

TOTAL LAKE WATER RESOURCES OF THE PLANET

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This paper is an attempt to evaluate approximately the amounts of water using the data on Eurasia, and then to give an approximate evaluation for the lake water resources on the Earth as a whole.

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The total area of the million lakes on the Earth amounts to 2.7×10^6 km². It is not easy to evaluate the lake water resources. Nineteen large lakes contain the main mass of lake waters *i.e.* 158.6×10^3 km³ of water (Table 1). 15 other large lakes, which are smaller in size but rather well known (Rudolf, Winnipeg, Nicoragua, Van, Venern, Athabasca, Edward, Dead Sea, Balkhash Alberta, Chad, Tana, Geneva, Sevan, Zaysan), contain 1.9×10^3 km³ of water. Small lakes contain much less water. The total amount of water in the small and smallest lakes is trifling despite the fact that they are so abundant and so large in area. This paper is an attempt to evaluate approximately the amounts of water using the data on Eurasia, and then to give an approximate evaluation for the lake water resources on the Earth as a whole.

The total lake area of the Earth amounts to 2.7×10^6 km²; the 19 largest lakes account for about 1×10^6 km², and all the other several millions of lakes for the remaining 1.7×10^6 km². Excluding the 6 largest lakes (Caspian,

TABLE 1

Largest lakes of the world (water volume ≥ 300 km³).

Item Nos.	Lake	Area, (10 ⁶ km ²)	Water volume, ($\times 10^3$ km ³)	Continent
1.	Caspian Sea .	0.424	76.8	Eurasia
2.	Baikal	0.031	22.8	Asia
3.	Tanganyika .	0.034	16.7	Africa
4.	Superior	0.082	12.2	North America
5.	Nyasa	0.031	5.8	Africa
6.	Michigan	0.058	5.1	North America
7.	Huron	0.060	4.1	North America
8.	Victoria	0.068	3.0	Africa
9.	Maracaibo . . .	0.013	1.9	South America
10.	Great Slave . .	0.029	1.8	North America
11.	Issyk-kul' . . .	0.006	1.7	Asia
12.	Ontario	0.020	1.6	North America
13.	Great Bear . . .	0.030	1.3	North America
14.	Aral Sea	0.066	1.0	Asia
15.	Ladoga	0.018	0.9	Europe
16.	Titicaca	0.008	0.7	South America
17.	Kivu	0.003	0.4	Africa
18.	Eric	0.026	0.3	North America
19.	Onega	0.010	0.3	Europe
	Total	1.017	158.6	
	Other lakes of the planet taken as a whole	1.683	7.4	
	Total	2.7	166	

Baikal, Issyk-kul', Aral, Ladoga, and Onega) in Table 1, all the other lakes in the territory of the USSR (2 814 723 lakes) account for 0.423×10^6 km², *i.e.* $\frac{1}{4}$ of the area of all the smaller lakes of the Earth (based on a total of 1.7×10^6 km²). Data obtained within the territory of the USSR and multiplied by a factor of 4 can be used to characterize the water resources of all the minor lakes of the planet. This relation (q) is further substantiated by the fact that about 95 % of the lakes in the USSR and 85 % of their total area are located between the 50 and 75th northern parallels, *i.e.* in the same latitudes as and under similar natural conditions (climatic, hydrological, etc.) to those of the overwhelming majority of lakes in other areas of the Earth (Finland, Scandinavia, North America and other areas). Data on the total number of lakes and their areas for the territory of the USSR are presented in Table 2 (the Caspian and the Aral Seas or lakes are excluded).

TABLE 2

Number and total area of water reservoirs within the territory of the USSR (according to Dubrovin *et al.*, 1971)

Water table area (km ²)	Number of water reservoirs (n)	Total lake area (S), (km ²)
< 1 ...	2 814 727	159 532
1 to 10 ...	36 896	87 075
10 to 50 ...	2 124	39 974
50 to 100 ...	234	15 939
100 to 1 000 ...	159	42 324
> 1 000 ...	26	143 596
Total	2 854 166	488 440

Interesting statistical relations (1) are revealed between the depth of a conventional lake belonging to the category under study and the total area of all the lakes covered by this category. These relations have been derived for lakes for which reliable data are available (Table 3). For lake categories with areas of 50 to 500 km², 500 to 5 000 km², and 5 000 to 50 000 km² the depth of the conventional lake per 1 km² of the areas of lakes belonging to a category grows by a factor of about 2 when passing to a group of lakes in a higher category. This relation (1) is

TABLE 3

Average depths of conventional lakes and lake categories (according to data on the USSR territory)

Lake category (km ²)	Number of Lakes (n)	Total area, S (km ²)	Total water volume of lakes (V) (km ³)	$l = \frac{V}{S}$ (m)
50—500 ...	82	11 663	56.3	4.8
500—5 000 ...	17	28 691	260.3	9.1
5 000—50 000 ...	5	117 290	2 381	20.3

Note: $l = \frac{V}{S}$ is the average depth of a conventional lake per 1 km² of the total lake area for a certain category of lakes (m).

also likely to be valid for lakes with smaller water table areas. Therefore, on the basis of this relation, the following average depths for conventional lakes may be expected: 2.4 m for the category with an area of $S = 5$ to 50 km², 1.2 m for the category with an area of $S = 0.5$ to 5 km², and 0.6 m for the category with an area of $S = 0.05$ to 0.5 km².

The relation between the average area of one lake from each category of lake areas and the category itself is also an essential factor (Table 4). If the average area of one category is increased by a factor of 10 (when passing from one category to a higher one), the average area of one lake will be about 10 times as large, and will be characterized by the following figure series: 2.4, 23.8 and 266.2. The following relation is obtained: $K = 2.4 \times 10^n$, where n is the category of lakes ($n = 0$ for category $S = 1$ —10 km², $n = 1$ for category $S = 10$ —100 km², $n = -1$ for category $S = 0.1$ —1 km², etc.). This natural relation can be employed for dividing lakes with areas of less than 1 km² into subcategories (these minor lakes whose area exceeds 2.8×10^6 within the territory of the USSR alone have been calculated in toto; detailed data regarding them are not available). Hence for lakes belonging to category $S = 0.1$ to 1 km² the average area of one lake will be 0.24 km², whereas for lakes belonging to category $S = 0.01$ —0.1 km² the average area of one lake will be 0.024 km². This relation (a tenfold increase with respect to the number 2.4) is also valid for lakes belonging to a higher category

TABLE 4
Area of an average lake in each lake category

Lake category (km ²)	Number of Lakes (n)	Total area, S (km ²)	Average area of one lake ($K = \frac{S}{n}$)	Remark
1—10	36 896	87 075	2.4	for the USSR territory
10—100	2 360	55 913	23.8	» » » »
100—1 000	159	42 324	266.2	» » » »
1 000—10 000	120	304 000	2 530	for the whole Earth

($S = 1\,000\text{--}10\,000\text{ km}^2$), *i.e.* the lakes of the whole planet.

The above relations may be used to calculate the total volume of all lake waters within the territory of the USSR (Table 5). The total amount of water in lakes with $S < 1\,000\text{ km}^2$ is only 770 km^3 and the share of lakes of the $S < 1\text{ km}^2$ category is only 121 km^3 . In addition the USSR has 12 natural lakes of the $S = 1\,000$ to $10\,000$ category with a water volume of $2.27 \times 10^3\text{ km}^3$ (Issyk-kul', Onega, Sevan, Alakol', Zaysan, Chudskoye, Khanka, Taimyr, Tengiz, Vyzozero, Belye, Chany), 4 lakes of the $S = 10\,000$ to $100\,000$ category with a total water volume of $24.12 \times 10^3\text{ km}^3$ (Baikal, Ladoga, Balkhash, Aral) and finally the Caspian Sea with a water volume of approximately $77 \times 10^3\text{ km}^3$. On the basis of total lake area, the territory of the USSR accounts for more than $\frac{1}{3}$ (35%) of the surfaces of all the lakes ($0.95 \times 10^6\text{ km}^2$ of $2.7 \times 10^6\text{ km}^2$) and for more than 62% of the lake water volumes of our planet.

As noted above, for the lakes of the $S < 1\,000\text{ km}^2$ category the total lake area of the whole planet is 4 times as large as the area of the lakes of the same categories located within the territory of the USSR; approximate data for the total area of lakes and their water volumes on the whole planet are presented for the different lake categories in Table 6. The total amount of lake waters on the Earth as a whole is approximately $166 \times 10^3\text{ km}^3$ (Table 7). Of this amount, the 19 largest lakes account for 95.5% and the 15 large lakes for 1.2% of the lake water volume. Thus, the 34 largest and large lakes account for 96.7% of total amount of lake water resources. The data on these lakes are most exact. The lakes with $S < 1\,000\text{ km}^2$ account for a total of about 2% of all lake water volumes; it was particularly for this two per cent and the fractions of it that the various relations mentioned above (q, l, k) were used, and therefore their possible variations cannot have any great effect on the total lake water balance of the planet. These relations were

TABLE 5
Lake water volumes within the USSR territory

Lake category (km ²)	Number of Lakes (n)	Total area, S (km ²)	Water volumes, V	
			($\times 10^3\text{ km}^3$)	%
< 1	2 814 727	159 532	0.12	0.12
1—10	36 896	87 075	0.15	0.14
10—100	2 360	55 913	0.20	0.19
100—1 000	159	42 324	0.30	0.29
1 000—10 000	12	43 830	2.27	2.18
10 000—100 000	4	133 500	24.12	23.21
> 100 000	1	424 300	76.80	73.87
Total	2 854 159	946 474	103.96	100.00

TABLE 6
Total evaluation of water resources in minor and medium-size lakes

Lake category (km ²)	Number of Lakes (n)	Total area, S (km ²)	Average Area per One Lake, $k = \frac{s}{n}$	$f = \frac{V}{S}$	Water volume, V (km ³) for the USSR	q	Total amount of Lake Waters on the Planet
0.01—0.1	2 389 727	57 353	0.024	0.5	29	4	116
0.1 —1	425 000	102 000	0.24	0.9	92	4	368
1—10	36 896	87 075	2.4	1.7	148	4	592
10—100	2 360	55 913	23.8	3.5	195	4	780
100—1 000	159	42 324	266.2	7	296	4	1 184

derived on the basis of statistical calculations performed on almost three million lakes. However, as the majority of these lakes are small and located in lowland plain and low-mountain areas, the values presented here characterize primarily such areas; for the mountain areas where the number of lakes is usually not large, the parameters vary and acquire other values. It is interesting to note the variation of the lake size coefficient (f), which is the average total lake area of the region per one lake; f refers to lakes of various categories and k to lakes of a certain category in larger regions (continents, etc.). This

coefficient has minimum values (f = 0.04—0.2) when applied to lowland, plain, low-mountain, and high-latitude middle-mountain regions, intermediate values (f = 0.5 to 1.1) when applied to medium-latitude and low-latitude middle-mountain regions, and maximum values (f = 1.3 to 3) when applied to high-mountain regions.

The distribution of lake waters with respect to sea level is shown in Table 8. The largest percentage of lake waters (58 %) is located below sea level.

Such are the new data on the lake water resources of our planet. The area occupied by lakes

TABLE 7
Total amount of lake waters on the Earth

Lake categories (lakes or their areas), (km ²)	Total Lake water volume		Number of Lakes on the Earth	Remark (lakes)
	(× 10 ³ km ³)	%		
Largest lakes	158.6	95.54	19	Caspian, Baikal, Tanganyika, Superior, Nyasa, Michigan, Huron, Victoria, Maracaibo, Great Slave, Issyk-kul', Ontario, Great Bear, Aral, Ladoga, Titicaca, Kivu, Eri, Onega.
Large lakes	2.0	1.20	15	Rudolf, Vinnipeg, Nicoragua, Van, Venern, Athabasca, Edward, Dad Sea, Balkhash, Albert, Chad, Tana, Geneva, Sevan, Zaysan.
Medium and Minor Lakes -Category:				
1 000—6 000	2.2	1.33	120	
100—1 000	1.2	0.72	600	
10—100	0.8	0.48	~ 10 000	
1—10	0.6	0.37	~ 150 000	
0.1—1	0.4	0.24	~ 1 700 000	
< 0.1	0.2	0.12	~ 10 000 000	
Total	166	100		

TABLE 8

Distribution of water volumes in the main lakes of the Earth with respect to the oceanic level

Item No.	Lake	Area of Lake ($\times 10^3$ km ²)			Total water volume ($\times 10^3$ km ³)		
		at water table level of lake	at oceanic level	at -0.2 km level	Below sea level	Above sea level	Altogether
1.	Caspian Sea	424	424	112	77	—	77
2.	Baikal	31	19	16	11	12	23
3.	Tanganyika	34	8	—	1.7	15	16.7
4.	Superior	82	28	—	2	10.2	12.2
5.	Nyasa	31	0.6	—	0.05	5.8	5.8
6.	Michigan	58	6	—	0.2	4.9	5.1
7.	Huron	60	0.8	—	0.01	4.0	4.0
8.	Maracaibo	13	13	6	1.9	—	1.9
9.	Ontario	20	10	—	0.5	1.1	1.6
10.	Aral	66	0.8	—	0.00	1.0	1.0
11.	Ladoga	18	17	—	0.8	0.1	0.9
12.	Onega	10	4	—	0.1	0.2	0.3
13.	Venera	5	1	—	0.024	0.14	0.26
14.	Ded Sea	1	—	1	0.1	—	0.1
	Total	853	532	135	95	54	149

(2.7×10^6 km²) amounts to 0.75 % of that occupied by oceans (361.2×10^6 km²) whereas lake water resources (0.166×10^6 km³) amount to only 0.012 % of the volume of oceanic waters (1.353×10^6 km³). In spite of that, lakes provide scenic diversity to the landscape of the Earth and frequently beautify it, thus characterizing the originality and the inimitable picture of the face

of our planet among all the other planets of the solar system.

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