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FEATURES OF FORMATION OF SHORES OF VILYUY RESERVOIR (OSOBENNOST--ETC(U)
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Draft Translation 633
July 1977

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HANOVER, NEW HAMPSHIRE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Draft Translation 633	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FEATURES OF FORMATION OF SHORES OF VILYUY RESERVOIR.		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) I.P. Konstantinov and V.L. Sukhodrovskiy		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Cold Regions Research and Engineering Laboratory Hanover, New Hampshire		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE July 1977
		13. NUMBER OF PAGES 5
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

EROSION
SHORELINES
DAMS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report briefly discusses the climate and features of formation of the shores of the Vilyuy Reservoir. A table of erodibility coefficients of the rocks that make up the shores of the reservoir is presented.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DRAFT TRANSLATION 633

ENGLISH TITLE: FEATURES OF FORMATION OF SHORES OF VILYUY RESERVOIR

FOREIGN TITLE: OSOBENNOSTI FORMIROVANIYA BEREGOV VILYUYSKOGO VODOKHRANILISHCHA

AUTHOR: I.P. Konstantinov and V.L. Sukhodrovskiy

SOURCE: Yakutsk, 1975, 4th AU Union Conference on Study of Shores of Siberian Reservoirs, p.11-16.

Translated by Office of the Assistant Chief of Staff for Intelligence for U.S. Army Cold Regions Research and Engineering Laboratory, 1977, 5p.

NOTICE

The Vilyuyskoye reservoir has a very complicated configuration and consists of several large pools, connected by a valley-like narrows with steep, sometimes precipitous slopes. The total area of the reservoir is 2,170 km^2 and the water volume is 36 km^3. The length of the reservoir to Vilyuy is 400 km, and to its tributary, the Chona, 470 km. At its widest point it is not more than 15 km across and its depth near the dam is about 70 m.

The region in which the reservoir is located is structurally a denudation plain with absolute elevations of 300-400 m, made up basically of igneous trap rock formations and in places Permian sedimentary rocks. Paleozoic carbonates are also encountered.

The most common trap rocks are diabases, usually fissured and extensively weathered. The thickness of the weathering zone is 4-8 m and sometimes 10-15 m. The sedimentary and tuffaceous rocks, subjected to the action of factors of contact metamorphism and intrusion, exhibit even greater fracturing.

The loose cover is made up primarily of coarse sand-loam, often rubble eluvial and slide rock sediments, sand-gravel and sandy loam alluvium, and also peat-silt lake floor and marsh sediments. The thickness of the loose cover usually does not exceed a few meters.

The climate of the region is decidedly continental. The long cold winter, with a minimum temperature of -63°, is followed by a short, but warm summer with a maximum temperature of 36°. The mean annual air temperature is -8°. The annual precipitation varies from 250 to 300 mm, and only a fourth of the precipitation falls in solid form. The mean monthly wind velocity during summer is 3.8 m/s, and the maximum velocity, recorded during transitional times of the year, reaches 17 m/s.

In accordance with the climatic conditions, permafrost rocks with a thickness of 100 to 500 m are developed everywhere. Their temperature at the depth of zero fluctuations is -1 to -5°. The depth of seasonal thawing, depending on the exposure of the slopes, composition and moisture content of the rocks and the character of vegetation, varies from 0.5 to 4.0 m.

The characteristic feature of the water level mode of Vilyuy reservoir, which took 6 years to fill (1967-1973), is a sharp increase of the water level from the middle of May to the end of June, caused by spring floods. Then the water level falls as a result of idle and operational discharges.

During the thaw period, which lasts 4.5 months (15 June-1 November), the amplitude of level fluctuation during the last 4 years has been 4.2 to 6.3 m, and 2.1-2.8 m in the winter.

The temperature mode of the water was analyzed by stationary and intermittent observations in various parts of the reservoir. The distribution of the average water temperature by depth during the thaw period in the shore zone (Table 1), was determined on the basis of the data of a 4-year survey (1971-1974).

Table 1

Глубина расположения датчиков, м	Температура, °С					
	VI	VII	VIII	IX	X	Среднее
0,0	5,4	14,9	16,1	11,5	5,3	10,6
0,5	5,0	14,1	15,7	11,5	5,3	10,3
1,0	4,7	13,7	15,5	11,5	5,2	10,1
2,0	4,5	12,7	15,2	14,4	5,2	9,8
3,0	4,4	12,1	14,8	11,4	5,2	9,6
4,0	4,4	11,4	14,4	11,3	5,2	9,3
5,0	4,2	10,9	13,6	11,0	5,2	9,0

Key: 1, Depth of placement of sensors, m; 2, Temperature, °C; 3, Average

The mean annual water temperature at the surface is 4.4°; at depths of 1, 2 and 5 m, the temperatures are 5.4, 5.3 and 5.0°, respectively.

During the 4 years of observations the depth of thawing of the floor rock under the thawing influence of the water masses was 9 m for diabases and 6 m for sand. In the dry zone, formed as the result of lowering of the water level in the reservoir, in areas made up of sand, the up to 2 m thick layer that thaws during the summer completely refreezes in the winter.

Stationary observations of the wind wave mode of the reservoir, conducted over a period of 3 years (1972-1974) in the region of the Duraninskiy reach, disclosed that 84% of windy days were days with a mild breeze (3-5 m/s). Some 12% were days with a 6-8 m/s wind, and 4% of the days had even stronger winds.

Statistical processing of the data of wind observations revealed the dependence of wave height on wind velocity and distance (Table 2), and also disclosed periods of waves with different heights (Table 3).

Table 2. Average Wave Height, cm

1 Скорость ветра, м/с	2 Длина разгона волны, км						
	I,2	I,4	I,7	2,6	3,0	4,I	I2,7
3–5	II	I2	I5	I7	I9	22	32
6–8	I4	I6	2I	32	40	50	70
9–II	23	26	30	43	50	63	I20
I2–I4	25	30	35	–	55	–	I50
I5–I7	–	–	–	–	70	–	200

Key: 1, Wind velocity, m/s; 2, Wave travel distance, km

Table 3. Average Wave Periods, s

1 Годы наблюдений	2 Высота волн, см						
	4–I0	I5–30	35–50	55–70	75–90	95–II0	I20–200
I972	I,37	I,56	I,82	2,I5	2,48	2,60	4,00
I973	I,25	I,60	2,00	2,40	–	–	–
I974	I,20	I,74	I,78	2,I8	2,23	2,60	–
3 Средняя	I,27	I,64	I,86	2,24	2,35	2,60	4,00

Key: 1, Years of observations; 2, Wave height, cm; 3, Average

The wave parameters thus determined were used to determine the summary energy of wave action, the largest of which occurred in 1972, when it was 53,090 tm, and the least in 1974 at 22,630 tm. In other parts of the reservoir, where direct wind-wave observations were not conducted, wave heights were determined by calculations done by A. P. Braslavskiy's method.

The beginning of work on the shores of Vilyuy reservoir involved activation of cryogenic slope processes, the rate of which depends on the height and steepness of the banks and the ice content of the frozen rocks. The stated processes were the consequence of destruction of the soil and vegetation cover in the wave breaking zone. Chiefly cryogenic sliding of the surface layer of rock, up to 1 m thick, occurs on the bank slopes above that zone, and this process is most active in areas of carbonate rocks. According to V. L. Sukhodrovskiy's data, the slopes that do not experience undercutting are stabilized in 5-10 years.

It must be assumed that working of the shores of Vilyuy reservoir that are made up of magmatic trap rocks will occur somewhat more actively than on the analogous shores outside of the permafrost rock region. This should be facilitated by active freeze weathering under the conditions of the permanently wet shore belt, on which attention was focused on arctic islands (A. Jahn, 1961). The receding of the shores made up of rubble rock and coarsely fragmented materials, formed as the result of freeze weathering, occurred during the first years of the existence of the reservoir at a rate of 2 to 5 m per year with an erosion volume of 3-8 m^3/lm [linear meter].

Thermal karst relief forms occur in three sections of the shore slope of the reservoir, confined to zones of tectonic fracturing. They were formed as a result of the thawing of adjacent fractured ice blocks up to 2 m thick, and subsequent breakup of the loose sedimentary overburden. The size and shape of the thermal karst formations vary widely. This phenomenon is examined in greater detail, albeit from somewhat different points of view, in V. I. Spesivtsev's report.

During the first years of operation of the reservoir the receding of shores made up of sand occurred at rates of 4.4 to 7.7 m per year, and the respective volumes of eroded soil were 6.5 to 14.2 m^3/lm per year; for lime-sandstones -- 3 to 8.7 m (3.8-10.9 m^3/lm); for strongly weathered limestone 2.4 to 6.5 m (5.5-15.6 m^3/lm); for weathered tuff 1.8-3.3 m (4.0-7.9 m^3/lm).

The average width of the abrasion sand shelves is 8.1 m at a slope of 10°17'. For other rocks the shelf width is 3-4, and sometimes 5-6 m at a slope of 9-15°.

The greatest shore destruction of the reservoir occurs from late August-early September to the middle of October, when thawing of the floor rock and wind-wave activity increase appreciably. During strong storms with a maximum wave height of up to 2 m, which occur once or twice a season, the shore destruction process is accompanied by the formation of steep ledges and wave-cut recesses. The maximum dimensions of the latter in unfrozen sand are: lateral recession 4 m, height 1 m.

The erodibility coefficients of the rocks that make up the shores of the reservoir were determined by Ye. G. Kachugin's method (Table 4).

Table 4

Kind of rock	Erodibility coefficient, m^3/tm
Strongly weathered limestone	$47 \cdot 10^{-5}$
Sand	$30 \cdot 10^{-5}$
Strongly weathered tuff	$27 \cdot 10^{-5}$
Calcareous sandstone	$25 \cdot 10^{-5}$
Weathered diabase	$20 \cdot 10^{-5}$
Weathered marls	$12 \cdot 10^{-5}$
Limestone	$7 \cdot 10^{-5}$

It follows from Table 4 that the erodibility of the nonglacial permafrost rocks that make up the shores of Vilyuy reservoir is several times lower than that of the analogous rocks outside of the cryolithozone. This is attributed to the substantial strength of permafrost rocks because of the relatively low temperature and the slow rate of heat exchange processes between the reservoir and underlying permafrost rocks. The shortness of the thaw period also plays an important role in this regard.