The main characteristics of the aquasoils of the Ussuri Bay of the Sea of Japan

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Abstract. The manuscript presents the main characteristics of aquasoils (granulometric composition, organic carbon, acid-base properties, total nitrogen) of the shelf zone of the Ussuri Bay of the Sea of Japan. A clear relationship between the content of organic carbon and fractions of granulometric composition in the studied samples was revealed. The excess of the maximum permissible concentrations values for lead was detected for only one point. The rest of the aquasoils are not contaminated with lead.

1 Introduction

Currently, research is actively underway on the ecosystems of marine areas, especially coastlines, coastal areas, bays and bays washed by the seas or the sea itself. One of the main components of this ecosystem is soils and bottom sediments (aquasoils).

Aquasoils or underwater soils according to [1] are pedon formed at the bottom of reservoirs under the influence of soilforming processes, as a result of which an organomineral complex - humus is formed. Humus is a part of organic matter, which is an important component of the soil, representing a complex chemical complex of organic substances of biogenic origin [1].

The humus content in the soil is an important indicator of all biological processes in it. Organic matter in bottom sediments is formed mainly under the influence of the vital activity of microorganisms. The decomposition process of organic matter is influenced by air, moisture and the chemical composition of rocks. With a lack of air and an excess of moisture in the bottom sediments, conditions are created for an anaerobic microbiological decomposition process. Also, in addition to the activity of microorganisms, the accumulation of organic matter in bottom sediments is influenced by acid-base properties and granulometric composition, which further affect the indicator of their ecological condition.

In this regard, it is necessary to consider the content of organic matter in the bottom sediments of the Sea of Japan and their coastal territories for further assessment of their ecological status [1].

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2 Materials and methods

The objects of the study are aquasoils (bottom sediments) selected during expedition 85 of the voyage to the NIS "Academician M.A. Lavrentiev" using geological columns from depths from 11 m to 72.7 m (depth, excluding deposition of the vessel 4.25 m), a layered study of samples up to 10 cm in the shelf zone of the Ussuri Bay, located in the Peter the Great Bay of Primorsky region. The sampling diagram is shown in Figure 1.

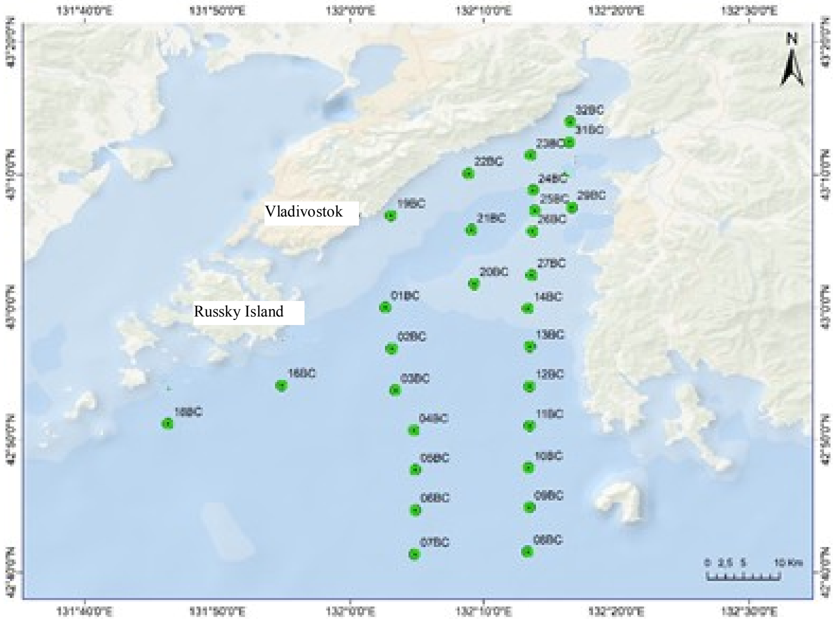

Fig. 1. Map-scheme of sampling of aquapoils of the Ussuri Bay of the Sea of Japan.

Standard soil analyses were used to determine the parameters, such as: soil pH was analyzed potentiometrically (Five Easy Plus FP20, Mettler Toledo, Russia) in suspension with 1 mol dm^{-3} KCl solution ratio 1:2.5 [2-3]. Soil organic carbon (Corg) content was measured using the wet combustion method—oxidation of soil organic matter (SOM) by a mixture of 0.07 mol dm^{-3} H_2SO_4 and $K_2Cr_2O_7$ with titration using Mohr's salt [4-5]. The content of heavy metals was determined by atomic absorption analysis on a Shimadzu AA-6800 spectrophotometer [6-7]. The granulometric composition of bottom sediments (aquasoils) was determined by the standard method [8], the total nitrogen content was determined by the standard method [9].

3 Results and Discussion

Soil acidity is a property of soils due to the presence of hydrogen ions in the soil solution and exchange ions of hydrogen and aluminum in the soil absorption complex [2-3]. It is divided into actual acidity – this is the concentration of hydrogen ions contained in the soil solution, when treating the soil (samples) with distilled water in a ratio of 1:2.5, potential acidity is the amount of hydrogen and aluminum ions associated with the solid phase of the soil, as well as exchange acidity – this is the amount of hydrogen ions displaced from the soil absorption complexes with neutral salt (KCl) [2-3].

Aquasoils formed in the north of the Ussuri Bay (samples 24, 29, 32) have a slightly acidic reaction of the medium - 6.19, 6.41, 6.45 (Table 1), presumably this may be caused by the proximity to the shore, with a depth of 33 m, 20.7 m, 11 m, respectively, as well as the impact of the Artemovka River, which flows into Muravinaya Bay. Also, slightly acidic values are present around O. Russian, in the west of the Ussuri Bay (samples 16,17), 6.46 and 6.47, respectively, but these values are quite close to neutral, but due to their proximity to the shore they are slightly acidic. In the north of the bay, near Askold Island, a slightly acidic reaction (6.29) is important, this is caused by depth and facies conditions. Thus, the study showed that in the Ussuri Bay, the pH depends on the depth and proximity to the shore, and the influence of sedimentary rocks also takes place.

The granulometric composition of the studied aquasoils of the Ussuri Bay is mainly represented by desalinated loam or loamy sand (Table 1, Figure 2), however, at points 21, 23, 24, 31 and 32, the granulometric composition is weighted to loam and powdery loam. This is due to the fact that these sampling points fall under the influence of terrigenous runoff, and are as close as possible to the coastline.

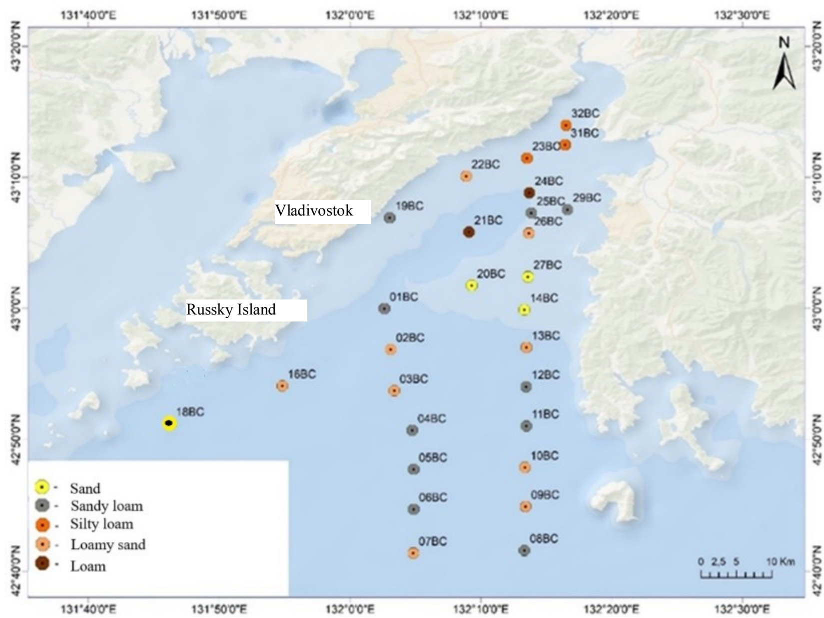

Fig. 2. Granulometric composition of aquasoils of the Ussuri Bay of the Sea of Japan.

According to the distribution of organic carbon in aquasoils, more than 1.00 % falls on points mainly near the shore (21, 23, 24, 25, 31, 32), where the transit zone passes and the rivers Artemovka, Petrovka, Gamayunova, Shkotovka flow into the bay, its content varies from 1.18% to 1.94% (Figure 3) The minimum of organic carbon (less than 0.50%) in bottom sediments is at four points 14, 18, 20, 27, where the sampling depth was 20-26 m. Most samples vary in organic carbon content from 0.50 to 1.00%. In general, the organic carbon content in bottom sediments does not reach 2.00%, regardless of the bottom of the relief and the proximity of the sampling points to the shore.

https://doi.org/10.1051/e3sconf/202449803015

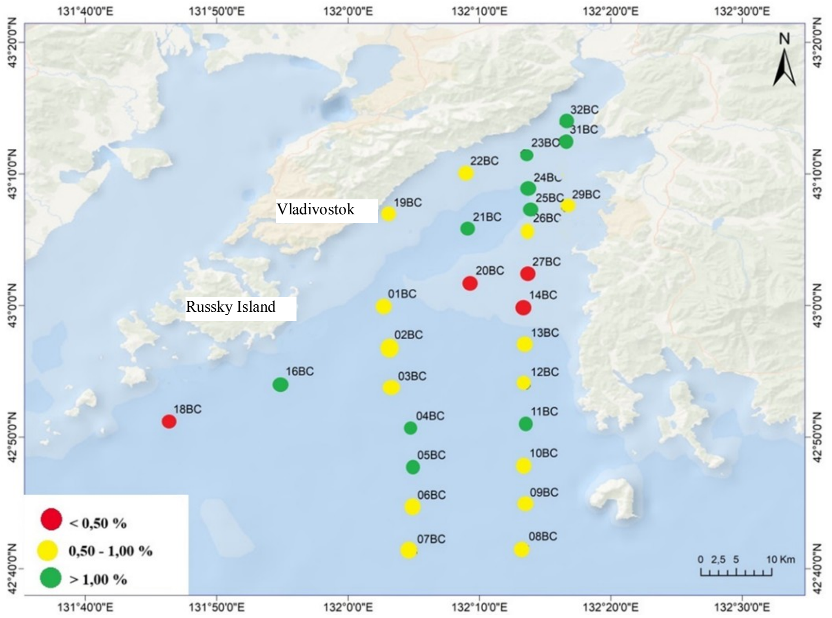

Fig. 3. The content of organic carbon in the aquasoils of the Ussuri Bay of the Sea of Japan, %.

Thus, studies have shown that the high content of organic carbon in the aquasoils of the Ussuri Bay of the Sea of Japan depends on the bottom relief, on the location of sampling points relative to the shore and transit zones, as well as on the granulometric composition, which is confirmed by the correlation between the content of organic carbon and the sum of the fraction of physical clay (r = 0.86) (Figure 4).

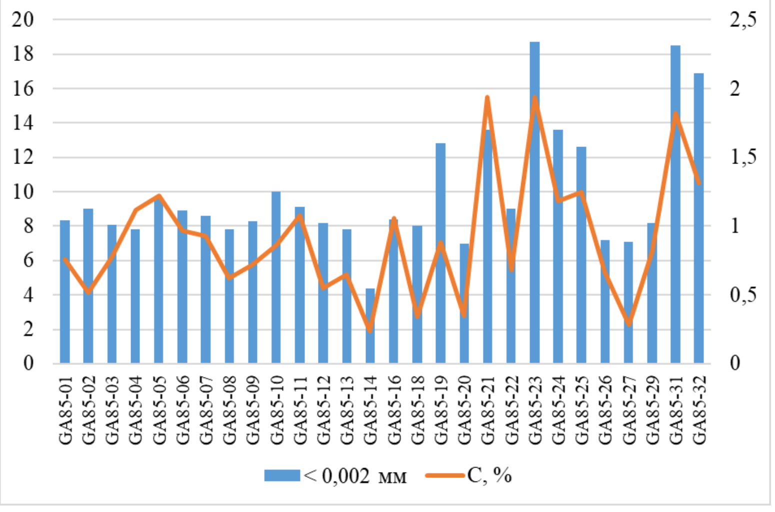

Fig. 4. Dependence of the granulometric composition and organic carbon in the aquasoils of the Ussuri Bay of the Sea of Japan.

According to the total nitrogen content in the aquapoils of the Sea of Japan, most of the studied samples contain nitrogen in the range from 0.12 to 0.32%, however, its maximum value falls at sampling points 21, 24, 31, 32 and varies from 0.41 to 0.94%. The minimum of total nitrogen is at points 6,10,14,16,18, where its content does not exceed 0.085%.

Since almost all carbon belongs to organic, based on carbon and nitrogen data, approximate data on the degree of mineralization of organic matter were obtained, which showed that high values fell at points 6.10, 16, where the C:N ratio ranged from 10.7 to 53.0 (Table 1). Perhaps this is due to the fact that organic matter does not contain nitrogen (nitrogen-free organic matter) or is a substance of non-organic origin (shell). In all other points, there is an almost uniform decomposition of organic matter from 2.0 to 8.0. The correlation between organic carbon and total nitrogen has shown a good relationship (r = 0,62).

Table 1. The main parameters of the aquasoils of the Ussuri Bay of the Sea of Japan.

No. sample	pH (H_2O)	pH (KCl)	Corg, %	Ntotal, %	The granulometric composition
85-01	5.96	5.95	0.76	0.33	Sandy loam
85-02	6.62	5.73	0.52	0.16	Loamy sand
85-03	6.73	5.7	0.77	0.12	Loamy sand
85-04	6.58	5.85	1.12	0.18	Sandy loam
85-05	6.5	6.15	1.22	0.16	Sandy loam
85-06	6.52	5.86	0.97	0.09	Sandy loam
85-07	6.52	5.45	0.93	0.34	Loamy sand
85-08	6.29	6.72	0.62	0.17	Sandy loam
85-09	5.81	5.63	0.72	0.26	Loamy sand
85-10	6.55	5.95	0.86	0.08	Loamy sand
85-11	6.1	5.93	1.08	0.30	Sandy loam
85-12	6.53	5.79	0.55	0.28	Sandy loam
85-13	6.78	5.92	0.65	0.22	Loamy sand
85-14	6.61	6.26	0.24	0.08	Sand
86-16	6.46	5.6	1.06	0.02	Sand
85-18	6.66	5.88	0.49	0.07	Loamy sand
85-19	6.71	6.17	0.35	0.21	Sandy loam
85-20	6.96	5.84	1.94	0.15	Sand
85-21	6.04	5.84	0.68	0.94	Loam
85-22	6.51	6.39	1.94	0.29	Loamy sand
85-23	6.13	5.99	1.18	0.22	Silty loam
85-24	6.19	5.61	1.25	0.42	Loam
85-25	6.8	6.52	0.67	0.14	Sandy loam
85-26	5.98	6.39	0.28	0.12	Loamy sand
85-27	6.56	5.94	0.82	0.13	Sand
85-29	6.41	5.79	1.82	0.23	Sandy loam
85-31	5.88	5.67	1.31	0.56	Silty loam
85-32	6.45	5.95	0.76	0.63	Silty loam

To assess the ecological state of aquasoils, data on the concentration of gross forms were obtained (extraction of gross forms of heavy metals is carried out using a solution of 5 molar nitric acid [6-7]) of heavy metals. In this paper, we present data on lead as the most toxic element (Figure 5).

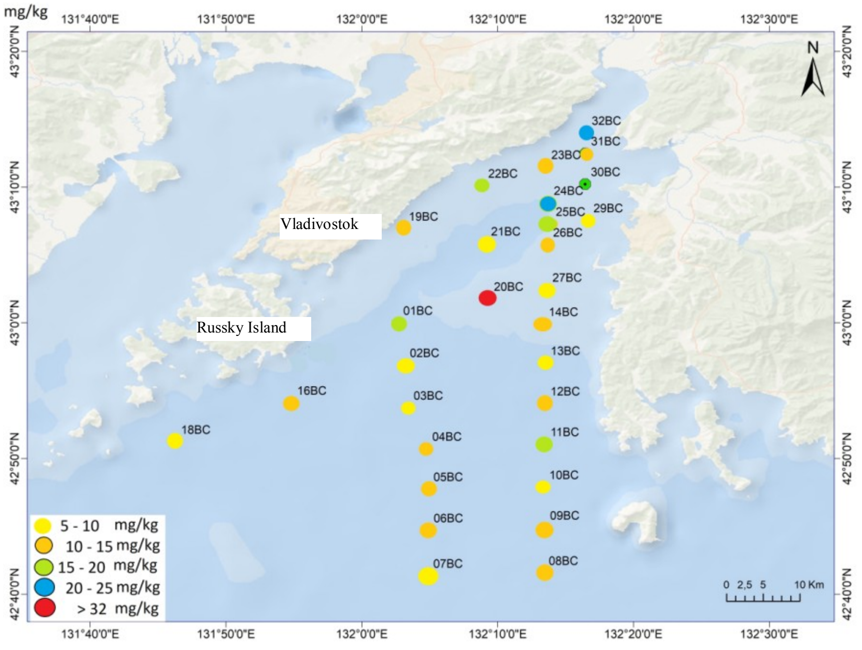

Fig. 5. The content of gross forms of lead in the aquasoils of the Ussuri Bay of the Sea of Japan, mg/kg.

In general, it can be seen that only at one point 85-20 we see an excess of the maximum permissible concentration [8] and amounts to 56 mg/kg. In this case, it is quite difficult to talk about anthropogenic pollution, especially since the Far Eastern region is characterized by the presence of geochemical anomalies with an increased content of lead, nickel and zinc in rocks [10]. If we characterize the entire study area, then the value of gross forms of lead ranges from 5 to 25 mg/kg and does not exceed the maximum permissible concentration of 32 mg/kg. The highest values of this element are characterized by aquasoils with a higher content of organic matter and with a predominance of fractions related to physical clay.

4 Conclusions

- The studied soils are slightly acidic, mainly sandy loam or clay sands, low-humus, with low nitrogen content.
- In general, aquasoils do not exceed the maximum permissible concentration for lead, with the exception of one station.

Acknowledgements

The work was carried out with the support of the State Assignment of the Ministry of Education and Science of the Russian Federation No. FZNS-2023-0011.

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