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Anthropogenic changes in water ecosystem on the example of the river Tisza.

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ABSTRACT

While conducting the ecological estimation of the hydro ecosystems (HE) condition of Tisza water basin, engineering ecological indices and their parameters are used. The system-basin research approach of the water basin based on systematization and data processing of the ecological monitoring for a long-term period is used. Such period allowed to set scientific regularities of naturally-anthropogenic hydro ecosystems development in the conditions of constant anthropogenic load on them.

1. Introduction.

On the modern stage of industry development and national economy the problem of rational nature management became extraordinarily urgent. First and foremost, it is related to constantly growing anthropogenic influence caused by a human on the environment. It is a well-known fact that rivers are the biggest sources of fresh waters for the economy and industry. However, they are also placing for waste waters and

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industrial wastes dropping which results not only in qualitative but also in quantitative exhaustion. Therefore, the solution of maintenance and restoration of the water basins environmental assets and their ecological condition becomes especially urgent.

Ukrainian part of the Tisza basin belongs to both Upper Tisza and Middle Tisza. The Tisza basin is the main source of the Zakarpattia region water-supply. The average runoff total resources are 13300 million m^3, in water-short year – 7290 million m^3. Except the river Tisza waters, they consist of 9 storage ponds (total capacity is 59,3 million m^3), 286 ponds (total capacity is 10,056 million m^3) and 32 lakes with the Synevir lake as the largest one (capacity of 1,75 million m^3) [3].

The river Tisza with its water mirror area of 157186 km^2 is the biggest Danube inflow. Its length is 966 km. The main part of flow is formed on the territories of four countries: Romania – 51%, Ukraine - 25,6%, Hungary – 10%, Slovakia - 13,4% [1,2].

For 1990-2016 period it can observe a tendency to a considerable reduction of water intake volumes which is possible mainly due to reduction of the use onto industrial and agricultural needs.

The water consumption level of the region is slight. In 2016 the total amount of water taken away from natural sources was 42,67 million m^3 (43% was taken from surface water sand 57% - from ground waters). On the territory of the region there are no water houses that need a great amount of water [4]. The ground water prognosis resources of drinkable quality make 399 million m^3/year, while the level of approved ones is 124 million m^3/year. As at 2016 only about 18,85 million m^3/year are used, i.e., the region has got a considerable potential for development for drinkable water-supply.

Contaminants come to the river Tisza basin through the natural and anthropogenic sources of contamination. The main contamination sources of the river Tisza basin surface-water are communal effluents (36%), industry (27%), agriculture (36%) and other (1%) [5].

For the last two decades, the political and economic situation caused changes in industrial activity that is realized in Zakarpattia. According to the state statistical accounting data about the waters usage, the total amount of water users dropping effluents into surface water objects of the river Tisza basin in 2016 was 106 subjects in the following sectors: 35 subjects in industry, including 2 in electricity, 1 in non-ferrous metallurgy, 1 in chemical and petrochemical, 4 in machine-building and fabricated metal, 5 in wood industry, 1 in wood chemical, 5 in building, 1 in light industry, 15 in food industry; 8 in agriculture; 1 in forest industry; 3 in transport; 1 in construction; 2 in trade; 3 in logistic support; 53 in housing and communal services [6].

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2. The main part.

Prognosis of water consumption of Tisza waters is determined by the rates of economic and public development. According to scientists' calculations up to the year 2031 the population of the river Tisza water basin will increase in more than 5 times. It will lead to increase of population density from 97,5 to 102,2 people/km2. The estimated water consumption of the region can be fully provided at the expense of local water resources – the measures of current water resources maintenance and restoration should be conducted.

The industry contamination caused by effluents organic substances is slight. The total amount dropped in 2016 was: 0.01 thousand tons (according to the BOD_{full}), 0.017 thousand tons (for COD_{Cr}) of organic substances.

Water quality estimations were carried out according to the monitoring data of 2013-2016. The key aim of research is the river Tisza ecological condition estimation by physical and chemical indices, the main sources exposure of anthropogenic influence and improvement directions determination of the water object condition.

The ecological monitoring statistical database was created for calculations. This database includes information about more than 200 water meters for hydro chemical characteristics.

Water tests showed content by the following indices: pH, BOD_5, suspended matters, taste, iron, potassium, calcium, magnesium, manganese, copper, natrium, mineral oils, COD, dissolved oxygen, synthetic surfactants, sulfates, phenols, phosphates, chrome (VI), oxygenating percent, hydro carbonates, resins and pyrobitumens, ammonium nitrogen, nitrite nitrogen, nitrate nitrogen, silicon, zinc, α-HCH pesticides, γ-HCH pesticides, p'-dichloroethylene pesticides, p'-dichlorobiphenyl trichloromethyl methane pesticides, p' - dichlorobiphenyl dichloromethane pesticides, and also coloration, smell, river water expense, flow speed, water temperature.

Concentration of hydrogen ions is one of major indices of waters quality. It influences the chemical balance of ions in the system and is of great importance for chemical and biological processes. Its value in the river Tisza ranges from 7,6 to 8,1 pH.

The content of calcium and magnesium in river waters during the research period was within the limits of 36-41; 6,5-7,3 mg/dm^3 accordingly and does not exceed their TLV (180, 40 mg/dm^3 accordingly). The content of magnesium is essentially predominated by the amount of calcium in all tests. There is a tendency of calcium concentration to be reduced streamwise.

The amount of hydro carbonates and chlorides in water is 128-152 and 10-17 mg/dm^3 accordingly. The content of chlorides is considerably lower than TLV (350 mg/dm^3) and indicates that there is no salt contamination by this anion in the water. The amount of sulfates ranges from 23 to 30 mg/dm^3 which is

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considerably lower than TLV (100 mg/dm^3). The concentration of hydro carbonates and sulfates streamwise the river is brought out to be reduced.

The average salt ammonium concentration in waters did not exceed TLV (0,5 mg/dm^3) for many years. Nitrites concentrations in water made 0,02-0,08 mg/dm^3 and content of nitrates ranged from 1,1-6,5 mg/dm^3 which do not exceed TLV (0,08 and 40 mg/dm^3 accordingly).

Therefore, due to the calculations, the average index values of salt structure contamination (I_1) are the following - 1,57; tropo-aerobiological (eco sanitary) index(I_2) - 3,12; index of toxic action specific figures (I_3) - 4,02; ecological index (I_e) - 2,94.

Prognosis data are showed in table 1. The prognosis reliability is estimated on the basis of meaningfulness level p: lesser meaningfulness level leads to higher reliability of prognosis. The prognosis with $p \leq 0,05$ is considered to be quite reliable. Obviously, prognoses of ammonium and iron content are just approximate, as their $p > 0,05$. All the other prognoses should be considered as quite reliable.

Table 1 – Prognosis data and prognosis reliability

Index, mg/dm3	Prognosis, mg/dm3	Meaningfulness level
Ammonium nitrogen	0,12	0,48
COD	6,1	0,004
BOD5	3,1	0,02
Phosphorus	0,13	0,007

While analyzing the results on the whole, it should be noted that content of such substances as mineral oils, ions of copper and zinc, surfactants, ammonium nitrogen, nitrite nitrogen, nitrate nitrogen and a chromium remains stable during the research period.

Prognostication of contaminants content gives an opportunity not only to prognosticate concentration but also to estimate the general tendency of seasonal substance change.

In order to conduct the condition prognosis of the river Tisza water system, we selected those indices which are limitative and most suitable for prognostication by statistical method: COD, ammonium nitrogen, phenols, phosphorus, mineral oils, synthetic surfactants, BOD_5. ‘A’ and ‘b’ parameters, needed for corresponding regression equations were calculated for selected indices. However, only those equations which have very close connection between characteristics (correlation coefficient value of ‘r’ is closer to 1) and which calculated value of t-criterion exceeds the tabular value (its how’s essential connection between concentration and time) can be used to prognosticate hydro-ecosystem condition.

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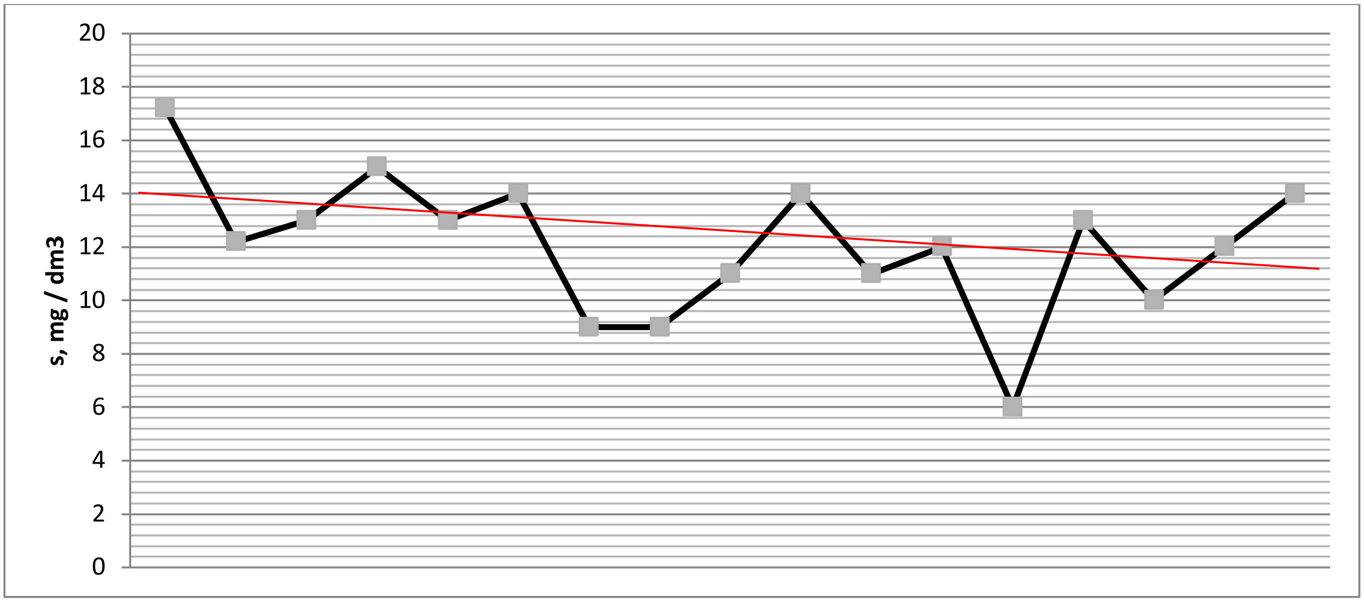
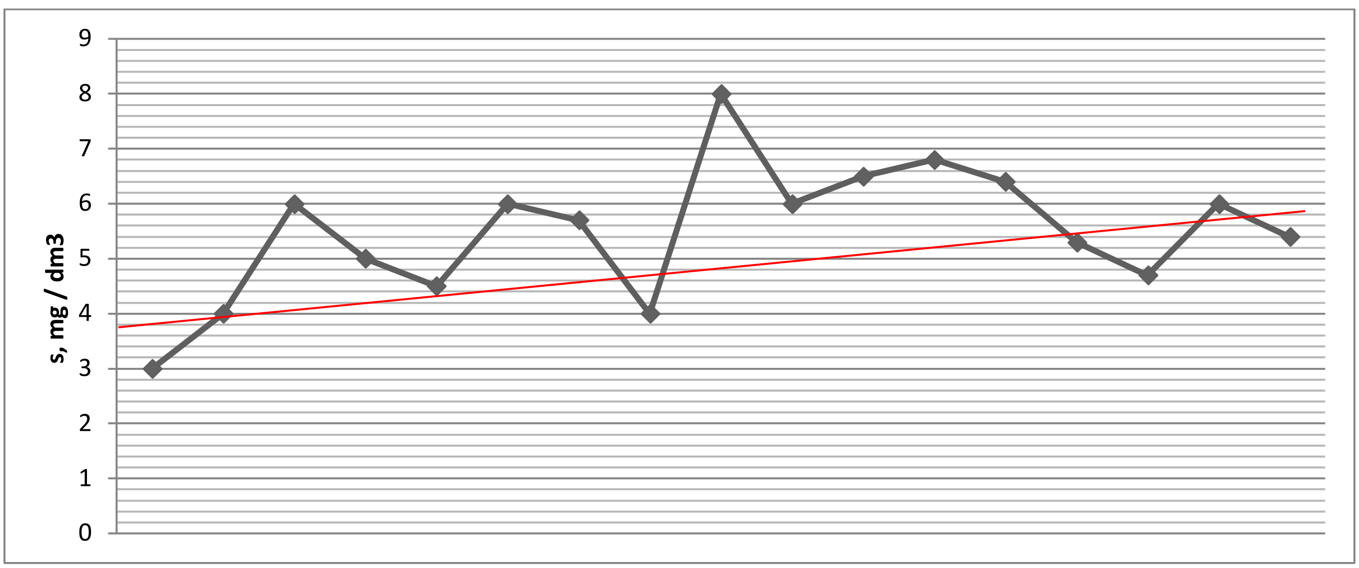
After determination of connection force between concentration and time, it has been found out that it is possible to obtain every small part of data for prognosis. Average annual data on COD, BOD_5, phosphorus and ammonium nitrogen are the most suitable for prognosticating by static method.

The urgent task of water control is the introduction of domestic effluents extra cleaning after bio scrubbing. It will lead to waters contamination preventing and water objects condition improving; recreational value of the region will also be increased.



Pic. 1. *Forward-looking prognostication of ammonium ions content*



Pic. 2. *Forward-looking COD prognostication*

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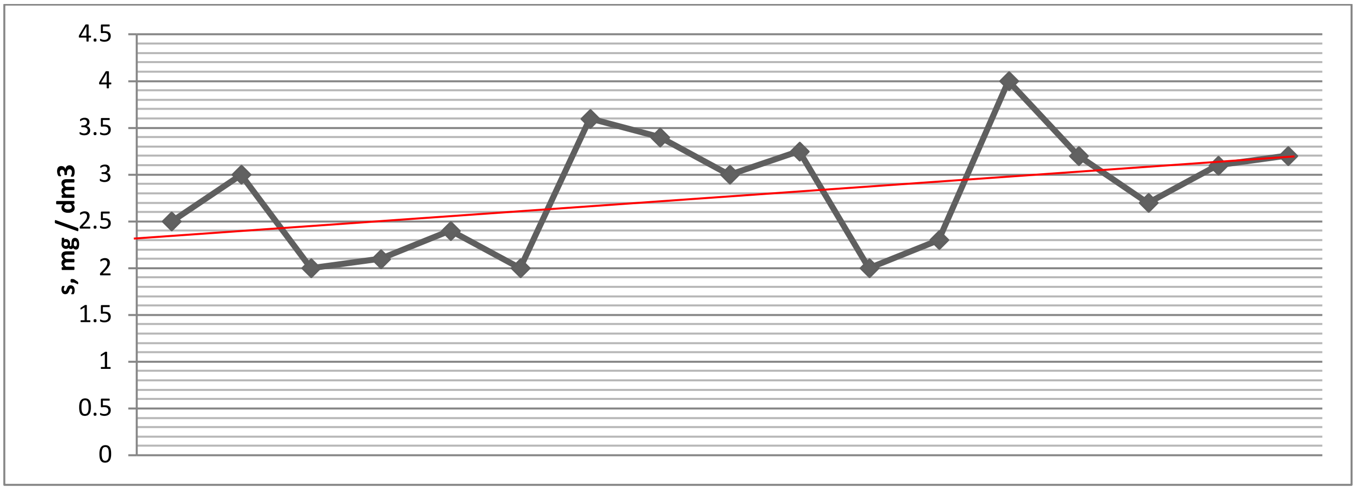
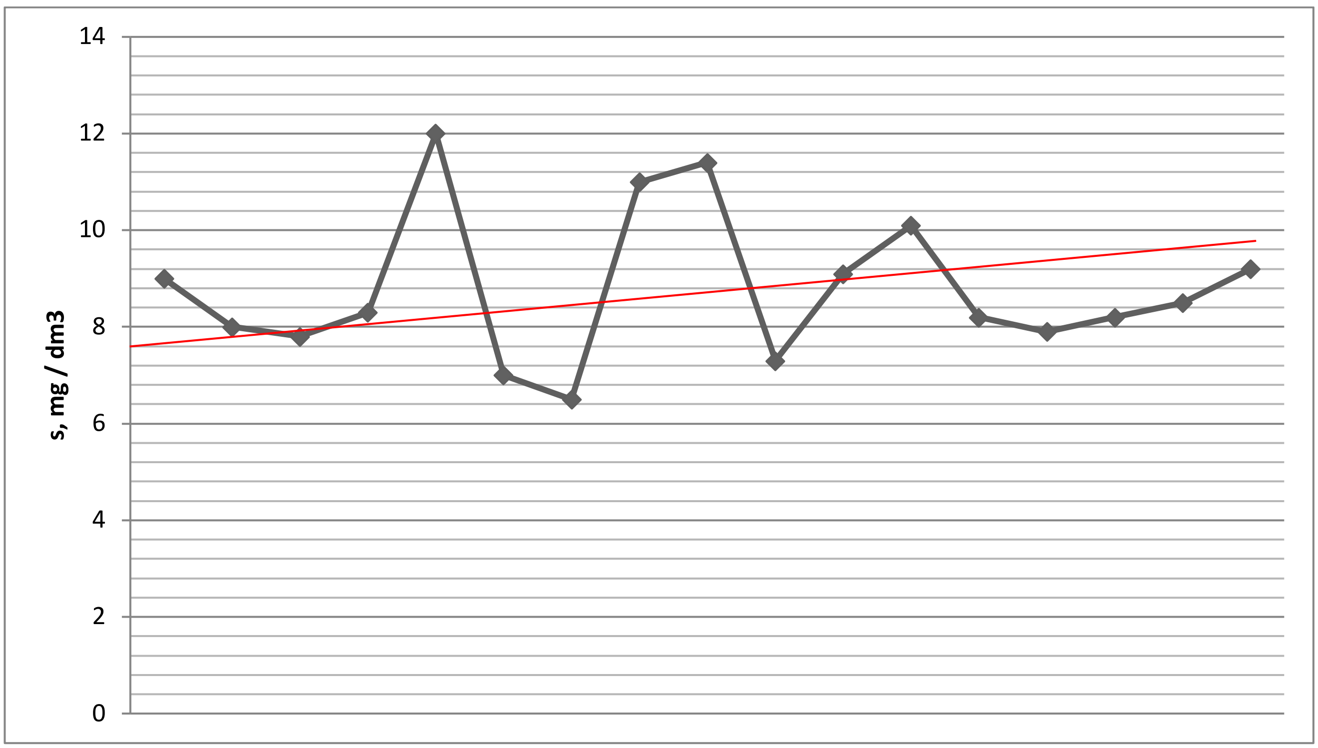


Pic. 3. *Forward-looking BOD$_5$ prognosis*



Pic.4. *Forward-looking concentration of phosphorus prognostication*

Conclusions

According to pictures 1-4, three basic indices -COD, BOD$_5$ and concentration of phosphorus – have a tendency to increase in the next 10 years, and the ammonium ions indices are going to decrease.

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Livestock farms, industrial and domestic effluents, surface flow from farmlands at ammonium fertilizers usage, food enterprises effluents, chemical-recovery, wood-chemical and chemical industries are the main sources of receiving the ions in water objects.

Increased ammonium and phosphates ions concentration is used as an indicatory index of surface and ground waters contamination process by domestic and agricultural flows.

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