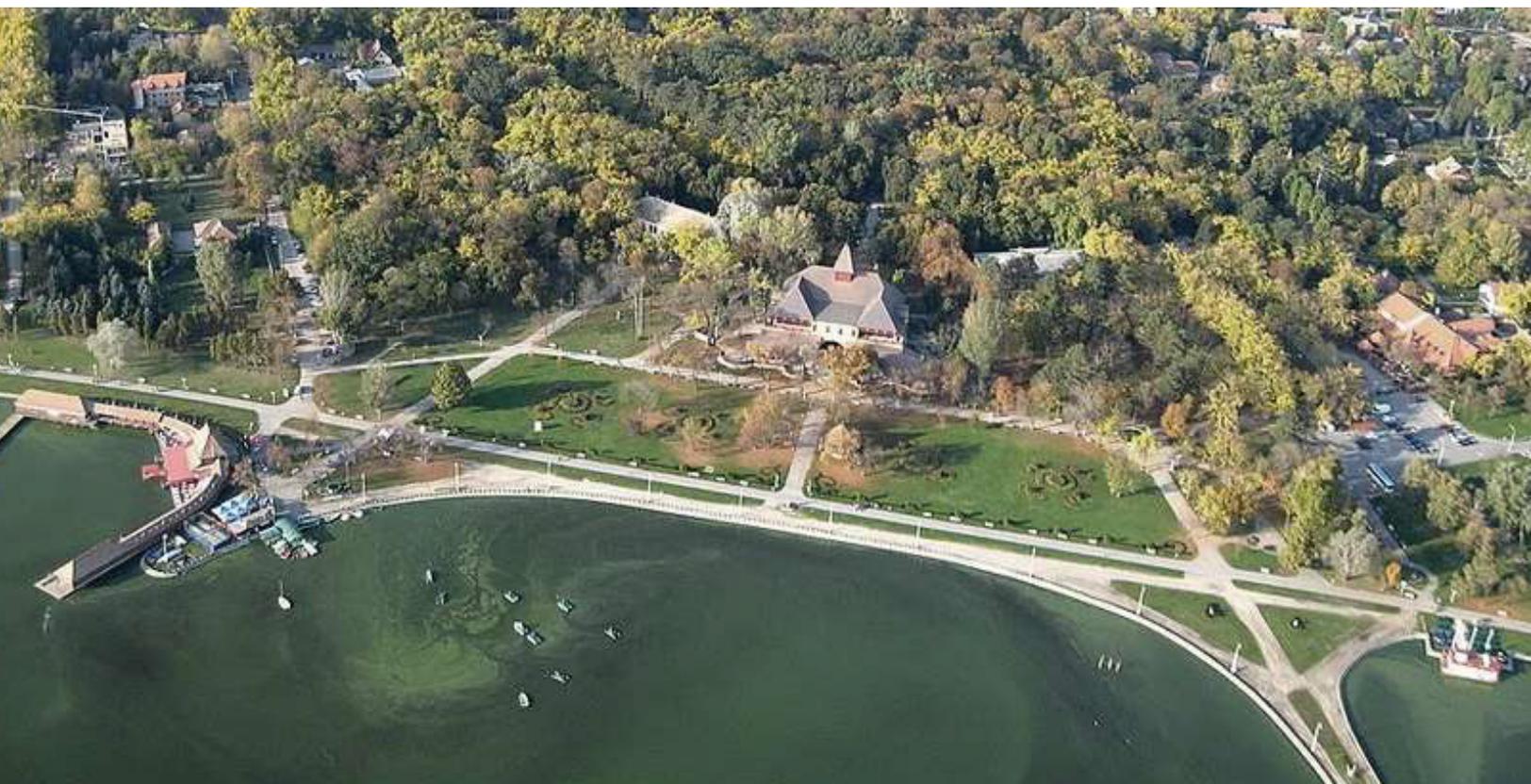


# Plan for the improvement of the ecological condition of Lake Palić and its surrounding

Subotica, July, 2014



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## I Introduction

Lake Palić is a significant resource for the development of the local community in Subotica. Decade-long influence of a number of unfavourable factors (absence of appropriate management, inflow of insufficiently treated or untreated wastewaters, agricultural activities and etc.) brought deterioration of the lake water and related biological communities. As a result thereof, our reality is that possibilities for the development of the resource are rather limited and in case of certain segments, totally impracticable.

The need for the improvement of biological, chemical, visual and other characteristics of the aquatic ecosystems (and thus Lake Palić) as well as the improvement of their sustainable development is clearly emphasised in a series of strategic documents adopted by Serbia in the previous years. Let us point out only some of them: National Sustainable Development Strategy (“Official Gazette“, No. 57/08), National Environmental Protection Programme (“Official Gazette“, No. 12/10), Biodiversity Strategy of the Republic of Serbia for the period 2011-2018, National Strategy for Sustainable Use of Natural Resources and Landscapes (“RS Official Gazette“, No. 33/12, Tourism Development Strategy of the Republic of Serbia, Water Supply and Water Protection Strategy in the Autonomous Province of Vojvodina, etc. In addition, Serbia is a signatory to the European Landscape Convention (Law on Ratification of the European Landscape Convention, “RS Official Gazette“– international agreements No. 47/11).

The area of Palić Lake is under protection of the City of Subotica as a conservation area of local importance – category III, named Nature Park «Palić» (Decision on Proclaiming the Conservation Area Nature Park «Palić», “Official Gazette of the City of Subotica“, No. 15/13 and 17/13-correction.).

At the initiative of the City of Subotica, in order to commence solving the problem of bad quality water and biological communities related to Lake Palić, in 2009 a working group was appointed with the task to provide conditions for the preparation of the project for the Palić Lake ecological restoration and remediation.

In line with the required project task, the Institute “Jaroslav Černi“ from Belgrade did a study titled “Feasibility Analysis of Cleaning up the Sludge from Palić and Ludaš Lakes“ (hereinafter: Feasibility Study) which, based on the collected data and review of technical documentation, proposed three versions of the solution for removing the sludge from Lake Palić. The Working Group, appointed by the Mayor's Decree II-021-22/2009 adopted the Version 1, which was the cheapest and entails internal allocation of sludge within the body of water by using hydraulic pumps. Based on the solution, yet another study was done “Return on Investment Study of whether a Planned Project Justifies cleaning up the Sludge and Remediation of Lake Palić“ as well as “Study of Environmental Effects of Cleaning up the Sludge and Remediation of Lake Palić“ (hereinafter: Study of Environmental Effects). An important segment of the Study is the proposal for the construction of wetland in the Sector II, which is to ensure additional treatment of wastewater from the municipal wastewater treatment plant (hereinafter WWTP).

The Administration of the City Subotica appointed the Technical Committee to assess the Study and the Committee gave positive opinion thereof but also pointed to drawbacks that could be a big risk to environment. The Study of Effects was open to public inspection which resulted in a number of objections and suggestions. Thereupon,” Master Project for the

Construction of a Locker for the Disposal of Sludge and Remediation of Lake Palić“was developed and in March, 2013, the Building Department delivered the Decision No. IV-04-I-351-19/2013 to the investor DOO «Park Palić», which clears works on cadastre lots 2530/1, 2511 and 2523/1 of the Cadastre Municipality Palić.

The environmental study ascertains the following: *“Prior to commencing the process of cleaning up the sludge and remediation of Lake Palić, it is necessary to attend to all existing sources of Lake pollution (wastewaters from the settlement of Palić, canals that discharge untreated water into the lake, point source pollution and alike) in a sanitarily and technically adequate manner, which is a responsibility of the local self-government..“* (Feasibility Study with the preliminary design of cleaning up the sludge and remediation of lake Palić, p. 95) and specifically emphasises *„...Based on the previously stated, it is clear that it makes no sense to commence the process of cleaning up the sludge and remediation of Lake Palić until such time as WWTP starts functioning in accordance with the projected operating regime and every point source pollution is accumulated, appropriately treated and transported to the final recipient, which are also activities that fall within the scope of responsibilities of the local self-government.“*; p. 84).

That is the reason why, following the preparation of the above-mentioned Study, the local self-government and competent enterprises started an overall review of measures that should be implemented in order to improve the state of Lake Palić, through informal working bodies that gathered local experts in different fields. At that point, different versions of working documents were drawn up which defined certain necessary measures and pointed to the fact that the removal of sediment from the lake would not solve key problems related to the water quality.

In January 2014, pursuant to the Decision No. II-021-6/2014, the Mayor of Subotica appointed the Working Group to take stock of different solutions to the problem of improvement of the ecological condition of Lake Palić and restoration of the landfill “Aleksandrovačka bara“.

Working Group has reviewed available documentation and draft versions of documents related to the improvement of the condition of Lake Palić and defined the platform for the improvement of the ecological condition of Lake Palić and its surrounding accordingly.

Following the public inspection and open discussion, acknowledgment of objections made by experts, the term “ecological status“ in the title has been replaced with the term “ecological condition“ in order to avoid confusions related to the meaning of the term “ecological status“ in the context of water regulations.

The Platform aimed at taking stock of the condition of Lake Palić, proposing measures for the improvement of the condition of Lake Palić and its surrounding as well as defining activities whose coordinated implementation will lead to target results.

## II State of the Biological Community of Lake Palić and its Catchment Area

Lake Palić is the largest lake in a series of shallow lakes on the border of the Subotica-Horgos sands and Bačka loess plateau. Once medicinal water and sludge of the alkaline steppe lake boosted the construction of a spa and park in the 19th century. Wastewaters from the city of Subotica, which remained either untreated or have not been adequately treated for decades, fed Lake Palić and brought drastic changes to its ecosystems. Today, the water from Lake Palić is hypereutrophic.

**Eutrophication is the ecosystem response to the addition of nutrients** (*trophos*= food), primarily salts from nitrogen and phosphorus. Increase in the content of nutrients in water causes excessive growth of certain autotrophs (cyanobacteria, algae and tracheophyta). Eutrophication is the problem particularly present in coastal and inland waters that can be inhabited by a huge abundance of phytoplankton (algae), which leads to reduced water clarity, ecosystem deterioration, reduced concentration of dissolved oxygen in water at night and fish kills. In addition, certain species of cyanobacteria (blue-green algae) release toxins that could be harmful to animals and humans, while some other species of cyanobacteria enrich water with excess nutrients through atmospheric nitrogen fixation.

Lake Palić is strategically managed with the view of creating conditions for the reception of water from the municipal treatment plant and preservation of spa tourism. Due to the impact of point and non-point pollution sources, which are an additional source of nitrogen and phosphorus salts, the quality of water in Lake Palić and related biological communities evidently deteriorated over the years. Sources of nutritive salts are mostly found in wastewaters and agricultural activities.

A detailed account of biological communities and their condition is given in a Study "Nature Park Palić – Proposal for Legally Regulated Protection as a Category III Type of Conservation area" (Provincial Institute for Conservation of Nature, 2011 (The Study is available at [www.pzzp.rs](http://www.pzzp.rs)).

### **III Measures for the Restoration and Improvement of the State of Lake Palić Biological Communities**

A pre-condition for the improvement of the state of the Lake is significant decrease of nutrient feed (nitrogen and phosphorus salts) into the lake and, within the context, **preventing further pollution of the Lake is a priority measure compared to every other measure.**

Nutrient sources mostly originate from wastewaters and agricultural activities in the Lake Palić catchment area.

In order to provide conditions for the exploitation of this important resource for tourist, sport, recreational and scientific purposes, the broader community too has to take part in complex measures that have to be implemented.

In the previous period, the prevalent opinion was that the removal of sediment (“desludging“) was the only way towards the “recovery“ of the Lake and that the removal of sediment would solve all problems concerning the water quality.

However, owing to the fact that the aggregation of sediment is only one of the factors that affect the water quality as well as the fact that sediment appears as a consequence of other activities that affect the water quality, a comprehensive approach to the problem solution is of utmost importance.

Activities have to aim at the following:

1. Preventing further pollution of Lake Palić,
2. Improving the management system of Lake Palić and its surrounding,
3. Eliminating consequences of previous negative impacts on Lake Palić
4. Monitoring the quality of water and biological communities in Lake Palić

All of the above-mentioned include a series of important measures that have to be simultaneously implemented and the order they are set out in the Platform does not necessarily relate to their priority.

## 1. PREVENTING FURTHER POLLUTION OF LAKE PALIĆ

Prior to commencing restoration or revitalisation activities at Lake Palić, the most important sources of the ecosystem deterioration and burden along with pollutants and nutrient feed into the Lake must be reduced to a minimum.

It proved that, from the perspective of recipient i.e. Lake Palić, the problem has not been solved in a satisfactory way, despite the fact that the negative impact of the up to then prevalent polluter of Lake Palić (wastewater treatment plant of the City of Subotica) was significantly reduced. Despite the fact that the municipal wastewater treatment plant operates in accordance with projected parameters (phosphorus, biochemical oxygen demand, chemical oxygen demand, suspended substances), the state of Lake Palić shows that it is still an important source of nutrients (phosphorus and nitrogen compounds). Furthermore, additional efforts have to be put in reducing negative impacts of other sources on the Lake. Every activity aiming at the restoration and revitalization of Lake Palić makes no sense unless all important sources of the ecosystem deterioration and burden are eliminated.

### 1.1. Increasing Efficiency and Ensuring Stable Operation of Wastewater Treatment Plant (WWTP)

**Problem description:** Treated waters of the City of Subotica that are fed into Lake Palić following the treatment in WWTP are the basic water supply source for the Lake. The Lake has the capacity of 10 million cubic meters (m<sup>3</sup>) and 10 to 13 million cubic meters (m<sup>3</sup>) per year are fed into the Lake from WWTP. The plant is designed in accordance with the EU standards (1 mg/l phosphorus, 10 mg/l nitrogen, 30 mg/l suspended substances, 20 mg/l biochemical oxygen demand<sub>5</sub>, 125 mg/l chemical oxygen demand – EU Directive on Water 2000/60/EC and Directive on Urban Wastewater Treatment 91/271/EEC) and operates in accordance with its projected regime. The above-mentioned maximum approved concentrations refer to sensitive fields. However, it is well-known that similar sensitive water recipients require even stricter standards when it comes to values of effluent discharge parameters. As regards stricter limit parameters, limit guidelines applicable to Lake Bodensee-Richtlinien can be a good example thereof (0.3 mg/l phosphorus, 15 mg/l biochemical oxygen demand, 60 mg/l chemical oxygen demand) as well as the Water Supply and Water Protection Strategy in the Autonomous Province of Vojvodina. Dutch recommendations advise the following for the maximum tolerable values of effluent quality risk (MTR): 0.15 mg/l phosphorus and 2.2 mg/l nitrogen (Source: Jaroslav Černi – Feasibility Study with Preliminary Design of the Project for Cleaning up the Sludge and Remediation of Lake Palić p. 95). The fact that this is the Pannonian shallow saline and steppe lake should be taken into account when adjusting to particularities of the recipient.

Previous experiences show that an important factor that affects performances of the water treatment plant is the large quantity of water rich in pollutants that is released from the municipal sewage network into the treatment plant (periodically) over a short period of time. It is difficult to establish the origin of these wastewaters due to the structure of sewage collection network and in compliance of certain users of the public sewage system with regulations (sewage tank lids are difficult to access, industrial water not separated from effluents and alike). Those can seriously disrupt the process of water treatment or even cause the wastewater treatment plant to stop operating.

**Activities:** It is necessary to consider measures for the improvement of efficiency and stable operation of the municipal WWTP and establish limit values that output water has to comply with. Wastewater treatment plant could meet stricter limit values set for the water quality without large investments, provided that the monitoring of public sewage users and implementation of obligatory water pre-treatment measures ensure input water not to depart from projected values. In order to obtain the required total phosphorus value of 0.3mg/l in the treated water only by means of biological treatment, the following steps are recommended:

1. Ensuring strict implementation of regulations that regulate wastewater discharge into the public sewage system in accordance with the Law on Waters, Law on Integrated Prevention and Monitoring of the Environmental Pollution and Provision on Limit Emission Values of Contaminants into Water and Deadlines for Reaching them (measuring the quantity and quality of waters discharged into the public sewage system, adhering to obligatory pre-treatment of water until reaching the set values and etc.). The absence of mechanisms for the adequate implementation of the regulations (due to their mutual inconsistency and unclear definition of competences at different levels of authority) results in an uncontrollable wastewater discharge into the public sewage. In order to prevent future accidents, polluter cadastre should be set up and strict control of potential polluters should be imposed. Mechanisms for the implementation of penal provisions for the departure from maximum tolerable values should also be established. One of the preconditions for this step is the revision of the present Decision on Public Sewage of the City of Subotica.
2. Procurement and installation of a sand washer. At the entrance into the WWTP the standard sand catcher is installed whose main function is to remove sand from wastewater. However, during small-scale flows in dry periods, sand catcher extracts certain amount of organic matter too. This organic matter is important for the efficiency of biological treatment. If the sand washer is installed, the organic matter will be re-introduced in the treatment process, thus improving the efficiency of denitrification i.e. reduction of the total nitrogen content in the water discharged into Lake Palić.
3. Improvement of the WWTP maintenance system. To a large extent, sustainable water quality depends on the functionality of the installed hydro-mechanical equipment, measurement and regulation devices and control system. Maintaining these elements continuously functional is directly related to so called cold reserve – equipment that is kept in a storeroom. Based on the experience with similar WWTP, the value of cold reserve is to amount to around 1% of the total value of the investment. As regards the given plant, since the device was put into operation, the value has amounted to only 0.2 %.
4. Providing frequency regulation on sludge recirculation pumps. The implementation of frequency regulation on sludge pumps would ensure the number of microorganisms that are part of the treatment process to be kept at the optimal level. Anticipated results of the improvement pertain to more sustainable quality of treated wastewaters.
5. Installation of a mixer in the old aeration pool. Concluding from the present WWTP capacity exploitation, the effects of aeration in the old aeration pool are scarce. In order to improve effects, mixers are required to make the treated water flow optimal.
6. Introducing new technological processes on the water line. Following the implementation of other measures aiming at the reduced inflow of nutrients into the lake, possible introduction of new technologies (and their economic sustainability) on the water line should be taken into consideration, targeting the adjustment to specific recipient (shallow lake of the Pannonian region with steppe-saline bed characteristics). Worldwide and in outstanding

circumstances, membrane filtration is increasingly used. Any other contemporary method would do provided that it meets particularities of the lake.

## 1.2. Solving wastewater problem in the area of the Lake Palić settlement

**Problem description:** The settlement of Palić has the population of around 7700 and is situated on the lake shore. Its sewage network is only partially constructed (1015 households and 50 business facilities are network connected, while the majority is not). Most of the households that are not network connected use (permeable) cesspits, while some buildings have either direct or indirect feed into the lake (through Tapšin canal). Permeable cesspits have a very negative impact on ground waters and thus Lake Palić too.

The existing sewage system in the settlement of Palić just collects wastewater but the network is not connected to WWTP and untreated wastewater flows into Lake Ludaš through «Palić-Ludaš» Canal. The proposed system solution for the waters would be to transport them to the municipal WWTP, which due altitude variations, would involve the discharge water transport in one segment thereof.

**Activities:** Completion of the sewage network around Lake Palić and connecting it to the municipal WWTP, which would include the following:

1. Connecting the Palić sewer pipes to the municipal network and transport of all wastewaters into WWTP. The municipal network covers the area up to the building of "Metro". Connection of the settlement of Palić sewage would provide additional quantities of water that would in turn better the exploitation of the WWTP capacities.
2. Completion of sewage network of big polluters (weekend homes, ZOO, Kanjiža Road, Solun, Lovran, Rit, Toričelija and Veliki Park Streets, west coast of sector IV and surrounding farm houses by the lake).
3. Establishing mechanisms that are to ensure obligatory connection of all buildings (public companies, homes, hotels, farm houses and other facilities in the Lake catchment area) to the sewage network, including the system of incentives and subsidies.

Sewage network development works and discharge line construction works have to be well-coordinated in order to avoid en masse connection to a newly-built sewage network before the discharge line becomes operational because it might lead to additional pollution of Lake Ludaš.

This method of wastewater treatment (planned according to present plans and design documents used for the reconstruction of WWTP) is just a temporary solution implemented for economic reasons.

From the perspective of natural resources protection, implementation of water regime and preservation of the water quality in Lake Ludaš, a long-term treatment of wastewaters should be based on the separate treatment of wastewaters from Lake Palić (that would provide larger quantities of water for Lake Ludaš, due to reduced evaporation, as well as the better quality of discharge from Sector IV).

## 1.3. Relocation of landfills for the Sewage Sludge Disposal from the Municipal Wastewater Treatment Plant (WWTP)

**Problem description:** Since there is no adequate location for the disposal of sewage sludge from WWTP, it is partially deposited near the Lake Palić shore wherefrom nutrients irrigate back into Lake Palić. Sewage sludge is examined and classified. It is placed in the category of non-hazardous waste and around 3000t of it is produced annually.

**Activities:** Finding the appropriate and economically sustainable solution for the disposal of sewage sludge from WWTP and reducing negative impact on the environment. Long-term disposal of surplus sewage and dehydrated sludge is the present project funded by the EBRD loan to the City of Subotica i.e. Public Utility Company "Water Works and Sewerage" Subotica. The Project is divided into two stages. The first stage includes the preparation of a study of excess sludge management on the wastewater treatment line and the drinking water treatment line at Water Intake I. The second stage of the Project deals with drawing up a preliminary i.e. master plan related to the selected solution for further disposal and/or treatment of excess sludge aggregated in WWTP in the settlement of Subotica.

One of the possible solutions is the disposal of sludge by means of phytoremediation (for example the method of using hybrid trembling aspen trees, which the Institute for Lowland Forestry in Vojvodina still examines).

Until the long-term solution is found, a new location for temporary disposal should be found while the present waste site, which is by the lake shore, should be closed.

#### **1.4. Closing the Landfill "Aleksandrovačka bara" and Restoring the Area in-between Lake Palić and the Landfill with the View of Preventing Pollution from Landfill Leachate**

**Problem description:** In the past, during the periods of high water level, the area in-between Aleksandrovačka marsh and Lake Palić was full of water thus making a whole with Lake Palić. By pulling back the portion of water and draining the area by the railroad, Aleksandrovačka marsh was separated from Palić, while the marshy soil remained in-between. At the end of the 1970s, the site became home for municipal waste and has been used as such since. The landfill covers the area from the remains of Aleksandrovačka marsh to the Budapest-Belgrade railroad, while east to the railroad, towards Senta road, lagoons and sludge basins were formed, which have continuously been used for the disposal of industrial and WWTP sludge. In addition, the main sewage collection pipe (open canal) runs through the central part of the location, transporting municipal wastewaters to WWTP. The depression in which the landfill lies is actually retaining extra water coming from the municipal sewage system in the periods with heavy precipitation, which results in the increased concentration of contaminants in waters transported to municipal WWTP.

The fact that landfills as well as above-mentioned lagoons and sludge basins lie in the historical bed of Lake Palić undoubtedly points to hydrological connection between the above-mentioned upstream locations and Lake Palić. Although there are no actual data on the type and quantity of pollutants that are introduced into the Lake in that way, it could well be expected that pollutants and nutrients which drained from the contaminated land as leachate to some extent are released into the lake through ground waters and to some extent reach WWTP running through the open canal.

It is important to note that land development project proposals were written before and during the exploitation of the site as a landfill but have never been implemented. Following the adoption of regulations and Waste Management Strategy for the territory of the Republic of Serbia with the view of defining future measures for the waste management and landfills as large contributors to environmental problems, it was necessary to define the called "zero" present conditions. In 2003 in accordance with present regulations, the Company

Vodotehnika“ from Belgrade developed the Structural Master Project titled: “Restoration, Closing and Reclamation Dynamics for the Municipal Landfill in Subotica“ with the view of establishing the degree of pollution and proposing measures for preventing, reducing and eliminating further pollution of the environment. The Ministry of Science and Environmental Protection adopted the Plan based on the Decision No. 19-00-264/05-1 of June 13, 2006.

The Project defined restoration measures for the existing landfill including preparation of the layer that was to facilitate formation of a new landfill on top of the existing one providing the optimal utilisation of space and meeting the criteria of sanitary landfills, which pertain to a defined system of using up the site for depositing waste, neutralising migration and preventing further leachate pollution of the immediate surrounding of Lake Palić.

The implementation dynamics of the landfill restoration and closing works was, among other things, interrupted because of the failure to meet the deadlines for the construction of a regional landfill, which resulted in continuous depositing of waste on the site. Since the planned measures were not implemented and adopted regulations require interventions in terms of protecting the population and surrounding facilities from pollutants (gases from landfills, unpleasant waste odours, uncontrollable drainage of water through landfills and effects on the environment through contacts with animals and people), the documentation should be prepared for the new project of landfill restoration and closing adhering to required quality standards and regulations in the field of environmental protection. A precondition for planning the dynamics of landfill restoration and closing activities is to know the deadline for putting the regional landfill into operation.

**Activities:** Restoration of the area in-between Aleksandrovačka marsh and Lake Palić in the manner that would ensure protection of the environment as a whole but especially the reduction of pollutants release through the landfill body into the environment to a minimum along with providing the appropriate top cover materials, groundwater drainage and appropriate measures for phytoremediation. Since the above implies closure of the open canal and preventing the communication between municipal wastewaters and the landfill body, it is necessary to solve the problem of excess hydraulic load in the period of increased precipitation, which might appear as a consequence of piping the open canal and landfill restoration by means of appropriate dimensioning of the sewage collection network and facilitating appropriate retention tank for excess water.

## **1.5. Formation of Protection Belts in Order to Decrease Diffuse Inflow of Nutrients and Toxic Substances from Agricultural Activities into the Lake**

### **1.5.1. Formation of a Multi-Function, Shore Zone Protection Belt around the Lake in Order to Decrease Diffuse Pollution from Run-Offs**

**Problem description:** Absence of the continuous protection belt around Lake Palić has unfavourable impact on the quality of lake water.

Agricultural activities are adjacent to the Lake shore (at some points less than 1m away from the Lake). Activities such as ploughing and lack of common reed cause erosion of the Lake shore and drainage of nutrients into the lake.

It imposes yet additional burden to water and stimulates the eutrophication process and discharge of sediment into the lake. Formation of the protection belt was under consideration during the 1970s restoration, but was not carried out. The necessity of the formation of

protection belt was emphasised in the Study of Protection – professional basis for the review of protection developed by the Provincial Institute for Nature Conservation. In the new Protection Act adopted after the review of protection (Decision on Proclaiming the Conservation Area Nature Park «Palić», “Official Gazette of the City of Subotica“, No. 15/13 and 17/13-correction.), *«formation of a multi-functional, shore-zone protection belt in the conservation area in accordance with the need for preserving biodiversity of the area and improving the quality of lake water »*, was listed as one of the goals of the proclamation of the conservation area. According to the recommendation given by the Provincial Institute for Nature Conservation, the average width of the belt should be at least 20m, which is around 15ha of agricultural land.

**Activities:** It is necessary to form a protection belt consisting of autochthonous ligneous, bush-like and grass species along the entire lake shore (the optimal width of around 20m) where there would be no application of fertilizers and chemicals but a path which would, in addition to tourist purpose (hiking, cycling and other activities), serve as an alley for park rangers and emergency vehicles.

One of the first steps in the formation of a protection belt is to develop a detailed regulation plan for the Palić and Krvavo shore zone as well as to solve property-legal relations on the cadastre lots intended for the protection belt.

### **1.5.2. Formation of High-Tree Shelterbelts around the Lake in Order to Decrease Diffuse Pollution from Aeolian Erosion**

**Problem description:** Absence of shelterbelts, unfavourable structure of soil and application of inadequate agro-technical measures make our region one of the most exposed regions to winds (Aeolian erosion). A part of the Lake sediment has been transported by wind, the evidence of which can be found in the high percentage of inorganic matter and granular metric analysis of the sediment. Winds, which are the strongest in the period when the arable land is newly ploughed or when the crops height is still small, transport organic matter and chemicals from the ploughed arable land thus increasing the intensity of diffuse pollution of the Lake. Primitive roads, narrowed during previous land consolidation processes, make the formation of shelterbelts along them impossible.

**Activities:** It is necessary to establish the network of high greenery shelterbelts (around 10m in width) and plant suitable autochthonous and allochthonous species in the broader belt around the Lake. A precondition is to select public areas for the formation of shelterbelts according to planning documents. That shelterbelt would contribute to the protection of agricultural land and improve conditions of life for game animals on one side and become green corridors for tourist and recreation paths on the other.

### **1.6. Registering Other Sources of Pollution in the Protection Zone of the Conservation Area Nature Park “Palić” and their Restoration**

**Problem description:** Inadequate solution for the disposal of wastewaters on sites close to the Lake (absence of sewage network, permeable cesspits and direct wastewater feed into the Lake without any treatment), as well as agricultural activities in the immediate vicinity of the Lake only contribute to the bad water quality. Non-existing data on the impact of the above-mentioned contaminants obstruct planning and setting priorities.

**Activities:** Registering all polluters in the Lake Palić surrounding area that have negative impact on the water quality. The data shall be collected within the boundaries of the protection zone of the conservation area of Nature Park «Palić» in order to determine the impact of point source and diffuse pollution.

As regards facilities whose connection to the community sewage network is not economically justified, the use of other autonomous systems should be considered – individual biological treatment device or non-permeable cesspits. It is necessary to find system solutions that would control and regulate cesspit emptying procedure in order to prevent irregular discharge of their content in the ground water and environment and ensure its treatment in the central treatment plant.

In addition to informing the users of facilities about the options and obligations provided by law that regulates wastewater discharge, it is necessary to find stimulating mechanisms for solving the problem of wastewaters in the zone affecting Lake Palić (e.g. favourable loans, payment collection system that would promote connection to public sewage network and alike. In order to prevent negative impact of agricultural activities, farmers, whose land is adjacent to the protection area, should be registered first, then trained and informed about organic farming options (especially those in the vicinity of Lake Palić) and good practices that would ensure protection regime friendly farming.

## 2. IMPROVEMENT OF MANAGEMENT SYSTEM FOR LAKE PALIĆ AND ITS SURROUNDINGS

In order to “get Lake Palić back on its feet“, it is required to rehabilitate the source of pollution and reconstruct the lake’s biological communities. However, to enable successful long term use of the lake for tourist, recreational, sports and scientific purposes, the lake must be regularly maintained. To successfully revitalise the lake, it is essential to regularly remove the excess biomass that will be formed within the concerned wetlands, as well as in sector 4. If such activities are omitted, or not strictly followed, it will surely lead to further degradation of biological communities, pauperisation of biological diversity and reduced availability of the resources.

### 2.1. Functional Reionization of Lake Palić and Drawing up of Water Vegetation Maintenance Programme with Respect to the Resource Users' Needs

**Problem description:** Lake Palić is the main resource for various activities; its potential and actual users are identified in the fields of tourism, sport, recreation, science and nature conservation. There are some common as well as specific requirements for all users, as regards the method of use of the resource, which determine the way of its maintenance. This primarily relates to the presence and the quantities of macro-vegetation in the water and on its shores. Even though the vegetation is a hindrance to some lake users, it is essential for the ecosystem stability and for securing the lake water transparency. In order to ensure the ecosystem stability, it is necessary to provide the presence of macro-vegetation (reeds, submerged vegetation) on, at least, 40 % of the shore and water area. We are the witnesses of the effects of extreme destruction of water vegetation: the turbid water with mass overproduction of algae and accidental fish kill.

**Activities:** It is necessary to reach a consensus among all legitimate resource users and define spatial (area map, water column and lake bottom) and time frames for the lake use, in accordance with the Decision on lake Palić protection, which will serve as a basis for drawing up maintenance plan for the parts of the lake that meet the users' needs and do not endanger the ecosystem stability.

It is necessary to draw up the Space management plan for the lake and its surroundings, which will consolidate formation and organisation of the shore, positioning and organisation of the protection belt as unified functional space unit, in accordance with the Law on Confirmation of the European Landscape Convention (Official Gazette of RS – international treaties 47/11).

For the purpose of drafting a Programme for sustainable water vegetation management, it is necessary to prepare a detailed mapping of macro-vegetation in Lake Palić, identify qualitative and quantitative composition of water plants, and test nitrogen, phosphorus and organic matter content in dominant plant species at least three times during the vegetation period. Since the quantities of nutrients in macro-vegetation (particularly in reeds) are susceptible to seasonal oscillations and highly depend on the local environmental characteristics of water bodies, having access to the information may significantly improve the efficiency of nutrients elimination from the lake.

The envisaged activities should be incorporated into the Management plan for the Nature Park “Palić” and the annual management plans.

## 2.2. Improvement of Technical Competencies of the Manager in Charge of the Protected Landscape

**Problem description:** Reed is a plant which uses nutrient from the lake's bottom and lake's water to grow and develop. By cutting the reeds and carrying it away, we create the effect of direct "taking away" nutrients from water. Nutrients are also taken up by the plants which grow submerged in water (submerged vegetation - *Potamogeton* sp., *Ceratophyllum* sp., *Myriophyllum* sp.). Although excessive development of vegetation, in some areas, may hinder sports and recreational, as well as other tourist activities, higher plants which live in water are very important for the processes of the water quality management. Therefore it is necessary to cut the reeds and pullout the submerged vegetation in a controlled way, on the locations, and during the timeframes that have been determined in advance.

**Activities:** All activities and measures that pertain to the maintenance of the lake and the areas surrounding it should be aligned, structured and incorporated in the long term plan and the annual management plans of the conservation area (adopted by the Manager: Palić Ludaš Public Company), in order to ensure their regular and high-quality implementation.

The city of Subotica, as a founder, should ensure provision of the funding to the Manager, both for the investments envisaged by this Platform and for the efficient implementation of the measures related to care and maintenance of the resource. Inefficient work of the Manager has negative impact on the quality of the resource (Lake Palić and its surrounding), which also causes suffering to all other sectors that use the resource: tourism, sports, fishing etc....

1. Procurement of an aquatic harvester – removal of excess biomass has been performed so far, however it has been done sporadically and in unorganised manner. It has to be carried out regularly according to the plan determined in advance, regardless of the weather and conditions. Therefore, it is necessary to provide a special purpose vehicle which can operate both on the shore and on the water (amphibian) and which may also serve to cut the reeds and pull out the underwater vegetation.
2. Procurement of a transport vehicle – the envisaged amount of removed vegetation may be significant and as such be a useful composting resource. Sale of the compost would partially compensate the maintenance costs. Therefore, all the removed vegetation should be further treated and stored in one place.
3. The Manager's technical and staff empowerment – the activities the Manager carries out in the protected landscape "Palić" have direct (both positive and negative) consequences to all lake users. In order to carry out its work in a responsible and efficient manner, the Manager must have adequate number of qualified staff and the adequate equipment.

## 2.3. Formation and Application of Water Regime Management System with Respect to the Resource Protection and the Resource Use Regime

**Problem description:** the lake's water-level, as well as its water-level dynamics, influence both the groundwater movement, the shore zone exposure to the atmospheric influences and aeration, and the creation of habitats in the shore zones. Due to the significant impact of

water-level and groundwater levels on the area's wet habitats, the Large park and the Zoo dendroflora, the water regime management must be in line with the levels of protection and the requirements for water quality improvement, as well as with the functional maintenance of the locks and dams between the lake's sectors.

**Activities:** Drawing up new Regulations on Palić-Ludaš System Locks Operation, in accordance with the proposal made by the Provincial Institute for Nature Conservation on December 2010, and ensuring implementation of the measures prescribed in the Regulations.

### 3. RESOLUTION OF EFFECTS OF FORMER NEGATIVE IMPACTS ON LAKE PALIĆ

Poor condition of biological communities in Lake Palić and the surroundings is the result of multidecade-long wrongdoing and lack of planned resource management. Today, the effects are evident and it is necessary to make additional efforts to rehabilitate the effects and restore the lake's ecosystem with its biological communities and species, taking into account the current water chemism and the spatial plans.

#### 3.1. Revitalisation of Lake Palić Biological Communities

The practice shows that the most attractive lakes are the ones with transparent water, surrounded by rich variety of living organisms. Although the water transparency of the Pannonian region shallow lakes is less than a meter, overproduction of algae does not occur in unpolluted waters. Such lakes are stabilised ecosystems, which have harmonised food chains due to diverse habitats that ensure favourable conditions for survival of distinct plant and animal species. The analysis of living organisms and ecological features of the lake and its surroundings, presented in the study prepared by the Institute for Nature Conservation, showed that the character of Lake Palić has permanently changed, which suggested that restoration, returning to a previous, saline lake state, was impossible and the activities related to revitalisation of biological communities must be focused on ensuring conditions for establishment of communities appropriate to the current conditions, through controlled and spontaneous colonisation by aquatic and semi-aquatic plants and animal species.

##### 3.1.1. Revitalisation of Lake Palić aquatic communities

**Problem description:** hyper-production of phytoplankton (microalgae and cyanobacteria) presents the largest problem for Lake Palić, and particularly for the sector 4. Lake Palić Zooplankton that should control the number of phytoplankton is rather poor according to the species composition and numbers. Disturbed food chains and unfavourable fish composition, consisted of allochthonous species, among which silver Prussian carp dominates (*Carassius gibelio*), which feeds on zooplankton and macro-vegetation, thus eliminating the main consumers and competition of phytoplankton, which grows uncontrollably. A team of experts from the Faculty of Sciences, University of Novi Sad - Department of Biology and Ecology, estimated the biomass and fish stock increase in sector 4 of Lake Palić, on August 2013. The result is that 96% of biomass in sector 4 belongs to silver Prussian carp.

Bio manipulative measures for reduction of the amount of phytoplankton would significantly contribute to water quality and tourist attractiveness of the lake. In addition to the reduction of the nutrients (nitrogen and phosphorus salts), the amount of phytoplankton may be reduced by means of stimulation of growth of higher aquatic plants (which are competition to phytoplankton, for they use the same nutrients) and zooplanktons (which feed on phytoplankton and thus directly regulate its numbers). Zooplankton is able to filter large

amount of water, feeding on phytoplankton, and thus improving water transparency and increasing chances for growth of higher aquatic plants.

**Activities:** to analyse measures for decreasing ecological pressures on zooplankton and macro-vegetation, which also implies examination of possibilities for fishing of allochthonous species for rehabilitation purposes, and colonisation by species that are appropriate for this type of lake, (including prey species as well), in order to decrease the pressure on zooplankton and additional water burdening with nutrients.

### 3.1.2. Revitalisation of semi-aquatic and terrestrial communities on the Lake Palić shore zone

**Problem description:** shore of Lake Palić is in very bad condition. Aside from the justified absence of shore vegetation on the part for tourists, significant parts of the flooded zone and the shore area immediately next to the water completely lack vegetation or it is very poor there.

**Activities:** Choosing optimum plant species (primarily herbaceous plants) and facilitating their survival on the (flooded) shore zone, using direct planting or other methods. The activity is physically and functionally related to the plan for formation of protection belt around the lake.

## 3.2. Rehabilitation and Remediation of the Aggregated Sediment

**Problem description:** During the past decades, a significant amount of sediment was aggregated in Lake Palić, decreasing its value in terms of its use for tourist and recreational purposes.

Based on the written data and the experiences with remediation of water bodies in other countries, during the past decades, a conclusion may be drawn that sediment removal is an expensive rehabilitation measure and its outcome is uncertain, in terms of water quality. Therefore, the sediment removal is applied when it is necessary in order to deepen a water basin or to use up the space.

Through dislocation of sediment from sector 4, we would manage to deepen the water body, increase the lake's aesthetic value, in terms of its use for tourist and recreational purposes, as well as to partially eliminate the nutrients.

### **Activities:**

Finding optimal and sustainable solution for dislocation and remediation of the sediment. Since interaction water – sediment has not been examined on Lake Palić, prior to the beginning of the activities on sediment dislocation, it is necessary to test the chemical composition of the sediment on the vertical profile and determine the possible interactions between the specific layers and water, in order to estimate what would be the potential impact of deeper sediment layers, if it would be dislocated.

## 4. MONITORING OF LAKE PALIĆ WATER QUALITY AND BIOLOGICAL COMMUNITIES CONDITION

Timely detection of the ecosystem changes that are known to lead to degradation of the ecosystem over a long period of time is the basis for efficient resolution of the problem. In this respect, regular review of the selected parameters (monitoring) is a significant segment of maintenance. In addition to the regular monitoring of physical, chemical and biological water

quality parameters, it is necessary to establish monitoring system for population of targeted species and habitat types.

#### **4.1. Improvement of Monitoring of Water Quality and Sediment Parameters**

**Problem description:** City of Subotica funds regular physical, chemical, microbiological and hydro biological parameters' monitoring of Lake Palić water, which, according to the predetermined dynamics, covers limited number of sites. The monitoring does not provide for non-scheduled analyses or the analyses of particular parameters that depend on the performed activities for improvement of water quality.

**Activities:** In order to monitor the efficiency of the measures taken to improve Lake Palić water quality, it is necessary to envisage the possibilities to increase the frequency of water testing and the number of the locations, as well as to introduce new parameters - specific indicators of specific processes.

#### **4.2. Establishment of System for Monitoring of Condition of Aquatic and Semi-Aquatic Biological Communities**

**Problem description:** The activities related to conservation of the protected and fishing zones, pursuant to the law that regulates the field, shall be further elaborated in specific plans and programmes enacted by the Manager («Palić-Ludaš» PC). In order to best coordinate the activities related to the improvement of the Lake Palić water quality, it is necessary to bring in line the priority activities concerning monitoring and maintenance with other measures that are used to improve Lake Palić water quality.

**Activities:** Defining target species and habitats and monitoring of their conditions, and taking into consideration the above mentioned measures while drafting a new or revising the existing management plans and programmes.

## IV Information and Educational Activities

The programme and process of gradual reduction of Lake Palić pollution, and the process of its protection and laying foundation for its sustainable development, require public participation in its broadest sense. The approach does not reduce responsibility of the competent institutions and administrative structures of the city, but defines more closely the tasks, responsibilities and direct participation of the broad public and the competent institutions.

Since the treated wastewater is the main source of water supply for the lake, the fact is that all inhabitants of Subotica contribute to a greater or lesser degree to the lake pollution. Living and doing commercial activities near the lake also significantly contribute to its direct pollution. Therefore, successful realisation of the proposed measures depends largely on the engagement of the entire community in the process of the implementation of the measures set forth in the Platform. Furthermore, it is very important for the decision makers, public companies' managers, corporate entities and all users of the area, to be appropriately informed on the way Lake Palić ecosystem functions, and on the measures for conservation and improvement of the lake's condition.

Therefore it is necessary to carry out information and educational activities in a systematic manner, with a view to:

- better informing the citizens about the processes related to the pollution and protection of the lake and its surroundings
- raising awareness about specific obligations and rights, and the methods of their realisation
- raising awareness about the efforts made by the competent authorities and institutions in terms of the lake's conservation
- facilitating participation of the public in decision making

During the past decades, the public often received information about Lake Palić that were not based on the expert opinion or were based on the outdated and obsolete knowledge. On websites, blogs and various portals, where it is possible to publicly express opinion without their prior professional verification, one can find opinions posted by the area users that are based on the wrong information (“reed-beds” accelerate creation of sludge“, “high water-level is best for the living organisms because it increases the living space“, “silver carp filters water / the fish should be allowed to eat the algae“, “desilting would solve all the problems“, etc.).

In order to avoid misinformation and dissemination of misconceptions, the information and educational activities must be in line with available state of art scientific and professional knowledge. The followings are the priority guidelines, according to the thematic areas:

- **History, current conditions and the future of the Lake Palić** (Palić as a natural saline lake, wastewater impact in the 19<sup>th</sup> and the 20<sup>th</sup> centuries, rehabilitation in the 70-ies, construction and reconstruction of the wastewater treatment plant, physical, chemical and biological water quality parameters, notion and causes of eutrophication, ways to protect the lake)
- **Natural and created values of Lake Palić** (conservation area, international importance, environmental networks, ecological corridors, strictly protected and protected species, horticultural values and dendroflora, cultural values, ecosystem services)

- **Reduction of pollutants in domestic wastewater** (use phosphate free detergents, avoid discarding substances, which may be treated as municipal waste, in the sanitary sewerage, prevent discarding hazardous waste into the sanitary sewerage)
- **Wastewater drainage and treatment** (adverse effects of direct discharge of untreated wastewater, learn about the wastewater treatment methods, importance of pre-treatment of process wastewater, importance of separation of process, sanitary and atmospheric wastewater, adverse effects of improper sumps, watertight sumps and individual treatment devices, importance of connection to a public sewer, where it exists)
- **Formation of protection belts** (the importance and the role of formation of coastal multifunctional belt around the lake, importance of prevention of ploughing the very shore area, importance of elimination or reduction of the use of fertilisers in the vicinity of the lake /up to 50m from the shore/, possibilities for organic agriculture and agricultural activities that are in line with the nature protection measures, importance of formation of green vegetation protection belts on the distances starting at 50m away from the lake, aiming to reduce aeolian alluviums and aeolian erosion)
- **Water regime management system in line with the water quality maintenance requirements and the protection of the natural values** (the importance of the regimes management, in terms of the water quality, importance of minimum annual oscillation of 0.4m, water-level impact on the Large park vegetation, preconditions for reed-beds to develop)
- **Revitalisation of the Lake Palić biological communities** (the important role of aquatic vegetation in absorption of nutrients, stabilisation of the ecosystem and prevention of overproduction of algae, the importance of elimination of allochthonous invasive species from fish stock, importance of sustainable fish stock management)
- Integral management of Lake Palić area (the space is consisted of areas defined by various documents and purposes – Conservation Area Nature Park "Palić"; Palić spa; protected cultural - historical heritage of Palić; tourist destination Palić; settlement Palić, agricultural land; land used in connection with the water management facilities as part of the subsystem "Tisa-Palić"- therefore it is very important to understand its multifunctional character, and particularly the need for harmonisation of the space use, as regards the afore mentioned functions)

Better understanding of the above mentioned processes and functions will contribute to long term sustainable management of Lake Palić and its surroundings, and enable participation of broad community in realisation of the common goals.

Since diverse target groups are involved in the process, it is necessary for the information-educational activities to be carried out on different levels, namely: via internet, through direct contact with target groups, electronic and printed media, regular educational and extracurricular activities in the educational institutions, facilitation of special events, lectures, presentations, seminars, workshops, round tables, forums, camps, and similar. During the implementation of the activities, we expect active participation of the civic sector.

## V Conclusions

Problem of the Lake Palić degraded biological communities is extremely complex, thus a single action related to relocation of sediment would not lead to the improvement of the lake water quality and would not improve the possibilities for the lake use for tourist, recreational, sports and environmental purposes.

Although the focus of the Platform has been Lake Palić, the future of Lake Ludaš has also been taken into consideration, due to the geographical nearness and close hydrologic relations between the lakes, and the commitment should be continued during the strategic planning process.

The lake revitalisation task should not only be based on the support provided by one sector. In addition to environmental protection, the lake revitalisation activities should be supported by the sectors of agriculture, water management, tourism, as well as other sectors that are users of the resource.

The Platform analyses the issue of degradation and possibilities for revitalisation of Lake Palić in the broadest context, without detailed elaboration of the deadlines or implementation methodology.

Measures envisaged in this platform will be implemented in accordance with the planning and programme documentation, taking into account legal competencies of holders of specific activities, and in accordance with the Management plan of Conservation Area Nature Park “Palić”, which pursuant to the Law on Nature Protection is adopted by the Manager of the conservation area.