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SURFACE AND GROUND WATERS IN TERRESTRIAL PERMAFROST REGION

CURRENT STATE OF PERIGLACIAL LAKES ON SVALBARD

R.A. Chernov[1], K.V. Romashova[2]

[1] *Institute of Geography, Russian Academy of Sciences,*
Staromonetnyi per. 29, Moscow, 119017 Russia; chernov@igras.ru
[2] *Arctic and Antarctic Research Institute,*
Beringa str. 38, Saint Petersburg, 199397 Russia

The current state of periglacial lakes on Svalbard and their quantitative estimates are presented. These lakes were formed in depressions upon recent recession of glaciers on the archipelago. Based on the Norwegian aerial imagery 2008–2012 and mosaics of Maxar Vivid 2013–2019 images of Svalbard, 629 new periglacial lakes have been identified in the areas released from glaciers. The map of new lakes and their distribution across the territory by different heights are presented. Most of periglacial lakes are located in the western and southern parts of Svalbard, where large-scale retreat of the glaciers has been observed. At the same time, new periglacial lakes are formed mostly in the northern and eastern parts of the archipelago, where most of the lakes have ice coasts. The total length of ice coasts of 306 lakes in 2008–2019 reached 233.8 ± 0.6 km, which is comparable with the length of the fronts of Svalbard outlet glaciers. The total area of periglacial lakes is 173.1 ± 0.7 km^2, and their total water volume ranges from 2.1 to 2.3 ± 0.1 km^3.

Keywords: *periglacial lakes, ice-contact lake, glacier retreat, lake area, Svalbard*

INTRODUCTION

The Svalbard archipelago is located in the northern part of the Atlantic Ocean; its climate promotes the spread of glaciers of various types. In the north and south of the largest island of the archipelago (West Spitsbergen), ice caps and semi-sheet Spitsbergen-type glaciers prevail; on Prince Charles Foreland and in the central part of West Spitsbergen (Nordenskiöld Land, Dixon Land, and Andre Land), numerous mountain glaciers are common; in the Northeastern Land, Barents and Edge islands, sheet glaciation prevails. To date, the glaciers of the archipelago cover about 60 % of the land area [*Hagen et al., 1993; Zemp et al., 2015*], their area is estimated in the range of 33 600–33 850 km^2 [*Nuth et al., 2013; Pfeffer et al., 2014*]. On about 68 % of the glaciation area, ice is discharged by outlet glaciers into the sea [*Błaszczyk et al., 2009; Nuth et al., 2013*]. In relation to climate changes in the Arctic, the glaciation of Svalbard is in the stage of degradation, which began in the first half of the twentieth century [*Troitsky et al., 1975; Kotlyakov, 1985*]. The maximum values of glacier recession are observed in the western territories, where the fronts of many mountain-valley glaciers retreated by 1.0–2.5 km over the past century [*Pfeffer et al., 2014; Chernov and Muraviev, 2018*]. Thus, since 1936, the glaciation area in Prince Charles Foreland has decreased by 51 %; in Nordenskiöld Land, by 49 %. In total, from 1936 to 2017, glaciated area in these regions reduced by 225 km^2 and continues to decrease with an average rate of 2 km^2 per year [*Chernov et al., 2019b*].

In the deglaciated area, a hilly moraine relief is formed; the degree of its dissection is directly related to the type of glaciers [*Troitsky, 1970*]. The presence of depressions and ridges in moraine complexes promotes the formation of a large number of periglacial lakes. By the end of the 20th century, 1606 large lakes were discovered in the polar regions, most of which lie in the northern territories of the continents [*Ryanzhin et al., 2010*]. Modern studies confirm an increase in the number of glacial lakes in the Arctic, which is primarily noted in Iceland, in the Canadian Arctic archipelago, and in Greenland [*Luthje et al., 2006; Harrison et al., 2018; Carrivick and Fiona, 2019*]. There are many lakes of different origins in Svalbard; their total number in the archipelago is unknown. When comparing maps based on aerial photographs of 1936–1937 with recent electronic maps of the archipelago, numerous lakes can be found in the areas previously occupied by glaciers. These lakes lie within the limits of the terminal and lateral moraines formed during the maximum glaciation, i.e., at the end of the 19th–the beginning of the 20th century. Descriptions of the periglacial lakes of Svalbard are extremely rare in the scientific literature [*Luthje et al., 2006; Harrison et al., 2018; Carrivick and Fiona, 2019*].

In high-altitude regions and in the Arctic, the expansion of lakes due to the retreat of glaciers has been noted [*Mool et al., 2001; Nie et al., 2018*], and the scale of this phenomenon makes it possible to effectively use remote sensing methods to search for lakes [*Strozzi et al., 2012*]. Regional studies of periglacial lakes are concentrated in the highlands, as they are important for assessing water resources and possible risks of glacial lake outburst floods (GLOFs). These dangerous phenomena cause a threat to the population and infrastructure located downstream [*Harrison et al., 2018; Carrivick and Fiona, 2019*]. In the polar regions, GLOFs are also known [*Groswald and Koryakin, 1962; Carrivick and Tweed, 2016; Nie et al., 2018; Chernov and Muraviev, 2020*]. In Svalbard, there is information about only a few lakes, where the events of their breakthrough and their formation are reported [*Liestøl, 1977; Liestøl et al., 1980; Hambrey, 1984; Kokin and Kirillova, 2017*].

Periglacial lakes are an important component of the landscape in the marginal part of mountain glaciers and glacial sheets. Lakes located in moraine periglacial environments contribute to the melting of dead ice, change the temperature regime of the surrounding space and the underlying surface, and, in the case of large-scale GLOFs, can transform the entire landscape. According to the scenario of the reference level of greenhouse gas emissions RCP4.5 by 2100, Svalbard is predicted to warm by 5–8 °C with a slight increase in precipitation compared to the end of the twentieth century. In this regard, it is expected that the glaciers of Svalbard will lose up to 50 % of their mass [*Zemp et al., 2015; http://archive.ipcc.ch/pdf…*]. It can be expected that the expansion of periglacial lakes will continue in deglaciated areas. This paper presents the current state of the periglacial lakes in Svalbard. Quantitative estimates are given in accordance with the administrative division of the archipelago by the name of the Lands [*http://toposvalbard.npolar.no/*]. The results of this study can be helpful for assessing climate changes in the archipelago taking into account the dynamics of lake formation.

METHODS

According to the first descriptions of the Arctic periglacial lakes, their location may be different in relation to the glacier, and they are also distinguished by the origin of lake depression [*Grosvald and Koryakin, 1962*]. To search for these lakes, marginal areas of the glaciers and the territory covered with moraine deposits have been considered. On topographic maps of the archipelago of 1937–1938, the areas of moraine deposits were marked with conventional signs. Also, these conventional signs are present on modern electronic maps [*http://toposvalbard.npolar.no/*]. At the same time, their outer boundaries coincide with the boundaries of the terminal moraines, which are clearly distinguishable in the background of electronic maps – aerial photographs of 2008–2012. Apparently, they point to the historical maximum of glacier advance, which was reached in the 19th and at the turn of the 20th century after the end of the Little Ice Age [*Mangerud et al., 1992*].

The search for lakes was carried out using the cartographic service of the Norwegian Polar Institute "KartoverSvalbard" [*http://toposvalbard.npolar.no/*], which is based on aerial photography of 1990 for the south of Svalbard and of 2008–2012 for its central and northern territories. In the southern part of Svalbard, the lakes were searched using the Maxar Vivid 2013–2019 mosaic of images available in the ESRI WorldImagery dataset. The spatial resolution of the data set is 1.2 m. The territorial and land division of the archipelago is adopted in accordance with the cartographic service "KartoverSvalbard".

As the basis of this inventory, lakes located in front of the glacier, or along its side within the lateral moraine or beyond, but dammed up by the moraine were considered. Lakes with a length of more than 100 m were taken into account, because smaller objects gave significant errors when measuring their length (including the length of their contact with ice) and area on digital maps. In addition, small lakes were hardly distinguishable on the available satellite images. For the lakes of less than 100 m in length, there were difficulties in their visual identification, especially for small open lakes, which may be temporary seasonal objects. The maximum length of the lake was a criterion, which allowed us to select lakes quickly, as assessing their area is a more time-consuming task. Numerous lakes located on sea terraces remote from glaciers and lying outside the moraines are not periglacial lakes and, therefore, were not taken into account. Also, the lakes located entirely on the surface of the glaciers were not considered, because their lifetime may be short-term.

The following characteristics of the lakes were measured: lake area, maximum length, altitudinal position, length of the ice coast, and coordinates of the center of the lake. We also took into account the name of the nearest glacier and the name of the region in accordance with the territorial division of the archipelago. Measurements of the length of lakes, their area, and the extent of the ice coasts were made manually using the built-in tools of the cartographic service "KartoverSvalbard" and the open-source source QGIS. The maximum length of the lake was defined as the distance between the most distant points of the shores, the position of which was assessed visually. Since measurements of the maximum length of the lake and its icy shores were carried out manually, the accuracy of determining the extreme points was assumed to be 10 m. Thus, the larger the size of the lake or its ice coasts, the smaller the relative error of measurements. The total error of the length of ice coasts of the lakes was is estimated as the mean square deviation, which was equal to 0.6 km.

RESULTS

Based on electronic maps presented on the website of the Norwegian Polar Institute and a mosaic of

MaxarVivid images, the characteristics and position of periglacial lakes throughout the archipelago were determined. As of 2008–2019, 629 lakes with the maximum length of more than 100 m were found. Half of them (306 lakes) had ice coasts, i.e., they were in contact with glaciers. We also identified 47 dammed lakes, among which 5 lakes were dammed by a lateral moraine, and the rest were dammed directly by glaciers. The maximum length of the lakes was in the range from 100 to 8640 m, the average value was 600.5 m. The area of lakes varied widely from 0.002 to 17.34 km^2, the average value was 0.27 km^2. The total area of all the lakes was 173.1 ± 0.7 km^2.

The position of the periglacial lakes in the archipelago is shown in Fig. 1. Lakes that have ice coasts are obviously in the formation stage, since their shores are changeable.

Despite different rates of glacier degradation and noticeable climatic differences between southern and northern territories, periglacial lakes are found everywhere in the archipelago. The southern and western parts of the archipelago are dominated by lakes that were formed on moraines and have no contact with glaciers. On the western coast of the archipelago and in the area of the Isfjord, the reduction of glaciers was noted in the second half of the twentieth century [*Kotlyakov, 1985*] and occurred on the largest scale [*Pfeffer et al., 2014*]. In the north and northeast of the archipelago, lakes with ice coasts predominate (Fig. 1). Apparently, the reduction of glaciers began in the north later than in the south.

Relatively few periglacial lakes are located in the central region of the archipelago, where mountain glaciation is widespread. There is also a significant reduction of mountain glaciers. In the central part of Andrée Land, there are small periglacial lakes with a maximum length of up to 350 m. This may be due to the fact that the narrow mountain valleys in Andrée Land and the complex relief of moraine complexes prevent the formation of large lake depressions. On the east coast of Svalbard, significant territories are occupied by outlet glaciers. Lakes are located mainly on lateral moraines, and lakes with ice coasts are often found. A significant number of lakes are located on the Edge Island and in the marginal part of the glacial sheet on the North-East Land island.

The general distribution of periglacial lakes by the lands of Svalbard is presented in Table 1. These data do not adequately reflect the overall spatial picture because of the differences in the relief, area occupied by glaciers, actual size of the particular lands. However, a clear tendency towards a decrease in the share of lakes with ice coasts (Table 1) from the north-

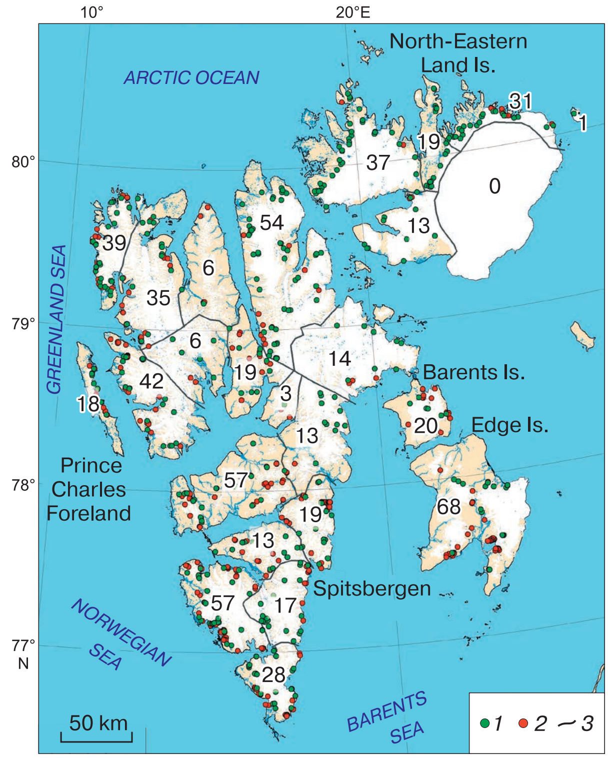

Fig. 1. The position of periglacial lakes in the Svalbard archipelago:

(*1*) lakes with ice coasts (contacting with glaciers), (*2*) lakes without ice coasts, (*3*) boundaries of Svalbard Lands. Numbers indicate the number of lakes within the boundaries of the Lands.

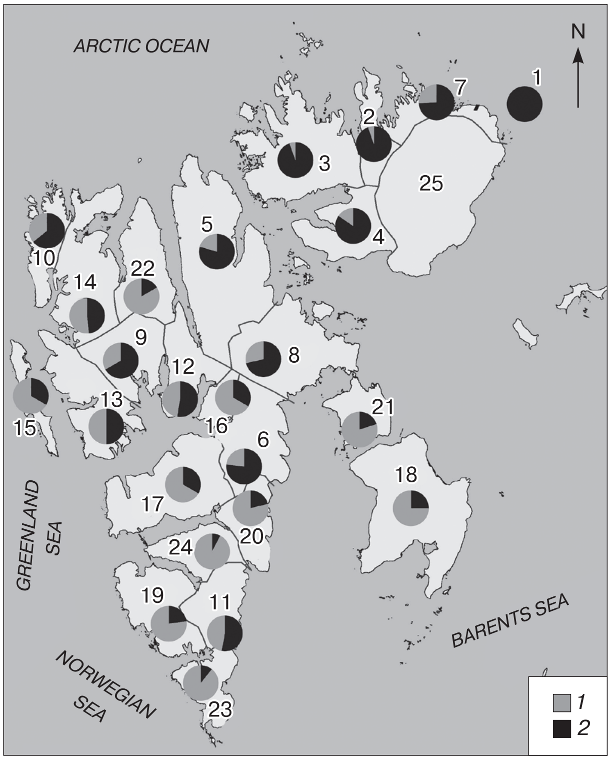

Fig. 2. The proportion between formed periglacial lakes (*1*) and lakes with ice coasts (*2*).

Numbers indicate Land numbers in accordance with Table 1.

Table 1. **Location of periglacial lakes on the Lands of the archipelago, their number, and proportion of lakes with ice coasts**

No.	Land	Average latitude, N	Part of the archipelago	Number of lakes	Number of lakes with ice coasts	Proportion of the lakes with ice coasts
1	Storoya	80	E	1	1	1.00
2	Prins Oscars	80	NE	19	18	0.95
3	Gustav V	80	NE	37	35	0.95
4	Gustav Adolf	80	NE	13	11	0.85
5	Ny-Fries	79	N	54	43	0.80
6	Sabine	78	E	13	10	0.77
7	Orvin	80	NE	31	23	0.74
8	Olav V	79	E	14	10	0.71
9	James I	79	W	6	4	0.67
10	Albert I	79	N	39	25	0.64
11	Torell	77	S	17	9	0.53
12	Dickson	79	Center	19	10	0.53
13	Oscar II	79	W	42	21	0.50
14	Haakon VII	79	N	35	17	0.49
15	Prins Karls	78	W	18	6	0.33
16	Bunsow	79	Center	3	1	0.33
17	Nordenskiold	78	Center	57	19	0.33
18	Edgeoya	78	E	68	17	0.25
19	Wedel Jarlsberg	77	S	57	13	0.23
20	Heer	78	E	19	4	0.21
21	Barentsoya	78	E	20	4	0.20
22	Andree	79	N	6	1	0.17
23	Sorkapp	77	S	28	3	0.11
24	Nathorst	78	S	13	1	0.08
25	Harald V	79	NE	0	0	0.00

northeast towards the south-southwest cab be seen southwest (Fig. 2). In the northern, northeastern, and eastern territories, where the climate is more severe, the share the proportion of lakes with ice coasts exceeds 74 %; in the center of the archipelago, it is about 50 %; in the west and south, less than 50 %. The mountainous territories of Andrée Land and Torell Land are separately distinguished by a small number of lakes because of the complicated mountainous relief.

The altitudinal range of periglacial lakes in the archipelago is very wide and extends from 1 to 840 m. However, 3/4 of the lakes lie below 200 m a.s.l. The average level of all lakes is 127 m a.s.l.; the average level of lakes with ice coasts is slightly higher and equals 175 m a.s.l.

Figure 3 demonstrates a diagram that reflects the altitudinal distribution of periglacial lakes by five equal ranges of heights. Obviously, with altitude, the number of periglacial lakes decreases, and the portion of lakes with ice coasts gradually increases. At the same time, lakes with ice coasts are relatively evenly distributed by heights below 500 m a.s.l. (Fig. 3).

Apparently, the long-term reduction of glaciation in the archipelago is manifested in the entire altitudinal range, which is clearly reflected in the formation of new lakes. This diagram illustrates the current moment of lake expansion in Svalbard; this process is close to the end at low hypsometric levels and is still active at higher levels. In general, the formation of new lakes in the archipelago is far from the end; only about half of all lakes (51 %) have been formed completely and have lost contact with glaciers.

Among the 629 lakes counted, the length of which exceeds 100 m, about 13 % (87 lakes) have a maximum length of more than 1 km. The average height of these lakes is 97 m a.s.l. These two indicators (length >1 km and altitudinal position) indicate the potential of periglacial lakes for the organization of temporary runways and the design of hydraulic

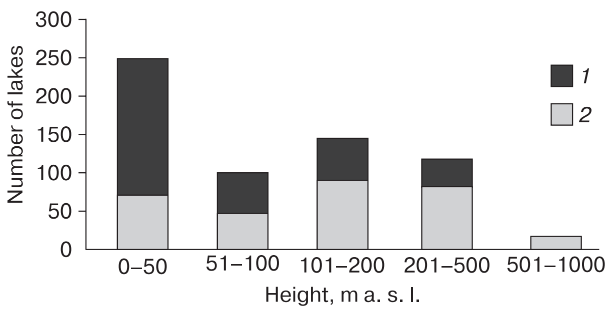

Fig. 3. Diagram of the distribution of lakes by altitude ranges:

(*1*) periglacial lakes, (*2*) lakes with ice coasts.

Table 2. **The largest periglacial lakes of Svalbard**

Lake name	Glacier in the lake basin	Land	Coordinates of the lake center	Height, m a.s.l.	Lake area S, km^2	Maximum length L, m	Length of ice coast, m
Trebrevatnet	Morabreen	James I	78.82506 N, 14.43698 E	17	17.31	8640	4760
Gandvatnet	Gandbreen	Edgeoya	77.71357 N, 22.81509 E	15	9.85	7680	7220
Brånevatnet	Etonbreen	Gustav Adolf	79.78787 N, 22.00294 E	10	8.83	5230	5420
Femmilsjøen	Longstaffbreen	Ny-Fries	79.78611 N, 15.87055 E	27	7.58	7630	1010
No name	Amenfonna	Gustav V	79.89795 N, 22.04735 E	246	6.42	5650	1140
Jäderinvatnet	Vonbreen	Haakon VII	79.25511 N, 13.81527 E	9	5.85	3950	1493
No name	Eidembreen	Oscar II	78.37686 N, 12.84774 E	2	5.17	5660	3920
Flysjøen	Austfonna	Prins Oscars	79.81992 N, 22.36555 E	141	4.96	4340	5370
Venesjøen	Austfonna	Prins Oscars	79.86286 N, 22.64040 E	244	3.75	3020	3240
No name	Hochstetterbreen	Olav V	78.88028 N, 20.77939 E	23	3.48	3190	1230

structures. About 5 % (35 lakes) on the archipelago have an area of more than 1 km^2, and they are relatively evenly distributed by heights from 1 to 250 m a.s.l. The characteristics of the largest periglacial lakes of the archipelago are given in Table 2. Their location is associated with vast flat spaces near the marginal part of glacial sheets and within wide valleys developed by outlet glaciers in the past. Also, several large lakes were formed in the side valleys dammed by glaciers.

The general nature of the formation of periglacial lakes is indicated by the correlation between the maximum length of lakes and their area. The relationship between these values attests to the appearance of a stable dependence as lakes of increasingly large sizes are included in the data array. A low correlation of these values is typical for small lakes with a length of less than 200 m (Table 3). Lakes, the length of which does not exceed 500 meters, constitute about two thirds of the total number of lakes. For these lakes, the relationship between their lengths and areas is statistically significant with the determination coefficient R^2 of 0.76. For the entire data array, the approximation accuracy improves, and the R^2 value reaches 0.93 (Fig. 3).

The relationship of the maximum length (L) and area (S) on a logarithmic scale is shown in Fig. 4 and is approximated by a continuous power function (1) with coefficients a and b equal to 0.5 and 1.8. The array of points is bounded at the bottom by a similar function with coefficient b equal to 1.4. The trend line actually coincides with the dependence:

$$L = b(S)^{a}, \tag{1}$$

where a = 0.5, and b = 1.8.

The obtained dependence directly indicates the common nature of the formation of periglacial lake depressions, which is important with a limited amount of information about measurements of the lakes' depths. To estimate the total volume of periglacial lakes based on the field hydrological survey in the area of Grønfjorden, the ratio of the average depth of the lake to its maximum length (A value) was calculated. It ranged from 0.010 for small lakes to 0.021 for large lakes. One of the largest lakes in this area is Lake Bretjorna with a maximum length of 2280 m and a maximum depth of 28 m. The average depth of the lake is 13.8 m. The maximum depth of numerous small lakes that occur on the moraines of glaciers in the fjord basin is 4–5 m.

Taking into account the nature of shaping lake depressions, we can use the A value to estimate the average depth h of lakes as:

$$h = AL + h_0, \tag{2}$$

where A = 0.021; L is the maximum length of the lake; and h_0 is the minimum average depth.

Table 3. **The value of the coefficients in Eq. (1) in dependence on the number of considered lakes**

Range of maximum lengths, m	Number of lakes	Share lakes with ice coasts	Value of the coefficients in Eq. (1)		Reliable approximation R^2
			a	b	
100–200	152	0.24	0.30	10.5	0.53
100–500	429	0.68	0.44	3.4	0.76
100–1000	534	0.85	0.47	2.6	0.85
100–1500	572	0.91	0.49	2.2	0.88
100–2000	592	0.94	0.49	2.0	0.89
100–2500	604	0.96	0.49	1.9	0.90
100–3000	612	0.97	0.50	1.8	0.91
100–4000	619	0.98	0.50	1.8	0.92
100–9000	629	1.00	0.50	1.8	0.93

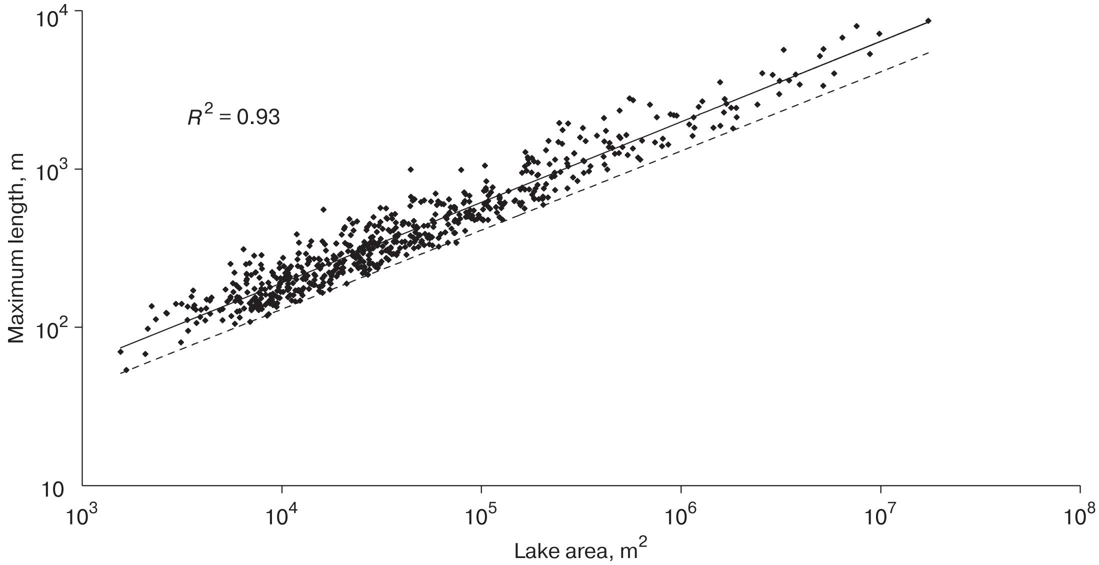

Fig. 4. The relationship between the maximum length and the area of the lakes.

Dotted line is the lower envelope line of the array of points.

This dependence was derived from the study of periglacial lakes in the Alps by *S. Cook and D. Quincey* [*2015*]. The authors assumed that the minimum average depth of lakes in the glacial landscape h_0 is 1.2 m. This value corresponds to the depths in small thawed out lakes and correlates with the depth of soil thawing in the summer. Dependence (2) satisfies the data of field observations for lakes of various scales. However, for large lakes, the average depth as a function of the length of the lake begins to take unrealistic values, so it is limited to 15 m. Then, the volume of each lake is equal to the product of the area of the lake and its average depth. Summing up all the volumes and taking into account the assumptions, we get an estimate of the volume of water contained in the lakes of the archipelago. The total volume of water in the lakes is 2.1 ± 0.1 km^3. For the whole set of lakes, the average depth turned out to be 12.5 m, which quite plausibly correlates with height differences within the areas with the ridged moraine relief.

At the same time, realistic estimates based on morphometric indicators of the landscape (incision of riverbeds, height difference of ridges, etc.), suggest that the minimum depth of lakes h_0 reaches 4.5 m. Then, according to the calculation by formula (2), the total volume of lakes increases slightly and becomes equal to 2.3 ± 0.1 km^3. The maximum value of the average depth, which in our case was equal to 15 m, has a more significant contribution to the volume estimation.

A feature of the current state of periglacial lakes is that they can be in the formation stage for a long time and change their configuration while they are in contact with the glacier and dead ice masses. Therefore, significant spatial variability of their boundaries is possible for the northern and northeastern territories in the present and future. In total, 306 lakes with ice coasts were been identified. On the basis of digital maps, the lengths of ice coasts were measured. An example of determining the boundaries of the glacier front at the contact with the lake is given in Fig. 5.

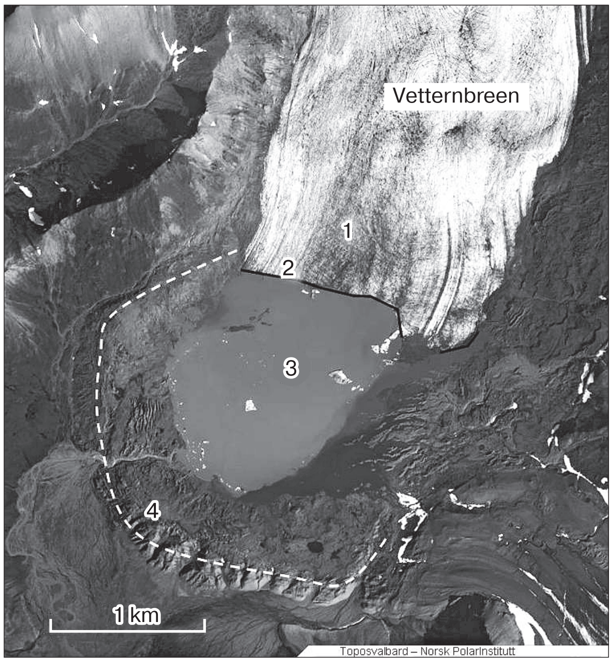

Fig. 5. The periglacial lake of the Vetternbreen glacier (Svalbard):

1 – glacier, 2 – glacier front, 3 – lake, 4 – terminal moraine.

The periglacial lake is located in front of the Vetternbreen glacier (Oskar II). The ice front has two segments in contact with the lake. The lake is formed in a depression formed by a glacier and its terminal moraine.

As of 2008–2019, the total length of ice coasts of periglacial lakes in Svalbard is 233.8 ± 0.6 km, which is comparable to the length of the fronts of outlet glaciers, which is about 740 km [*Nuth et al., 2013*]. According to estimates [*Nuth et al., 2010; Martin-Espanol et al., 2015*], about 10 km^3 of ice is dumped into the sea annually by the outlet glaciers. It is difficult to estimate how much ice melts into periglacial lakes, since the velocity of ice movement and ice thickness at the fronts of glaciers are different. According to the authors' estimates based on field measurements of ice velocity and ice thickness in the marginal parts of the East Grenfjord and Aldegonda glaciers [*Chernov et al., 2019a*], the annual ablation of glacial fronts in contact with the lakes does not exceed 0.01 km^3, i.e., it is incomparably lower than ice loss due to iceberg formation at outlet glaciers.

DISCUSSION

The search and mapping of new periglacial lakes revealed their ubiquity in the archipelago (Fig. 1). Most of the lakes are located near the coast, as many of the outlet glaciers have now retreated and end on land. This is especially typical for the western and northeastern parts of the archipelago, where ice caps and sheet glaciers are widespread. In the area of mountain valley glaciation of the archipelago, periglacial lakes are distributed relatively evenly throughout the territory, with the exception of Prince Charles Foreland, where glaciers are grouped only in the eastern part of the island.

The process of periglacial lake formation in the modern period indicates the climatic differences of the southern and northern regions of Svalbard. Based on the information obtained, the northern and eastern territories of the archipelago should be identified as a zone of active lake formation (Table 1). Quantitative estimates of the proportion of lakes with icy shores are important information for describing the current state of lake expansion. Currently, the rate of retreat of the fronts of Svalbard glaciers varies from the first tens of meters per year to 100 m or more. Since our statistical estimates give the average size of the lakes of about 600 m, the distance of glacier retreat over a decade is comparable to the size of the studied lakes. Therefore, we may expect significant variability of periglacial lakes in short periods of time. This indicates the possibility of assessing climate changes in Svalbard both in general and in individual areas based on the comparison of information on the state of periglacial lakes at different moments in time. In contrast to glaciers, it is important to compare statistical data, since individual water bodies can change randomly. It was determined that over a period of about 80 years, 629 new lakes with a length of more than 100 m have appeared in the archipelago. The number of small periglacial lakes may be more than 500, but they were not taken into account in this study. It should be assumed that the dynamics of the appearance of new lakes may be different in various parts of the archipelago. Thus, when comparing different-time aerial photographs, a comparison was made of groups of lakes located in the central part of Svalbard on Harald V Land. From 1993 to 2008, the number of lakes decreased by about 20 %, and their configuration and area also changed. It is most likely that such changes are associated with the melting of dead ice in the moraine, and also with changes in the beds of glacial rivers in the area, which lead to the destruction and erosion of moraines. Apparently, this example is a special case of the variability of periglacial lakes during the general expansion of lakes in the archipelago. Nevertheless, it is possible to assume that the number of lakes will decrease in those areas where glaciers have been shrinking for a long time and the melting of dead ice continues for several decades.

Based on the information on periglacial lakes and ice lake coasts, it is possible to make comparative estimates of climate changes for the archipelago as a whole and for its separate lands.

CONCLUSIONS

Owing to the modern warming of the climate in Svalbard and the recession of glaciation, numerous lakes have formed in the areas released from glaciers. Based on remote methods, 629 periglacial lakes with the maximum length of more than 100 m were identified. They occupy natural depressions of the moraine-ridge relief in front of the glaciers or are formed due to the damming by the lateral moraine or by the glaciers themselves. About one third of these lakes are over 500 m long, and the average maximum length of the lakes is 600.5 m.

The area of periglacial lakes is in the wide range from 0.002 to 17.34 km^2. The average value is 0.27 km^2, and the total area of the identified lakes is 173.1 ± 0.7 km^2. The largest number of periglacial lakes was found in the southern and western parts of Svalbard, where the reduction in the glaciated area was especially large-scale. At the same time, the largest lakes are found in the northern territories, in the periphery of sheet glaciation, where the glacial relief of the adjacent territory is less dissected. The number of lakes in the central part of Svalbard, in the area of mountain glaciation, turned out to be the smallest.

The formation of periglacial lakes in Svalbard continues at the present time; about half of the lakes have contacts with glaciers (ice coasts). They are relatively evenly spaced in the altitude range from 1 to 500 m, which indicates the development of the process at all altitudinal levels. Most of such lakes are found in the northern and eastern territories of the archipelago, where the climate is more severe and the degradation of glaciers began relatively recently. At present, the total length of ice coasts of periglacial lakes in the archipelago reaches 233.8 ± 0.6 km, which is comparable with the length of the fronts of outlet glaciers of the archipelago descending into the sea.

Through the ratio of the maximum lengths and areas of lakes, a common feature of lake formation has been revealed; it is associated with periglacial relief and allows one to assess the volume of glacial lakes. Their volume is estimated in the range from 2.1 to 2.3 ± 0.1 km^3.

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