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PROCESSES OF FORMING THE UNDERGROUND WATER CHEMICAL COMPOSITION IN THE ZONE OF DRAIN RECLAMATION

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ABSTRACT

The results are presented of the natural observations and laboratory experiment which testify to changes in forming the chemical composition of groundwater in the zone of drain reclamation and to their effect on the underground water and streamflow.

INTRODUCTION

Monitoring of the groundwater level in the zone of drain reclamation is aimed at decreasing the moisture content, better aeration of the upper peat layers that change the ecological and geochemical conditions, under which the chemical composition of water is formed.

Reclaimed lands of the Byelorussian Polessie (the Pripyat basin) were taken for the study of the soil and underground water as well as the streamflow chemical composition in swapmed drainage basins.

RESULTS

It is found that draining increases the rate of biochemical mineralization of the organic matter in peat, causes the soluble oxidation products (sulphates, nitrates, carboxylic acids, ammonium etc.) to be formed. The mechanism of forming the soil solution composition depends on the groundwater level, the thickness and composition of the drained deposit, the duration and methods of farming. The latter fact has been established from the analysis of many years' observations over the changes in the hydrochemical composition on various plots of the Polessie Experimental Reclamation Station reclaimed by different means and at different times (Table 1). As follows from these data, draining and subsequent farming act to decrease pH,causes

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TABLE 1

Chemical composition of soil and ground water at Polessie Experimental Reclamation Station(mean annual content, mg/l)

Location	Observation terms, years	pH	HCO_3^-	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	$Na^+ + K^+$	Total ions
I. Soil and ground water, 0.03-2.0 m deep									
Reservation	1952-1961	6.4 6.0-7.0	62.8 34-134	3.0 0.9-8	1.8 0.1-10	19.7 12-38	1.8 0.1- 6	0.8 0.2-1	90.5 50-183
Reservation, early reclamation	1962-1969	6.3 6.1-7.0	65.0 11-161	9.9 0.4-30	6.1 0.2-19	22.3 11-46	4.3 1-10	4.1 0.2-11	107 31-231
Reservation drained	1976-1979	5.8 5.2-7.2	61.3 24-113	37.3 0-86	8.6 0.2-22	31.0 16-62	5.0 2-12	3.9 0.2-9	161 93-291
Plot, drained 5 years, not farmed	1976-1978	6.1 5.5-6.7	100.8 84-126	88.2 22-139	13.7 7-20	54.2 29-74	11.2 6-17	5.2 2.7-8	274 181-343
Plot, crop farming, 8-17 years	1976-1979	5.7 5.0-7.7	73.4 28-228	78.1 0-180	54.2 4-147	52.6 16-134	11.7 3-30	39.9 2.4-124	320 129-765
II. Underground water of antropogenic aquifers, 3.3-10.7 m deep									
Reservation, North and East part of plot under farming	1972-1973	6.8 5.5-8.0	126.5 21-271	19.3 1.6-90	16.2 5.1-37	38.5 8-66	6.7 1.2-13	10.5 0.1-43	220 40-440

Note: The numerator is the average; the denominator is the extreme contents.

a slight change of the hydrocarbonate ion concentration, results in a 20-fold increase of sulphates (from 3.0 to 78.1 mg/l), a 25-fold increase of chlorides, a more than two-fold amount of calcium, 5-times increase of magnesium and a more than 40-fold amount of alkali metals simultaneously; the total quantity of the salts rises at average 4 times. The soil and ground water has more sulphates, chlorides and alkali cations, as compared with the underground water of the underlying antropogenic aquifers (ref.1).

A special laboratory experiment performed for three years to investigate the variable water supply effect on the chemical composition of the peat water has revealed that by monitoring the groundwater level it is possible to control formation of its composition. Transition from overmoistening to a normal water supply and excess draining is accompanied by a decrease of the absolute contents and fractions of hydrocarbonates, an increase of concentrations of sulphates, chlorides, nitrates, organic carboxylic acid and ammonium, the latter two being intermediates of mineralization of organic matter of peat (Table 2). Natural observations and the laboratory experiment show that in the aeration zone sulphate, nitrate, chloride - sulphate and chloride - nitrate calcium groundwater is formed, that is not typical of the natural hydrochemical background (ref.2).

The hydrochemical changes on the drained soils involve the whole hydrosphere of the area under reclamation. In the aquifer underlying the surface, which is hydraulically connected with the peat soil, mixed hydrocarbonate and sulphate - chloride underground water is formed with different contributions (sometimes of primary importance) of chlorides, sulphates, alkali metals and calcium, that exceed the contents in the natural background typical of the antropogenic bed of Byelorussian Polessie, which amount to 3.5 to 20 mg/l, 3.5 to 35 mg/l, 3.5 to 15 mg/l, 7.5 to 50 mg/l, respectively.

Analysis of the changes in the chemical composition of the streamflow in the Pripyat drainage basin for the recent 10 years as compared with the time before reclamation (1950 to 1960) also indicates that the total mineralization of the river water has increased at average by 25 to 43% primarily due to concentrations of sulphates (2 to 2.5 times), chlorides (2.4 to 4 times), calcium (by 35-50%). Seasonal variations imply that the amount of soluble products supplied to river water with the surface flow (spring flood) increases (ref.3).

The results obtained are important for estimation of entrainment

of useful biological substances by water flow, regioning and mapping of the reclaimed areas, for development of the methods to protect water from pollutions.

TABLE 2

Change of the ion composition of peat water phase under alternating overmoistening and excess draining in laboratory experiment,% mg equiv.

Conditions	Observation time	
	the 1st year	the 2nd year
Overmoistening	$\frac{HCO_3 87\ SO_4 6\ Cl 6}{Ca 66\ Mg 16\ (Na+K) 14}\ \frac{NH_4 4}{}$	$\frac{HCO_3 55\ SO_4 21\ Cl 17\ NO_3 5}{Ca 58\ NH_4 22\ Mg 15\ (Na+K) 5}$
Normal water supply	$\frac{HCO_3 75\ SO_4 16\ Cl 9}{Ca 64\ Mg 18\ NH_4 17}$	$\frac{HCO_3 36\ SO_4 25\ Cl 17\ NO_3 11\ C^* 11}{Ca 55\ NH_4 24\ Mg 16\ (Na+K) 5}$
Excess draining	$\frac{HCO_3 69\ SO_4 16\ Cl 15}{Ca 59\ Mg 22\ (Na+K) 13}\ \frac{NH_4 6}{}$	$\frac{SO_4 30\ HCO_3 26\ C^* 16\ Cl 15\ NO_3 13}{Ca 77\ NH_4 9\ Mg 8\ (Na+K) 6}$

*C, unbalanced organic anions (carboxylic acids), the difference of the cation and anion sums.

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