Ecological Consequences as a Result of New Shipping Way Organization in the Danube Delta

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Practically nobody in Ukraine refute the necessity of deep water shipping (DWW) between the Black Sea and Danube River. For a long time (approx. ten years long) were hard discussions about the better variant of this way. In these discussions were involved not only Ukrainian specialists and also western experts, NGO, mass media etc. The better way or optimal variant means economic advisability of organization and using the way and the same time minimization of anthropogenic press. At present there are enough scientific facts and arguments for detail analysis the situation and final decision [1-6].

At first factor is - all kinds variants cross the area of the Danube Biosphere Reserve. The next factor is - all kinds of variants need dredging works into the sea shallow water so called bar's zone for marine entrance channel.

As for natural factors there are also two. The first one is a long term delta evolution and the second is the process of water discharge redistribution. Both of them are the natural factors. If the human influence to the first factor still limited for the second factor the influence can be unlimited. It is easy to do by jetty or dams construction.

Very important factor for DWW organization is state border between Ukraine and Romania, Biosphere Reserve location and location of the Danube cities and settlements that need an economic and social development.

There are nine possible variants of the DWW in Ukrainian part of delta (Fig.1).

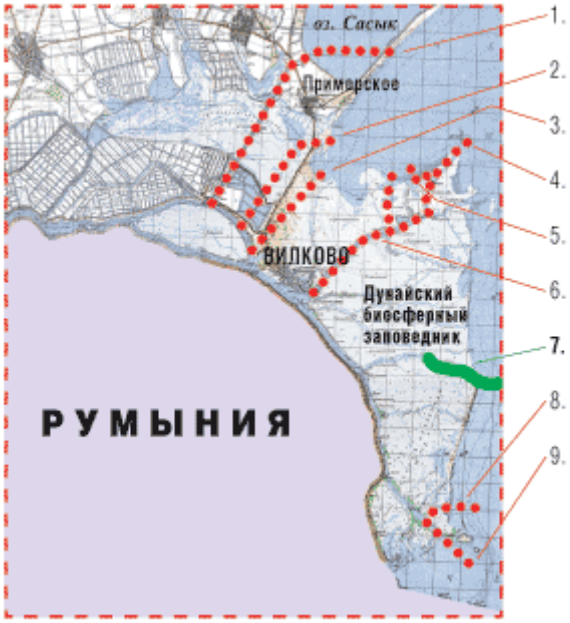

Fig.1. The different variants of the deep water shipping way between the Black sea and the danube

1. The Danube – liman Sasyk
2. Variant of engineer P.S. Chekhovich (1904)
3. Solomonov branch – Zhebryany bay engineer V.P. Zizak (2000).
4. Prorva branch
5. Connective canal
6. Ochakovsky branch – port of Ust-Dunaisk
7. Bystry branch
8. Tsyganka branch
9. Starostambulsky branch

Variant 1. The Danube – liman Sasyk (Artificial canal (as ameliorative) is in existence at present, needs dragging works inside, needs dam reconstruction between the sea and liman, needs huge bridge because Vilkovo city isolated from mainland, crossed the wetlands area of the Danube Biosphere Reserve, redistribute water discharge from the Danube up on 16,6% from the Danube run off (3000 m^3/c, 54 km, hydrological regime in Ukranian delta will change and ecological conditions will be sharply worsened (Romanian part includes). DWW using as the ameliorative artificial canal build at 80-s between the Danube and Sasik liman. The depth of the canal is 3 m and the depth of the liman is 3m also. This project supposed a giant dredging works on the land.

Variant 2. The Project of engineer P.S. Chekhovich (1904). The length of the canal is 10 km. (Artificial canal, needs the bridge, crossed the wetlands area, redistribute water discharge from the Danube).

Variant 3. Solomonov branch – Zhebryany bay engineer modern Project by V.P. Zizak (2000), Artificial canal with locks, needs the bridge -, crossed the wetlands area -, redistribute water discharge from the Danube up on 2,27%. The length of the canal is 9km. Two last variants have orientation from Solomonov arm to Zhebriany bay.

All these canals are artificial and pass via land (by the way it is the territory of Biosphere Reserve). The damage from this construction will be too high and DWW organization will be too expansive. Besides, it is planned to build a new port in Zhebriany bay with railway connection, a big bridge, because Vilkovo city turns into an island. This activity can destruct natural wetland and marine ecosystem. But the main damage is waste of water run off which will be withdrawn from the Chilia system and dropped into the sea. Hydrological regime in delta will be changed and ecological conditions will be sharply worsened. According to the project documentation the width of the canal (on bottom) is 60m, the depth is 8,5 m, so the water run off in this canal will be approx. Q= 500 m^3/c. It is the half of the natural arm Bystryy water run off. But it will be a new artificial canal and this new construction will stimulate redistribution of water run off, about 16,6% from the Danube run off (comparing with Q = 3000 m^3/c, 54 km distance from the mouth). It is very big value (16,6%) and it will provoke water decreasing in the Chilia delta (lower Vilkovo, 18 km). Besides, it will have bad reflection in the situation in Ukrainian part of delta and provoke the negative reaction to Romania because this redistribution of water run off will sharply decrease of water coming in Romanian part of delta. In case of new canal with locks the water loss will make up on 2,27%. It is also big enough value and all above mentioned problems will take place. At the same time the water run off in common (Romanian – Ukraine) Starostambulsky arm will be decreased that provokes the silting of Musura bay where the silting is one of ecological problem at present.

The second problem is shallow water in Zhebriyany bay. This bay is the part of the Danube estuary system [4] granulometric composition of the bottom sediments is identical to the other parts of the Danube – in front of Bystryy arm etc. Thus, marine canal could be much longer than in front of Bystryy arm and will be under permanent process of silting because of stationary anti-cyclone circulation in the bay [5]. All of it needs very expensive works and will change the natural conditions both in Ukraine and in Romania. The third problem is salty cline penetration

into the new artificial canal. As for new canals – Zhebriyany bay – Solomonov arm, according to the project, surplus of water in the artificial canal will make it necessary to drop it in to the wetlands. It will change hydrological and chemical balance in the wetlands and can provoke wetlands degradation.

Finally, as a result of new artificial canal construction to Zhebriany bay there is new powerful source of fresh water input. Well known that Zhebriany bay is the place for sturgeon's feeding. So, the changing of salinity regime in bay provides decreasing of forage reserve.

The other variants of DWW linked with Ochakovsky and Starostambulsky arms systems.

Ochakosky system is dying off system from geological point of view [6]. There are two arms which can be examined for DWW – Prorva arm and Potapovo arm. Ukraine has an experience using Prorva DWW during the period from1957 to1994. Exploitation of this DWW was rather expensive; the value of dragging is increasing higher and higher each year. After Soviet period in 1994 the last attempt was made to reconstruct Prorva DWW but after strong storm in autumn DWW was silted finally. Besides, Ochakovska system needs to dyke along both of shores but its construction may have strong influences on ecosystem.

The second variant in this system is Potapovo DWW. So, all problems with dyke constructions are continued besides this DWW pass throw the one of the Strict Protection UNESCO zone in Biosphere Reserve, so call iadro. Thus, according to international laws Ukraine authorities must protect this area and avoid additional anthropogenic press on this area.

For fundamental reconstruction Ochakovska system it is necessary to redistribute water discharge in inner delta. It means to construct the dam in Starostambulsky system and redistribute water to Ochakovska system. In this case ecological situation in Starostambulsky system will be catastrophic. Hydrology regime modification reflects to the animal and plant's kingdom. In the Starostambulsy mouth there is also the Strict Protection UNESCO zone in Biosphere Reserve.

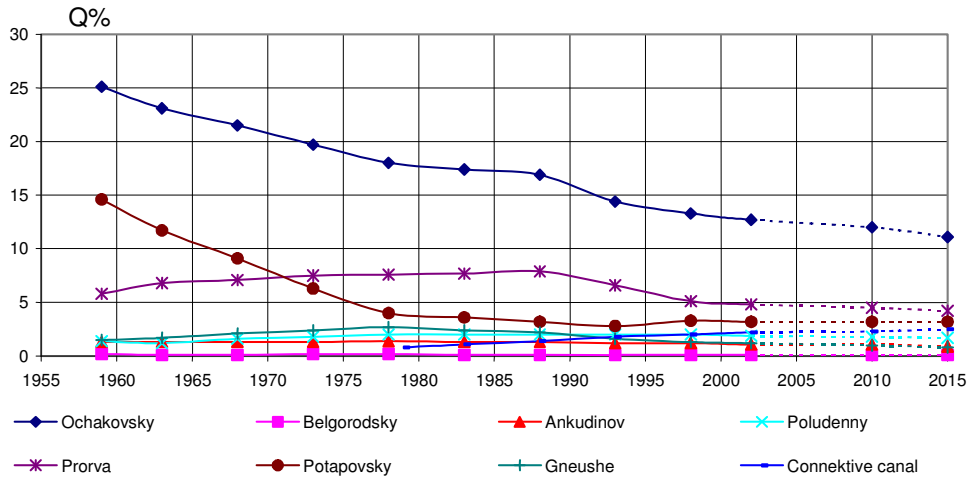

Fig.1 The water runoff distribution in Ochakovsky system (Data of Hydrometeorological Observatory, Ismail)

The last alternative variants are linked with Starostambulsky system itself. Except of Bystry arm Vostochny - rather small arm, there are two arms: Starostambulsky itself and Tsiganka arm. As well as Potapovo arm both of these arms pass through the second Strict Protection UNESCO zone in Biosphere Reserve. More than 90% "including to the Redbook" birds habitude in this part of delta – in Kurilskie islands. The second problem for DWW organization is the place of marine dumping. For DWW it is necessary to use marine dumping for permanent dragging bottom sediments. According to the hydrological regime general

direction of sea currents in this area are from North to the South, so the place of dumping must be only to the South from marine canal through the bar's zone. No doubt that dragging works on the marine canal and activity in the dumping place will make strong influence on the neighbor's (Romanian) Sulina DWW. The dumping place must be located close to Romanian state border then the silting process will take place in Sulina marine canal. It will provoke fair protest from Romanian side.

Bystryy arm and some results of monitoring of DWW organization

This part is devoted to the problems of the Ukrainian project to build a deep-water navigation canal on the Chilia delta of the Danube, following the Bystroe arm into the sea. According to opinion of many Ukrainian and foreigners specialists there is a wide spectrum of negative criticisms which taking place not only Ukrainian but and Romanian part of the Danube delta. One of the main notes is that Deep Water shipping Way (DWW) goes through the Danube Biosphere Reserve. Evidently all kinds of industrial activity are negative for the environment. However in the case of using Bystryy arm for DWW can have negative influences reflected only on marine ecosystem because not one cubic meter of bottom sediments was dragged from Bystryy arm. It was not necessary. Bysrtryy arm is one of the natural Danube branches. Natural depths in this arm are 12 – 14 m, and it is more than enough depth (8,5m) for navigation. Real dragging works took place in the open sea in front of the Bystryy mouth. The dragging had been done in the shallow water zone so called bar zone. It was the key works linked with DWW organization because of a big volume of suspended matter from the river (so called hard run off) that forms 3 km long bar zone.

TABLE 1

The volume of dragging works in DWW which was done in 2004

EXCAVATION, THOUSANDS QUBIC M		DAMPING, THOUSANDS QUBIC M	
Marine Bar's zone	1473	Marine damping	1544
Riverine bed (upper 20km)	973	Shores dumping	687
		Riverine bed dumping	215
Total	2446	Total	2446

(In a period of 2004 from 22 perspectives shores parts for dumping place, total area = 134 hectares, only 4 parts, total area 19 hectares were used – Katenjka island – 2,2 hectares, the place between 41 -39,1 km of shore side – 7 hectares and Ermakov island – 9,7 hectare. The analyses of dragging bottom sediments had been done by independents experts in Geneva University and shown non high level of pollution concentration [3])

The principal question is: what kind of this new marine canal (3 km long and 8,5 m deep) influences to the marine ecosystem and will be water run off redistribution in the whole delta as a result of canal construction? This main question is very important for Ukrainian delta riverine ecosystem and Romanian as well. A priori many scientists approved that water run off redistribution will take place, so the damage will be done to Bilateral Biosphere Reserve. But it is only assumption. The direct scientific observations and analyses show the inverse situation.

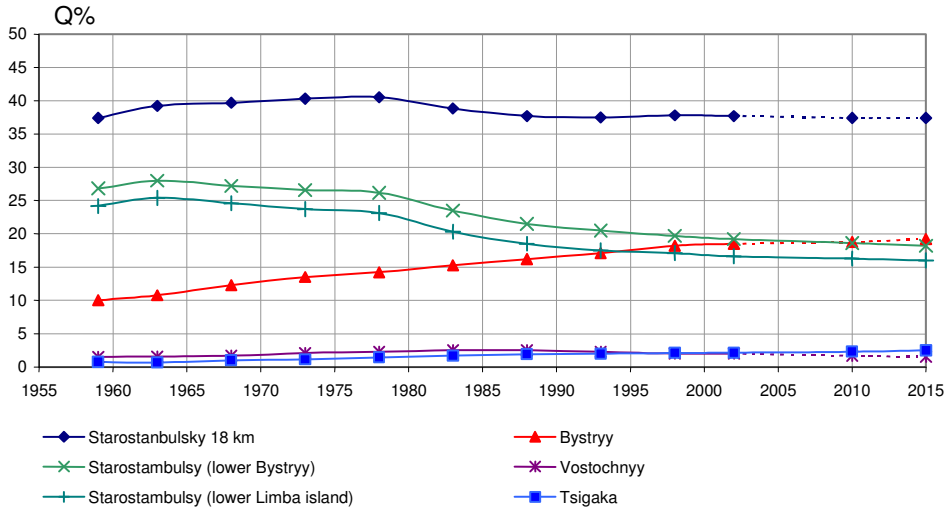

Fig.1 The water runoff distribution in Starostambulsy system (Data of Hydrometeorological Observatory, Ismail)

According to numerical (modeling) calculations [1] dragging in the bar's zone in front of the Bystryy has very weak reflection to the run off distribution in the Chilia delta. At mean water period the water run off in Bystryy arm can increase up to 1 – 2 m^3/c only under dragging in the bar's zone canal up to 7 – 9 m deep. At the same time there is no influence of dragging to the other Chilia arms. Moreover, in a period from March to December 2004 additional and quickened of water run off measurements in Bystryy, Starostambulsky and Ochakovsky arms had been done by Danube Hydrometeorological Observatory (Ismail, Ukraine) in frame of complexes monitoring Program. The results are: no increasing of water run off in Bystryy arm, the tendency of decreasing water run off in Starostambulsky (lower Bystryy) and Ochakovsky goes on in 2004 [2].

There are some questions linked with the process of works in a period 2004 in marine canal, marine jetty and dumping place. Unfortunately the results of ecological monitoring were not published in national Ukrainian press. At the same time monitoring had been started parallel with start of engineering works in the sea (May, 2004) in the place of works in front of Bystryy arm. But the results were published only at the beginning of 2006 [2].

At the beginning of the dragging marine navigate canal opposite the arm Bystryy the special complex of investigations had been done. The place of work is coastal shallow water zone, so called – bars.

So, the sampling was done in the open sea directly near the places of bottom sediments dragging and damping. The general direction of suspended matter transportation was determined by marine current meter. The sampling was done in 5 different layers by bathometers. The same investigations have been done in additional three stations in the distances 1 and 15 km from damping place to the South and 18 km – to the North. Suspended matter concentrations on the surface and near bottom layer are shown in Fig. 1-2. The results of investigations give the opportunity to estimate spatio-temporal scale of suspended matter distribution i.e. anthropogenic influence to marine ecosystem. In our case there were marine dragging ships Josef Möbius and M-30.

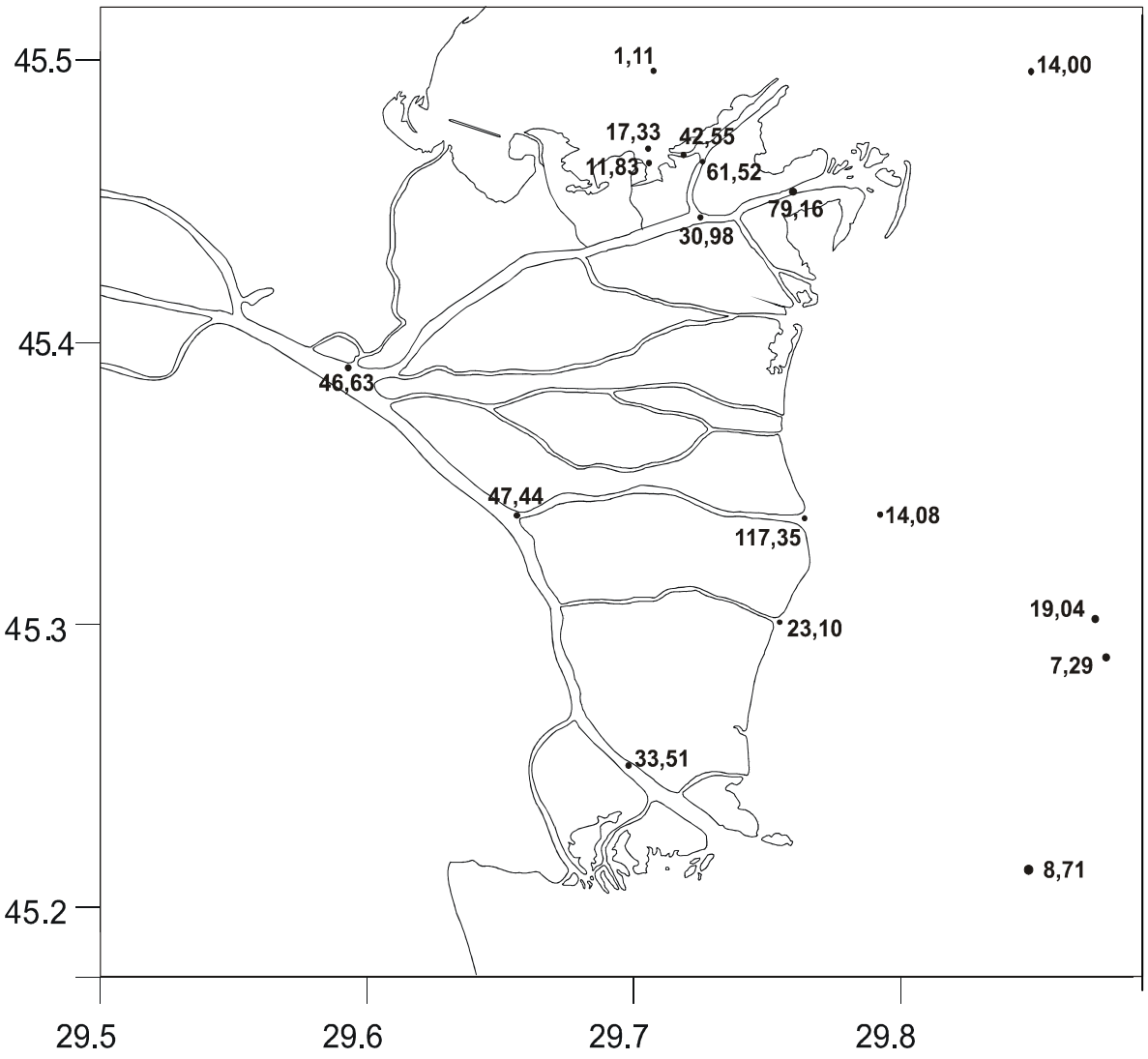

Fig 2. Suspended matter distribution (mg·dm^{-3}) on the surface in the Danube estuary (25 – 28, May, 2004)

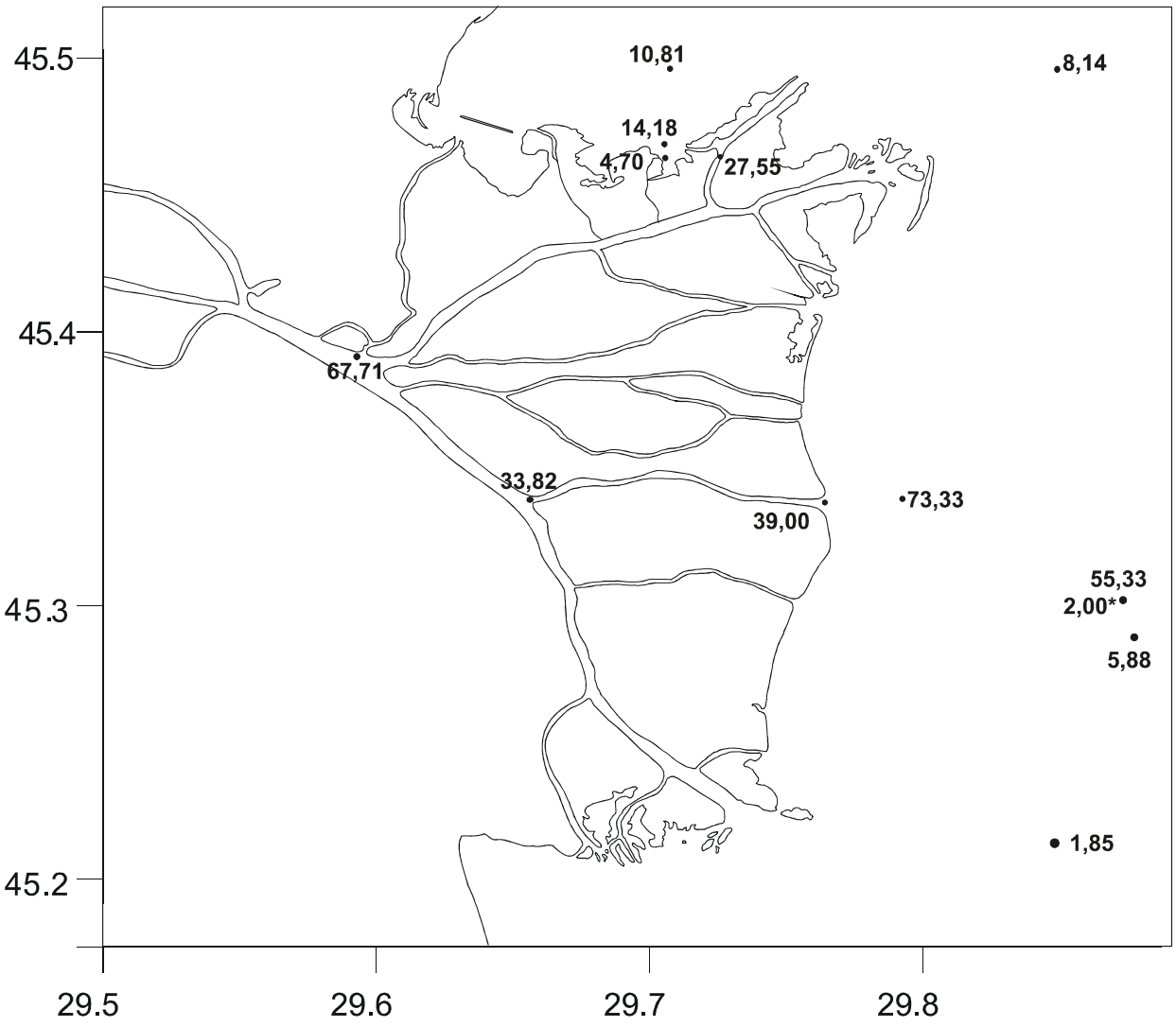

Fig. 3. Suspended matter distribution (mg·dm^{-3}) near bottom layer in the Danube estuary (25 – 28, May, 2004) (* - concentration of suspended matter 50 minutes later after local damping process)

Near the places of bottom sediments dragging by "Josef Möbius" max concentrations of suspended matter were near the bottom layer (the depth of sampling is 9,6 m) and achieves 73,33 mg dm^{-3} . In the center of damping place - 45º19'13"N, 29º51'58"E (this is the circle with 1 marine mile diameter and 7 inner segments for special technology infill) in a distance of 150 m from real damping ten minutes later the damping process showed the concentrations near bottom layer 55 mg dm^{-3}, but 50 minutes later it decreased to 2 mg dm^{-3}. It illustrates short-term influence of works to the marine ecosystem.

Directly in the point of damping max concentration – 61,56 mg dm^{-3} had been fixed near bottom (depth – 22m). At the same time on the surface concentration was 5,89 mg dm^{-3}, on the layer 15m deeper concentration was 8,25 mg dm^{-3}, i.e. upper 15 m in the water column the influence from the damping process wasn't marked. This important fact is the evidence of sparing working technology used by German specialists of "Josef Möbius" company and the place of marine damping location was chosen correctly. Damping operation takes place just in near bottom layer and the development of seasonal termo- and halocline (see table 1) is restrict the suspended matter distribution to the upper layers and concentrates the cloud near bottom. It minimized the negative influence of suspended matter to phyto- and zooplankton in the most of

pelagian part of the sea. Loss of water bio-resources for phyto- and zooplankton is limited only by near bottom water column 5 – 7 m thickness.

For estimation of spatial distribution of suspended matter as a result of damping and dragging in the sea coastal zone opposite the Arm Bystryy and for comparing with common condition of marine ecosystem the control point (station) had been done in a distance 16 km far to the South, opposite the Arm Starostambulsky – 1 km long from the marine border with Romania. The concentration of suspended matter was 8,71 mg dm^{-3} on the surface and 1,85 mg dm^{-3} – near the bottom (the depth of the station is 20,5m). It's very typical natural characteristics of suspended matter for this region. The distance from the mouth of the Starostambulsky arm is 9 km and concentration of suspended matter in the mouth is 35,33 mg dm^{-3}. So, it has been proved that marine works in the Bystry region does not influence the neighbor country area.

Additional control measurements have been done at a distance of 18 km to the North from the damping place opposite the arm Potapovsky – 3 km far from the mouth. The concentration of suspended matter was 14,00 mg dm^{-3} on the surface and near bottom (19 m deep) – 8,14 mg dm^{-3}. It means that there is no influence of dragging and damping in this region also.

The next measurements have been done in the point (station) 100m further from the dragging machine M-30 according to general direction of marine currents. There was integral transportation of water masses in the column 0 – 2 m to the North – West direction under stable South – East wind with 10 -12 $m \cdot c^{-1}$ velocity. In a period without M-30 activity (when dragging machine does not work) concentration of suspended matter was 11,05 mg dm^{-3} on the surface and 34,21 mg dm^{-3} - near bottom (2 m deep). In a period of activity of the dragging machine the concentration near bottom increased up to 316,30 mg dm^{-3} , at the same time on the surface concentration of suspended matter increased slightly – up to 15,50 mg dm^{-3}. Following according to the general current (transportation of suspended matter) 450 m far from the place of work the integral concentration in the water column (0-1,5m deep) was 25,61 mg dm^{-3}. At a distance of 800 m from the place of work opposite the Ptichy island concentration on the surface was 28,63 mg dm^{-3}, near bottom – 36,86 mg dm^{-3}. It is comparable with average long-term concentrations of suspended matter in this estuary region (25-30 mg dm^{-3}) because of influence of the Bystryy arm itself. In a period of investigation in the Bystryy mouth the concentration 117,35 mg dm^{-3} on the surface and 39,00 mg dm^{-3} near bottom was fixed. For instance the average long–term concentration in the Bystry mouth is 90 mg dm^{-3}.

The main conclusion is the influence of anthropogenic (technologic works) in the shallow waters coastal zone near the arm Bystryy is limited by area not more than 1 km long.

During the 2004 period of work 1,1 mln, cubic m of pulp to the damping place has been carried out. Pulp density is 1,6 $ton \cdot m^{-3}$, it is 700 thousands ton, if it is recalculated to the dry weight. Granulometric fractions of ground with practical sizes less than 0,005 makes up max 5% or 35 thousands ton. Only these fractions can be transferred to the considerable distances. Thus, if the diffusion and dispersion processes are ignored and suppose that all matter arrives in Sulina canal its amount is less than 1% from its hard river runoff.

Conclusions:

1. All kind of alternative variants of DWW are dangerous for ecological condition of Chilia delta because considerable part of fresh water will be withdrawn from Ukrainian part of delta (upper 20 km) and it will provoke degradation of living condition for water plants and animals in the delta and Biosphere reserve including. The other Projects are directly linked with strong influence on the zones under strict protection (UNESCO) in the Danube Biosphere reserve. So, safest project is Bystryy DWW, because its conditions created by nature itself and don't need additional artificial constructions. Ukrainian DWW in Starostambulsky arm can be the reason of ecological and economic problems for Romanian side (silting of Sulina DWW).

2. As a result of ecological monitoring it was established that dragging in the marine bar's zone doesn't influence to the fresh water redistribution in the Danube river system.

3. Direct measurements have shown that suspended matter as a result of dragging works and dumping activity in the marine ecosystem is limited by the distance not more than 800 m long and can't achieve Romanian border (20 km far from the Bystryy).

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