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TECHNOGENIC POLLUTION AND IMPROVEMENT OF ECOLOGICAL CONDITION OF GOLOSEEVSKY PONDS

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Abstract. *The ecological assessment of a condition of Goloseevsky ponds on the basis of experimental data on biotesting and multiple-factor statistical modeling of influence of pollution of reservoirs on a condition of biological object is carried out. On the basis of the multiple-factor analysis the prospect of use of the highest water plants for cleaning of these reservoirs is proved.*

Keywords: biotesting; ecological assessment; multiple-factor analysis; technogenic pollution.

1. Introduction

Kyiv has a reputation of green city. However, probably, the majority of its inhabitants also doesn't suspect that the capital of Ukraine is rich not only in parks and squares. In our city there are many rivers and rivulets, and still - a set of ponds and ponds.

One of unique jewelry of the capital of Ukraine is the Goloseevsky wood in which there is a network of streams and ponds. The reservoirs of the Goloseevsky wood formed owing to barrage of river or rill valleys, it is possible to carry to three main groups. It, first of all, Gorikhovatski of a rate (on p. Gorikhovatka) Didorovsky rates (on Didorovsky a stream) and Kitayevsky rates (on the Kitayevsky stream). The specified reservoirs belong to type drainage or decorative and recreational. All of them test strengthened eutrophication (water enrichment by biogenes). So, for today there is an imperative need of an assessment of their ecological condition.

Goloseevsky park in Kyiv – is one of the largest and the oldest in the capital of Ukraine. The Orekhovatsky valley, and also the cascade from four ponds is sight of Goloseevsky park in Kyiv. Despite the plates, forbidding to bathe and catch fish, there are always many people at the ponds which considerable share is made by children. Unfortunately, the rates are very polluted, often is confirmed by considerable death of fish, last of which is recorded on March 24, 2011. The frequent reason of they are emergency dumpings of sewage from the Myshelovsky collector of JSC Kyivvodokanal and GKP "Pleso" belongs. In Goloseevsky ponds essential pollution by synthetic superficially substances periodically is registered (having fallen down), nitritny nitrogen, inorganic phosphorus, ortho-phosphate etc.

Relevance of work consists of a solution of the problem of decrease in an evtrofikation of Goloseevsky ponds in connection with dumpings of polluting substances. For purification of waters in Goloseevsky ponds we suggest to use the Highest Water Plants (HWP). Our offer recognizes that typha root system and a cane have a high heat-sink ability of rather heavy metals, and the cane has high adaptive properties and is capable to sprout in reservoirs very polluted by industrial sewage.

Object of research is polluting substances and biotestings for Lactuca Sativa

Object of research is influence of polluting substances on growth and development of the test of object (Lactuca Sativa).

2. Methods of researches

In work [Klochenko 2010] the analysis of degree of impurity of water city facilities of Kyiv was carried out by inorganic compounds of nitrogen and phosphorus.

According to classification of quality of a surface water of a land taking into account average values of concentration of biogenes, the following is defined:

1) Kitayevsky and Didorovsky rates are the purest according to the maintenance of NH_4, "weak", and sometimes "moderate" pollution of water by ammonium nitrogen: it is observed in Goloseevsky ponds;

2) Kitayevsky rates is "pure" or "rather pure" according to the content in water of nitrites; Didorovsky rates though sometimes "moderate pollution" waters ions NO_2^- in a class "polluted" here is registered belong to this category too or "dirty" nitrite nitrogen it is possible to carry water of Goloseevsky ponds;

3) "pure" or "rather pure" according to the content nitrates in water Kitayevsky rates whereas concentration of these connections in nuts-vatskikh

and Didorovsky ponds characters storages their water as "pure" – "moderately polluted";

4) "polluted" (poorly or moderately), Gorikhovatsky ponds are sometimes "dirty" by quantity of ions of PO_4^{3-}, water of Kitayevsky and Didorovsky ponds according to the content of ortho-phosphates is in limits of categories "rather pure" – "considerably polluted"; sometimes cases of excessive pollution of water inorganic phosphorus Didorovsky a rate N 4 are registered.

In mass media periodically there is information on considerable death of fish. The last poisoning was recorded on March 24, 2011.

The work **purpose** is to give an assessment of an ecological condition of Goloseevsky ponds and to analyse influence of various technogenic factors on a condition of Goloseevsky ponds.

3. Problem statement

Due to the need of a solution considerable eutrophication of Goloseevsky ponds there is a number of tasks:

– to determine categories of a water quality by chemical indicators on the basis of literary data of a concentration of separate pollutants on rates;

– to take water samples from everyone a rate on 3 cascades;

– to carry out biotestings of tests of water on test object as which length of a root of Salad (Lactuca Sativa) acts;

– to construct models of influence of impurity of reservoirs nitrites, nitrates, phosphates on test object as which length of a root of Salad (Lactuca Sativa) acts;

– ecological assessment of prospects of use of the HWP for cleaning of Goloseevsky ponds.

In these researches methods of biotesting and further modeling on the basis of the obtained experimental data on biotesting and literary data on concentration of biogene substances in ponds are used.

Biotesting allowed to define phytotoxicity tests. Biotesting techniques for Lactuca Sativa were used. In Petri's each cup with the filters moistened with tests of water, displayed on 25 seeds of salad. Cups were closed were located in a dark, damp and warm place for 3 days. Then a share of the sprouted seeds was defined and measured length of root from a thickening (small knot) to their tips. The share of growth of backs was determined by the obtained data concerning control.

When modeling steam rooms the multiple models of dependence of an indicator on one, two, three and four factors were used [Myhalevska et al. 2009].

4. The characteristic of water quality of Goloseevsky ponds on biogene elements

Classification of water quality was carried out on a basis of Techniques of establishment of ecological standards of quality of a surface water of a land and estuaries Ukraine [Romanenko et al. 2001]. The researches conducted in spring, so chemical indicators are reflected too according to this time of the year.

Phosphates and nitrites are the main pollutant of these reservoirs. Broad application of synthetic detergents became the reason of pollution of a water surface by polyphosphates, slowly hydrolyze with formation of ortho-phosphates. Getting to reservoirs, phosphates promote reproduction of blue-green algas which destroy an ecosystem of reservoirs. Nitrites as connections are unstable, are shown only at rather recent pollution of a source of water. The amount of nitrogen of the nitrites, exceeding 0,002 mg/dm^3, allows to suspect water pollution by fossils of an animal origin.

According to average data for a year of Gorikhovatsky pond of the cascade belong to: N 1 in 3 categories II class: good (on a condition) and rather pure (on purity degree), and all the others (N 2, N 3, N 4) to the III class, 4 categories: satisfactory (on a condition) and poorly polluted (on purity degree. In general indicators across Gorikhovatsky of the cascade are the worst among all 3 cascades of the Goloseevsky wood (Table 1).

Table 1. Classification of water quality of Gorikhovatsky ponds

Ingredients	Concentrations of substances, mg / l	Class	Categories
Pond 1			
N/NH_4	0,08	1	1
N/NO_2	0,005	2	2
N/NO_3	0,08	1	1
P/PO_4	0,06	3	4
Pond 2			
N/NH_4	0,09	1	1
N/NO_2	0,005	2	2
N/NO_3	0,09	1	1
P/PO_4	0,089	3	4
Pond 3			
N/NH_4	0,12	2	2
N/NO_2	0,003	2	2
N/NO_3	0,06	1	1
P/PO_4	0,129	3	5
Pond 4			
N/NH_4	0.09	1	1
N/NO_2	0,003	2	2
N/NO_3	0,07	1	1
P/PO_4	0,129	3	5

According to average data for a year of the Kitayevsky pond the cascade No. 1 and No. 4 belong to 3 categories of II class: good (on a condition) and rather pure (on purity degree), and ponds N 2 and N 3 to 2 categories of II class: very good (on a condition) and pure (behind purity). In this cascade the raised content of phosphates in ponds N 1 and N 4 within a year is observed (Table 2).

Table 2. Classification of water quality of Kitayevsky ponds

Ingredients	Concentrations of substances, mg / l	Class	Categories
Pond 1			
N/NH_4	0,14	2	2
N/NO_2	0,011	3	4
N/NO_3	0,14	1	1
P/PO_4	0,068	3	4
Pond 2			
N/NH_4	0,18	2	2
N/NO_2	0,012	3	4
N/NO_3	0,19	1	1
P/PO_4	0,153	3	5
Pond 3			
N/NH_4	0,18	2	2
N/NO_2	0,027	3	5
N/NO_3	0,51	3	4
P/PO_4	0,046	2	3
Pond 4			
N/NH_4	0,18	2	2
N/NO_2	0,047	3	5
N/NO_3	0,81	3	4
P/PO_4	0,054	3	4

According to average data in a year all ponds Didorovsky the cascade belong to 3 categories of II class: good (on a condition) and rather pure (on purity degree). Here the raised content of phosphates (especially Didorivsky there was N 4) and nitrates (Didorivsky N 3) is observed (Table 3).

So, on chemical indicators Gorikhovatsky's ecological condition of the cascade are the worst among all 3 cascades of the Goloseevsky wood.

5. Results of biotesting on Lactuca Sativa

Biotesting was carried out on Lactuca sativa L. This biotest analyzes the growth of backs and estimates early stages of growth and a survival of plants (Table 4).

As a result of biotesting it was appeared that the smallest percent of germination of seeds is in Gorikhovatsky N 1 and N 2, Kitayevsky N 1 both Didorovsky N 2 and N 3 that speaks about less favorable conditions for plants in these ponds.

Table 3. Classification of water quality of Didorovsky ponds

Ingredients	Concentrations of substances, mg / l	Class	Categories
Pond 1			
N/NH_4	0,13	2	2
N/NO_2	0,009	2	3
N/NO_3	0,33	2	3
P/PO_4	0,071	3	4
Pond 2			
N/NH_4	0,11	2	2
N/NO_2	0,007	2	3
N/NO_3	0,42	2	3
P/PO_4	0,112	3	5
Pond 3			
N/NH_4	0,12	2	2
N/NO_2	0,01	3	4
N/NO_3	1,05	4	6
P/PO_4	0,042	2	3
Pond 4			
N/NH4	0,3	2	3
N/NO_2	0,027	3	5
N/NO_3	0,34	2	3
P/PO_4	0,305	5	7

Table 4. Results of biotesting on Lactuca Sativa

Ponds	Germination, %	Average root length, mm
Control	60	15,8±6,4
Gorikhovatsky ponds		
1	38	19,1±3,3
2	33	23,3±4,1
3	40	23±8
4	42	22,2±8,6
Kitayevsky ponds		
1	27	15,8±6,5
2	53	16±2,2
3	53	18,8±7,2
4	38	24,3±2
Didorovsky ponds		
1	58	18,5±1
2	33	16,2±1,6
3	38	23,3±6,6
4	67	20,8±0,5

Didorovsky N 1 and N 4 both Kitayevsky N 2 and N 3 were more favorable. Concerning length roots, on all rates observed big length, than in control.

6. The analysis of the constructed models of influence of impurity on test object

The ecological phenomena and processes depend on a large number of factors. As a rule, each factor separately doesn't define studied, completely. Only the complex of factors in their interrelation can give more or less complete idea of character of the studied. Multiple correlation arises from interaction of several factors with a productive indicator.

In our case of an Indicator (In) length of a root of Lactuca Sativa undertook, and technogenic factors concentration in Goloseevsky ponds of NH_4^+ acted (H1), NO_2^- (X2), NO_3^- (X3), PO_4^{3-} (X4).

Steam rooms and multiple models of dependence of an indicator on one, two, three and four factors were constructed. In total amount of steam rooms and multiple-factor models 16 models (63,64% of all models) with coefficient of determination is higher than 0,9 are revealed that speaks about a fine precision and reliability of researches.

Exact models among the even in Kitayevsky rates on influence of phosphates

In (X4) = 0,6 +5,79 X4,

in Gorikhovatsky on nitrates

In (X3) = 1,3 +0,15 X3

and to phosphates

In (X4) = 1,33 +0,7 X4,

in Didorovsky on nitrites

In (X2) = 1,14 +7,9 X2

and to nitrates

In (X3) = 1,0,3 +0,4 X3.

Among multiple models with two factors exact appeared: on Kitayevsky to rates – nitrites-phosphates

In (X2, X4) = 1,75-158,7 X2 +0,69 X4

and nitrates-phosphates

In (X3, X4) = 0,5 +0,94 X3 +6,05 X4.

Concerning Gorikhovatsky of the cascade, exact models are ammonium with nitrite

In (X1, X2) = 0,29 +6,7 H1-1, 8H2

and ammonium with phosphate

In (X1, X4) = 0,4 +5, 8x1 +0,3 X4.

In Didorovsky rates the best 3 models – ammonium with nitrate

In (X1, X3) = 0,7 +1,4 X1 +0,5 X3,

nitrite with nitrate

In (X2, X3) = 0,8 +0,49 X2 +13,3 X3,

phosphate with nitrate

In (X3, X4) = 0,8 +0,6 X3 +0,9 X4 are.

Among multiple models with three factors in Kitayevsky ponds dense communication has model on such factors, as nitrite, nitrate and phosphate

In (X2, X3, X4) = 1,18-43,3 X2 +2,7 X3-2x4.

In Gorikhovatsky – ammonium-nitrate-phosphate

In (X1, X3, X4) = 0,21 +7,5 H1-0, 16H3-0, 38H4.

In Didorovsky ponds dense communication 3 models on such factors, as ammonium-nitrite-nitrate

In (X1, X2, X3) = 7,74-126X1 +1200 X2-3X3,

ammonium have nitrate-phosphate

In (X1, X3, X4) = 0,67 +4,2 X1 +0,38 H3-2, 4H4,

nitrite-nitrate-phosphate

In (X2, X3, X4) = 0,9 +38,8 X2 + 0,27 X3 - 2,35 X4.

That is these factors in a combination carry out strong influence on root length.

In models on four factors dense communication Didorovsky rates, since here have the greatest coefficient of correlation

In (X1, X2, X3, X4) = 0,67 +4,2 X1 +0,38 H3-2, 4H4.

In many models there is a feedback. It is explained by considerable ability of reservoirs to self-cleaning. The tendency to increase of accuracy of models together with increase of their complexity (the accounting of bigger quantity of harmful substances) is also noticeable.

When performing experiments it was noticed a number of tests in which growth of test object is most approached to control. Thanks to it it is possible to consider that the ecological condition of reservoirs isn't influenced by such concentration of substances ammonium – 0,08–0,09 mg/m^3, nitrites – 0,005 mg/m^3, nitrates – 0,08–0,09, phosphates 0,06–0,089. Concentration of substances confidants to an optimum are observed in Kitayevsky N 1 and 2 and in Didorovsky N 2. When sampling for the analysis in these ponds a large number of the HWP (reeds, bulrush, cattail) was noticed.

7. Ecological assessment of prospects of use of the highest water plants for improvement of a condition of Goloseevsky ponds

The Highest Water Plants, such as a cane, a reed, typha, possess ability to delete from water such polluting substances as biogene elements (nitrogen, phosphorus, potassium, calcium, magnesium, manganese, sulfur), heavy metals (cadmium, copper, lead, zinc), phenols, sulfates, oil products, synthetic superficially substances (having fallen down), and to improve such indicators of organic pollution of the environment, as the biological consumption of oxygen and the chemical consumption of oxygen.

Water plants in reservoirs carry out the following main functions [Stolberg et al. 2003]:

– filtrational (promote subsidence of the weighed substances);

– absorbing (absorption of biogene elements and some organic substances);

– accumulated (ability to accumulate some metals and difficult decomposing organic substances);

– oxidizing (in the course of photosynthesis water is enriched with oxygen);

– detoksikatsionny (plants are capable to accumulate toxic substances and to turn them in nontoxical).

For purification of waters in Goloseevsky ponds we suggest to use the following species of the HWP, as a cane, a reed pond, typha leaved and broad. Our offer recognizes that typha root system, a cane has high heat-sink ability of rather heavy metals, and the cane has high adaptive properties and is capable to sprout in reservoirs very polluted by industrial sewage

In work [Gersberg et al. 1986] it was estimated the ability of three species of the HWP (a cane, a reed and typha) to delete nitrogen from the polluted waters and to reduce BPK.

At average concentration of ammonium in drains of 24,7 mg/l, after cleaning with VPR use its concentration made (mg/l): for a cane – 1,4, for a reed – 5,3, for typha – 17,7. Efficiency of decrease in BPK was also higher in a cane and an oche-secret. It is experimentally established that extent of water purification from phosphorus and nitrogen respectively makes 98, and 92,9%, at this BPK and HPK decreased by 98,6 and 91% [Direnko, Kotsar, 2006].

From the called plants we suggest to create a bioplateau which represents the engineering construction used for cleaning and tertiary treatment of the polluted superficial drain and which doesn't demand (or nearly doesn't demand) expenses of the electric power and use of chemical reagents at insignificant operational service. The natural processes of self-cleaning inherent in water and water related ecosystems are put in a basis of technology.

From these plants we offer a bioplato which is the engineering structure used for the cleaning and purification of polluted runoff, which does not require (or almost requires) cost of electricity and the use of chemicals with little maintenance. The technology puts natural self-purification processes inherent water and ecosystems.

In addition to its functions as bioengineering structures bioplato as high-performance ecosystem creates spatial heterogeneity in the existing antropogen natural landscapes, provide additional habitat and food resources for many species of flora and fauna, which in turn creates favorable conditions for maintaining biodiversity. Using the principles of landscape design in the design and construction of buildings the bioplato will make extensive use of decorative possibilities of these structures to improve the aesthetic characteristics of recreational areas [Kotsar, 1999].

8. Conclusions

In all ponds of NPP Goloseevsky periodically are registered increase contain some polluting substances (phosphates and nitrites in the Gorikhovatsky cascade, nitrates in Didorovsky, phosphates in the Kitayevsky cascade).

By means of statistical methods we noticed the influence of polluting substances on an evtrofikation of Goloseevsky ponds and found out that as a number of models have the return the action direction, we draw a conclusion that polluting substances at total actions considerably accelerate growth of plants, speaks about prospects of application of plants for cleaning of Goloseevsky reservoirs.

Also there are models, in which test object growth the most nablizhenmy to control. Therefore thanks to these models it is possible to consider that the most optimal for growth of plants there are such concentration of substances ammonium – 0,08–0,09 mg/m^3, nitrites – 0,005 mg/m^3, nitrates – 0,08–0,09, phosphates 0,06–0,089. Concentration of substances confidants to an optimum are observed in Kitayevsky N 1 and 2 and in Didorovsky N 2. When sampling for the analysis in these ponds a large number of the HWP (a reed, a cane, typha) was noticed.

In our opinion, it is necessary to apply the protection of these remarkable reservoirs against pollution by more widely biological methods of water purification which water vegetation uses. For purification of waters in Goloseevsky ponds we suggest to use the HWP.

The offer recognizes that typha root system has high heat-sink ability of rather heavy metals, and the cane has high adaptive properties and is capable to sprout in reservoirs very polluted by industrial sewage.

From the called plants we suggest to create a bioplato which represents an engineering construction, the natural processes of self-cleaning inherent in water and water related ecosystems are put in a basis of technology.

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Т.В. Михалевська, М.О. Кравець. Техногенне забруднення та поліпшення екологічного стану Голосіївських ставків

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Проведено екологічну оцінку стану Голосіївських водойм на основі експериментальних даних по біотестуванню і багатофакторного статистичного моделювання впливу забруднення водойм на стан біологічного об'єкта. На основі багатофакторного аналізу обґрунтовано перспективу використання вищих водних рослин для очищення даних водойм.

Ключові слова: біотестування; багатофакторний аналіз; екологічна оцінка; техногенне забруднення.

Т.В. Михалевская, М.О. Кравец. Техногенное загрязнение и улучшение экологического состояния Голосеевских прудов

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Проведена экологическая оценка состояния Голосеевских водоемов на основе экспериментальных данных по биотестированию и многофакторного статистического моделирования влияния загрязнения водоемов на состояние биологического объекта. На основе многофакторного анализа обоснована перспектива использования высших водных растений для очистки данных водоемов.

Ключевые слова: биотестирование; многофакторный анализ; техногенное загрязнение; экологическая оценка.

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