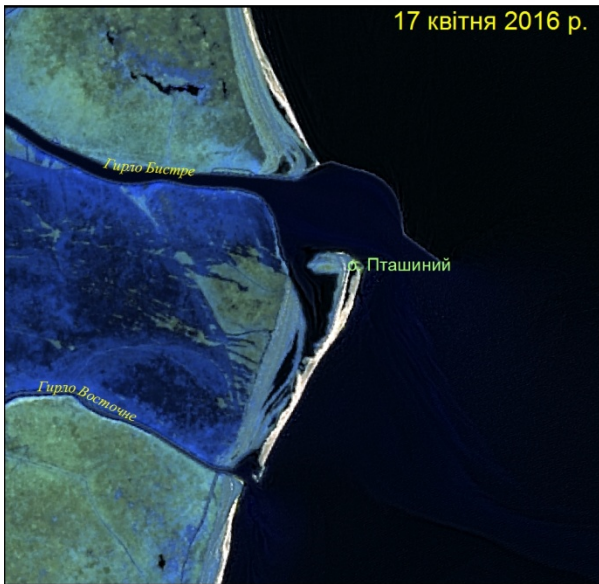
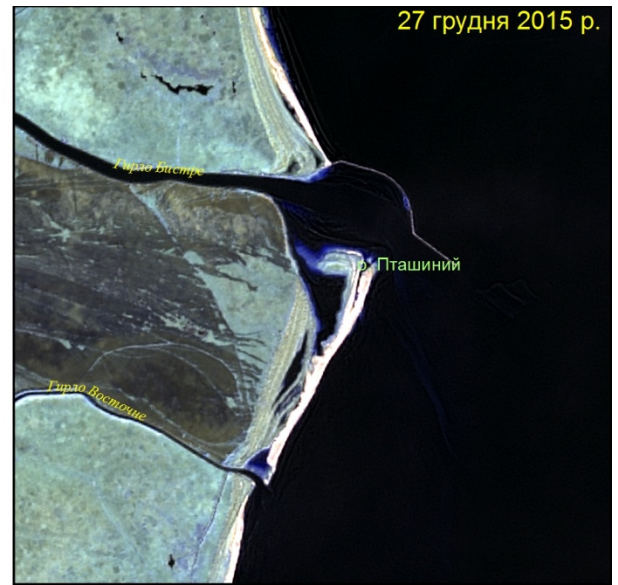
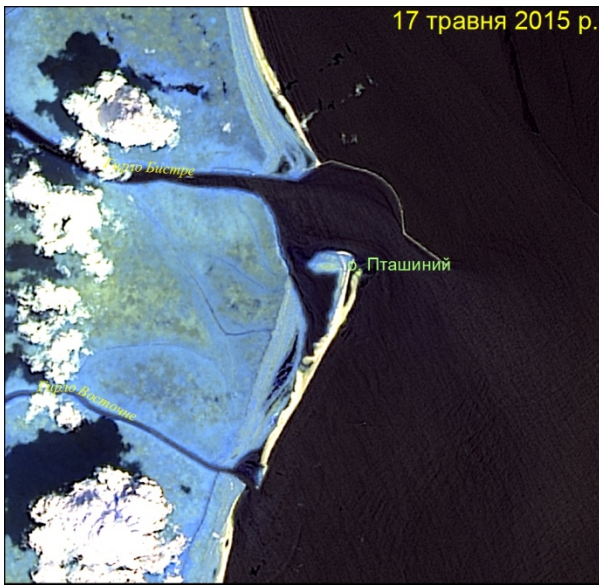


Fig. 7.2. Reconfiguring of the coast of the Ptichiy island

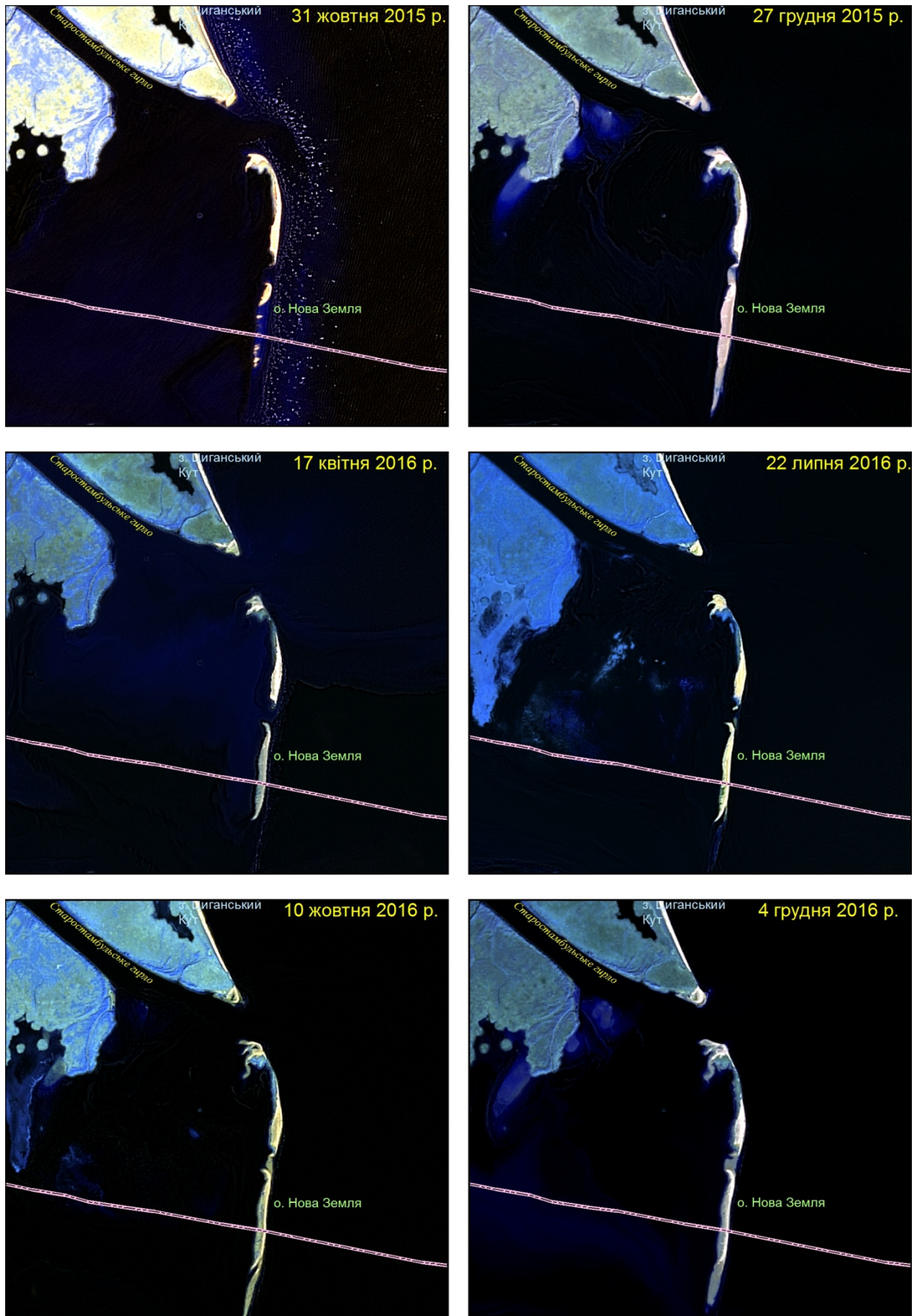


Fig. 7.3. Reconfiguring of the coast of the Novaya Zemlya island

In comparison with the period of 2010 - 2013 when the islands were scattered, the island is almost united in a single structure in 2014, which continues to grow stronger, accumulating sediments. The processes in 2014 thanks to which is actively increasing shore structures - the island, marine sand bars - slows down in 2015 the contours are not substantially changed. In 2016 the structure of the islands of Novaya Zemlya is a dynamic with long-term preservation of a trend of erosion in the first half of the year and the increase of configuration in winter.

Thus the spatial and temporal changes in the coastline of the Danube estuary under the influence of natural factors were affected by seasonal fluctuations while preserving the overall shape of the structural elements.

### **Dynamics of suspended solids**

The analysis of satellite images over the period of 2016 allow to reflect the dynamics of suspended solids of the western part of the Black Sea near the river delta of Danube. For a quantitative estimation was performed analysis and the relative concentrations of suspended solids in the coastal part of the Black Sea near the estuary of the Danube Delta were shown.

## **8. Monitoring of marine hydraulic spoil dump under the conditions of exploitation of the DWF Danube - Black Sea (CHERNOMORNIPROEKT)**

Studies have focused on the analysis of the current state of the marine environment of the area of the dump of soil, assessment of the expected scale of prevalence of contaminants in the soil at the storage conditions of dump, determination of residual volume capacity of soil dump and research of the further possibility of its use in carrying out dredging in the marine part of the DWF "Danube - Black Sea", subject to the measures aimed on increasing of volume capacity of soil and the term of continued operation of soil dump and measures aimed on minimization of the negative impact on the natural environment.

Calculation of residual soil volume capacity performed by the method of modified by automation of calculations and implementation of GIS techniques, programs and packages Sagaxis, QUANTUMGIS, Autocad Civil3d, set out in the regulations RD 31.74.07-79, 31.74.04-2002 RD, RD -94 31.74.08.

Figure 8.1 shows the three-dimensional model of the surface of the sea dump of dredging soil with hydrographic cast for 2014, 2015 and 2016.

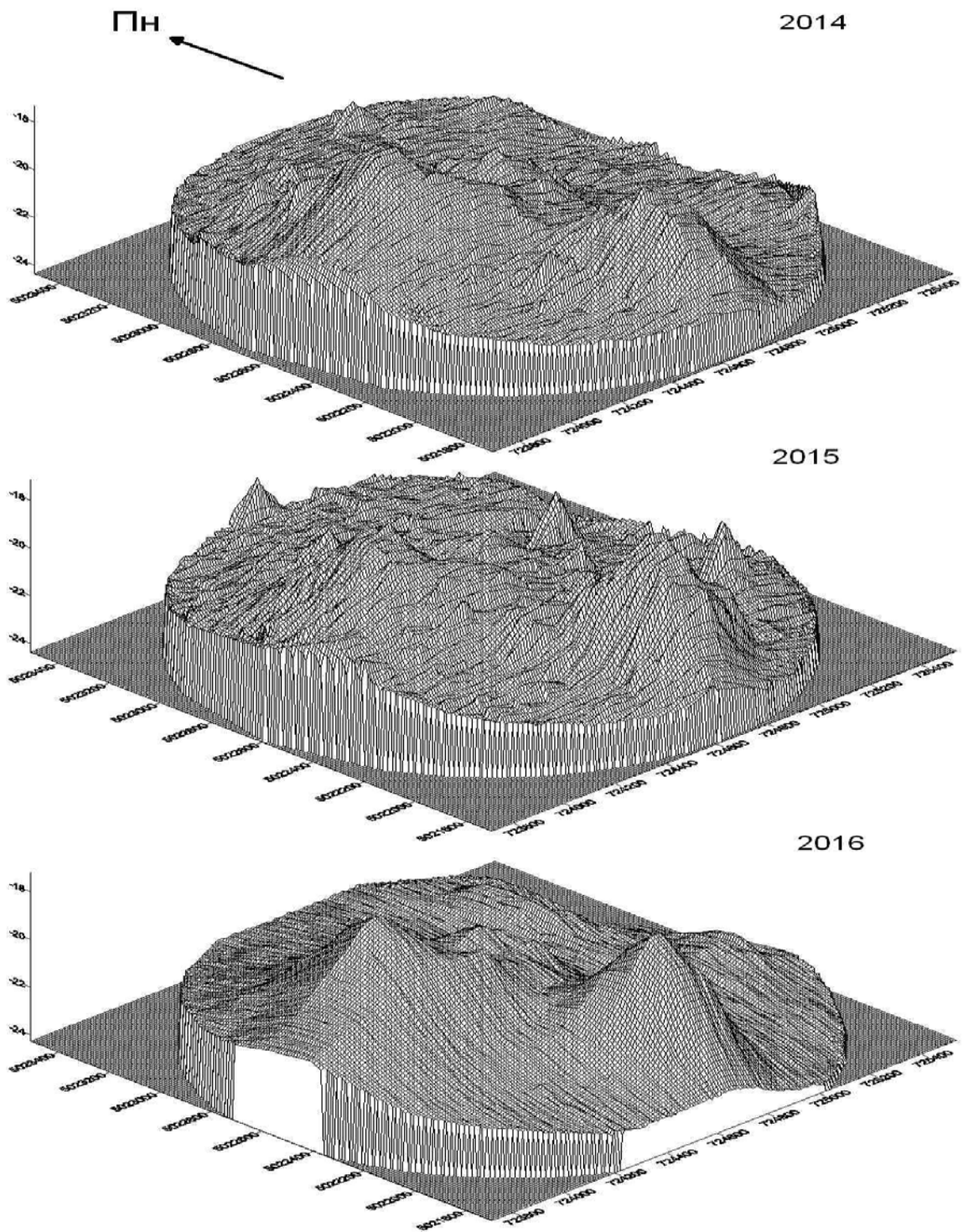


Fig. 8.1. The three-dimensional model of the surface of the DWF sea dump of dredging soil with hydrographic cast for 2014, 2015 and 2016.



## CONCLUSIONS

"The program of complex environment monitoring during exploitation, the deep water fairway Danube-Black Sea in 2016-2017 years. Area of the sea access canal " has been fully implemented in all directions in 2016.

The volume of the water flow of the Danube in 2016 amounted to 208.5 cu. km, of which Kiliya arm held 103.7 cu. km (49.7%). Through the arm Byistryiy to the sea received 39.0 cu. km of water (18.7%).

Analysis of measurements of water flow for period 2005-2015 shows that currently at the top of the Danube Delta is preserved long-term trend of decreasing of water content of Kiliya arms system which is related to the transboundary impacts of hydraulic engineering works in the Romanian part of the delta.

Carrying out full-scale hydraulic works envisaged in the second phase of the project of the DWF Danube-Black Sea - namely the further deepening of the SAC of the bars of Byistryiy arm and development of all ten shoals of the Kiliya arm to project marks is the most real opportunity to stabilize the water flow of Tulchinskiy and Kiliya arms.

Excess of quality standards for pollution for cultural and social water usage (MAC c/s) and for fishery water usage (MAC f.) observed starting from the cross-border area (observation point - R01 Danube River 71 miles above Reni). In this section of the river is systematically observed a significant excess of maximum permissible concentration of suspended solids, COD, iron, phenols.

The waters of the Danube delta, as well as in previous years above permitted contaminated with suspended solids, organic substances, nitrites, and metals. Above permitted contamination of the river water by hydrochemical parameters of pollution and pollution of sediment by metals has been observed for the cross-border area (observations point R01 Of the Danube, 71 miles).

Summarizing the research materials in 2016 may be noted that in general, significant disturbances in ecosystem condition Danube River on biological parameters have been identified in 2016.

Monitoring of plant and animal communities of the coastline and flowing of the Danube Biosphere Reserve (DBR) during exploitation of deep water fairway Danube - Black Sea in 2016 took place in accordance with the terms of reference and programs.

The biggest negative impact on natural ecosystems of the DBR, which leads to rapid and irreversible changes, is the reduction of water flow of Kiliya mouth of the Danube due to redistribution in favor of the Romanian mouths.

The results of ichthyological studies indicate that currently among the the lower Danube sturgeon fish are relatively more numerous sturgeon and beluga. This is supported by the study of slope and catches of young sturgeon received in recent years.

Investigations have shown that the area of the north-western Black Sea, adjacent to the soil storage area, remains a high-performance. Preserving of existing ichthyocomplex is an important problem that affects on the state of the commercial fish stocks of north-western Black Sea.

The direct influence of soil development and the dumping on the fish fauna is relatively low. The analysis satellite images in 2016 showed the presence of delta changes in the Danube by the processes of accumulation and erosion.

In general, the processes in 2014 thanks to which is actively increasing shore structures - the island, marine sand bars - slows down in 2015. In 2016 natural spatial and temporal changes in the coastline of the Danube estuary show seasonal fluctuations with storage of common form of structural elements.

In the sea area of dump the fototona anomalies were not observed.

The analysis of the dynamics of soil storage of dredging allowed to estimate used storage technology as appropriate. The advantage of storage conditions is recommended to provide the boot blocks II, III, IV, VII, located in the northern and north-eastern part of the sea dump.

Significant transboundary impacts from Ukraine to the Romanian territory as a result of resumption and exploitation of the deep water fairway Danube - Black Seathe are not detected.