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SURFACE AND GROUND WATERS IN TERRESTRIAL PERMAFROST REGION

FLOODPLAIN TALIK WIDTHS IN RELATION TO RIVER CATCHMENT AREAS AND CHANNEL TYPES

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Data on the width of floodplain taliks in river valleys of the mountainous areas in the northeast of Russia and adjacent areas of the Far East were gathered and organized. The investigated region extends from the Arctic coast to the southern limits of the continuous permafrost area. To assess talik widths, satellite images of high resolution from the *Google Earth* service and previously established indicative landscape features were applied. The catchment areas at downstream ends of the chosen 340 representative river sections varied from less than 10 to more than 200 000 km^2; talik widths, from 41 to 4100 m. The rivers were subdivided into four channel types according to the degree of channel branching based on the previous studies confirming that the floodplain taliks were formed only by braided rivers on coarse-grained alluvium. The studied sites are generally evenly distributed both over the territory and according to the selected channel types. The changes in talik widths from marginal coastal to central continental river basins in relation to the channel type are discussed in this paper. The parameters of the empirical power-law dependence of the talik width on the catchment area of the river are calculated. The results obtained allow us to estimate the range of variation in the talik zone width on floodplain in dependence on the given river catchment area and determine the most probable minimum value of this parameter. In future, this approach in combination with field research will contribute to the improvement of remote sensing data interpretation.

Keywords: *permafrost, floodplain taliks, talik width, river catchment areas, river channel types, interpretation of remote sensing data*

INTRODUCTION

Studies into the development and distribution of thawed zones in permafrost and methods for indicating taliks and estimating their size are among the traditional and important fields of geocryological research. For a long time, floodplain taliks remained the least studied. The term floodplain talik was first used in the monograph by I.A. Nekrasov [*1967*], though data on talik zones occupying the entire width of floodplains and even nearby sections of terraces had been mentioned earlier mentioned by A.I. Kalabin [*1960*] and V.M. Ponomarev [*1960*].

The monograph [*Mikhailov, 2013*] considers the history of the pertinent research in detail and sets out an integral concept that links all the previous studies.

The core mechanism for the development of floodplain taliks is intensive heat and water exchange between river and groundwater flows. The groundwater is mainly concentrated in a powerful filtration flow covering the entire zone of channel reformations and directed along the slope of the valley.

Water exchange happens due to the mismatch between the direction of this flow and flows in the river branches and channels. The most obvious examples are the straightening of the bends of the channels by the flows and inter-flow filtration.

The river water is the main heat source in the talik–river system, since it is a natural receiver of the solar energy, and filtered water is a perfect heat carrier from the channel to the alluvium.

An important single factor theoretically capable of ensuring the development of taliks even under otherwise unfavorable conditions is high permeability of channel alluvium. This factor exceeds by an order of magnitude the values that until recently have been cited in the hydrogeological references as the maximum possible values amounting to hundreds of meters per hour. In mountainous areas, this factor is associated with multi-branching because of the highly gravelly nature of the bedrock prevailing in the river basin (according to the size of rock fragments forming at the first stages of weathering) [*Mikhailov, 2011*]. In water flows, these fragments roll down to boulders and gravel, whereas the content of fine-grained fractions remains small. In this paper we exclusively discuss multi-branched rivers flowing within mountain structures.

It follows that the floodplain talik is an integral, genetically unified formation. Therefore, attempts to identify within it an under-channel talik, proper floodplain talik, and, possibly, terrace talik are meaningless from a hydrogeological point of view [*Mikhailov, 2013, p. 42*].

The high permeability of alluvium also provides for an abundance of tree species that require aeration of the root layer: in the floodplains that require aeration of the root layer: chosenia and poplars. According to the works of I.A. Nekrasov [*1967*] and V.R. Alekseev [*1968*] such forest stands have served as a common and actually a single indicator of floodplain taliks for a long time.

Information about the size of floodplain taliks is still scattered. Their width varies from a few tens of meters in low-order valleys [*Zelenkevich, 1964; Mikhailov, 2013*] up to several kilometers near high-water rivers [*Vtyurin, 1964; Nekrasov, 1967*]. This is associated with insufficient and extremely uneven knowledge of the permafrost zone. However, there are two more important factors: (1) the availability of only black and white aerial photographs of a scale, as a rule, no larger than 1:40,000 and (2) application of a single criterion for remote interpretation of the talik boundaries.

Nowadays, possibilities for interpretation are larger due to availability of color satellite *Google Earth* imagery. It allows one to distinguish between deciduous and mixed forest stands more confidently. This commonly used feature is also supplemented with the possibility to trace channel branching, which is also important for interpretation of talik zones. The “trinity” of floodplain taliks, branching rivers, and poplar-chosenia forest stands was first noted by G.N. Egorova [*1983*]. In addition, separate areas of the earth’s surface in *Google Earth* are captured with a very high resolution (up to 0.35 m), which makes it possible to detect taliks in the valleys of small streams.

The goal of this paper is to find out the nature and degree of connection between the transverse dimensions of the floodplain taliks, stream discharge, and types of multi-branch channels. The results obtained should contribute to the improvement of methods for interpreting talik zones in river valleys and determining accurate territorial estimates of their distribution. The explored river valleys are located in the northeast of Russia and in adjacent regions of the Far East. Branched river channels often predominate in the east of Russia; hence, floodplain taliks are common in permafrost areas. In other parts of the permafrost zone of Russia, branching channels and taliks are rather rare.

THEORETICAL BASIS

Terminology. Some of the used terms have ambiguous interpretations in the scientific literature. In such cases, formulations adopted from a number of options with links to primary sources are given in a reference dictionary [*Timofeev, 1981*]. They are as follows:

Floodplain: (1) the lowest periodically flooded part of the river valleys (*p. 116*) and (2) surface or strip of relatively flat land adjacent to the riverbed and formed or being formed by the river (*p. 117*).

Floodplain talik is a thawed zone, which is formed “directly under the channel, on the floodplain, or, in some cases, within river terraces” [*Nekrasov, 1967, p. 18*].

Channel: (1) the entire width and length of the river during the low-water season (according to V.I. Dal’ dictionary of Russian language); (2) part of the valley bottom, where river flow takes place during the low-water season (*p. 160*). River channel is entirely located within the floodplain...” [*Voskresensky, 1985, p. 75*].

Branching channel is the channel of the river divided into several branches forming a complex network of small merging and diverging arms (*p. 160*).

Terraces are relatively horizontal areas located at different heights above the modern bottom of the valley (*p. 183*).

Transverse dimensions of taliks and indication of their boundaries. As follows from the concise description given in the introductory part, floodplain taliks are distributed within the zone of highly permeable sediments. Its minimum width coincides with the width of channel branching zone, where deposition of fine-grained material is prevented by frequent erosion and redeposition. Beyond this zone, episodic washout of alluvium occurs as a result of seasonal displacement of peripheral branches and arms. The presence of taliks under accumulative terraces (apparently as residual formations) indicates that permeability of sediments can be sustained for a long time by high velocities of groundwater flows in preferential flow zones. However, permafrost may also exist on floodplains (that are sometimes hypsometrically hardly distinguishable from the adjoining low terraces). Despite a relatively small transverse dimension of the branching zone, it plays the role of the key “reference” indicator of the talik and its boundaries, because the are occupied by the geobotanical indicator of taliks is even smaller. Thus, within a key area (2 × 2 km) subjected to a detailed survey on the Kolyma River floodplain, poplar-chosenia and mixed forest stands occupied only about 30 % of the territory [*Mikhailov, 2013*], whereas a larger part of the talik was under relatively high larch forest with an insignificant admixture of other species. Similar forest stands are quite confidently distinguished on satellite images compared to suppressed low forests on permafrost soils, and, therefore, can attributed to geobotanical indicators. A similar role belongs to the willows inhabiting the newly formed areas of low floodplain.

The foregoing does not cover all the possibilities and difficulties of delimiting areas of talik and permafrost distribution in river valleys. Specific features are characteristic of the floodplains of small streams,

Fig. 1. The Yama River branch disconnected in the upper reaches from the nearest large channel and fed by a seepage flow (upstream from point 338, see appendix, sheet 1).

where branching may not be clearly expressed. Specific features are also characteristic of terraces composed of thawed sediments [*Mikhailov, 2013*].

Quite often, unambiguous interpretation of satellite images is impossible without additional field studies. In the present paper, such situations are usually excluded from consideration.

Taliks and the main characteristics of river channels. The most detailed studies of branched river channels in Russia are mainly based on the classification of channel branching, which includes 11 varieties [*Chalov, 2017, 2019*]. However, they do not consider the width of the zone of channel transformation.

It seems that the width of the channel transformation zone is directly dependent on the number of branches and channels in the cross section of the valley. Quantitative indicator is called the braiding index or braiding intensity in the foreign reference. Such indices, their comparability, and their variability in dependence on the hydrological conditions are discussed in detail in [*Egozi and Ashmore, 2008*],

These indices differ from one another and significantly depend on water levels. It is concluded that measurements should be carried out at several water levels to obtain representative results. This makes it quite challenging to apply quantitative estimates when using satellite data. In floodplain taliks with intense filtration flows the situation is complicated by the fact that the concept of an active branch (channel) becomes indefinite.

In secondary arms and channels, water discharge can decrease downstream up to complete disappearance of surface water flow (water flow becomes absorbed into the alluvium). Vice versa, a channel with

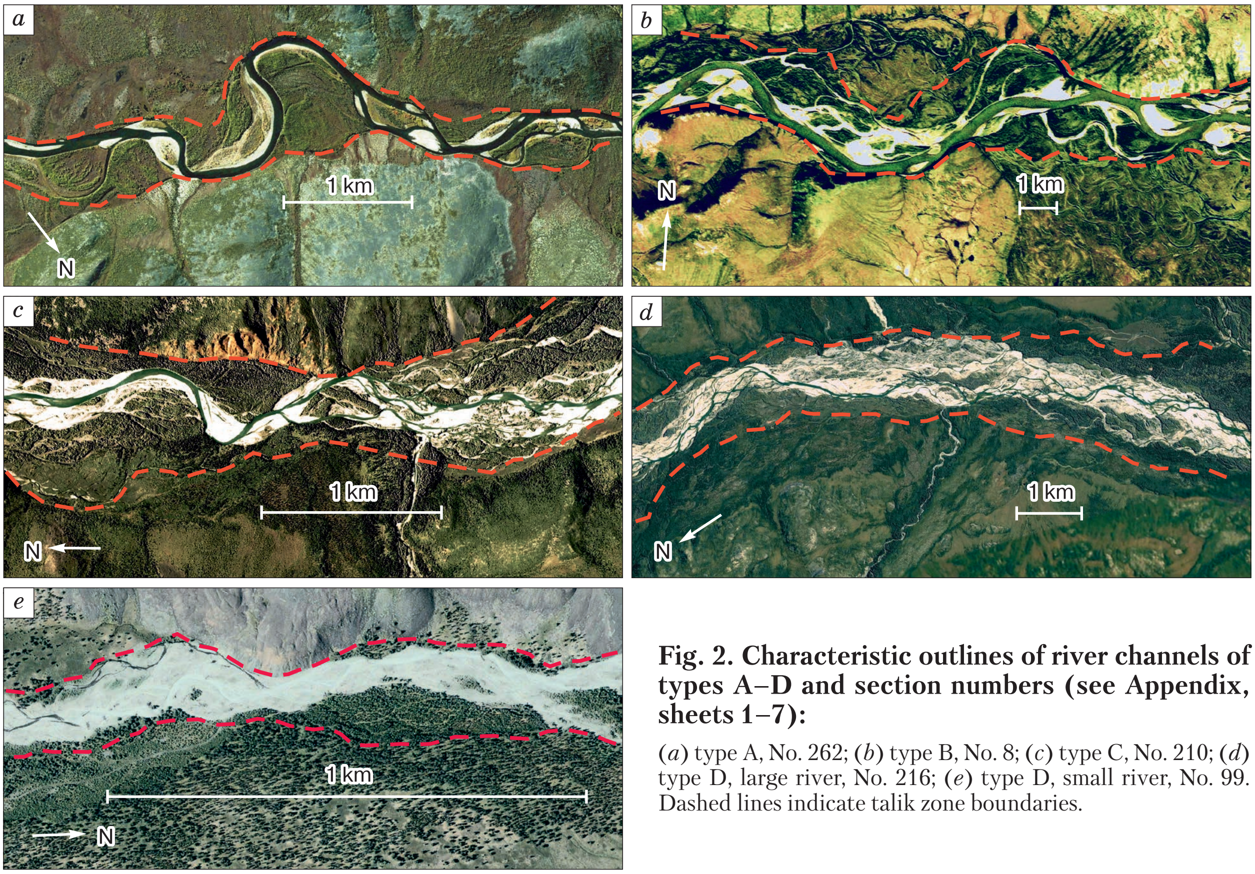

Fig. 2. Characteristic outlines of river channels of types A–D and section numbers (see Appendix, sheets 1–7):

(*a*) type A, No. 262; (*b*) type B, No. 8; (*c*) type C, No. 210; (*d*) type D, large river, No. 216; (*e*) type D, small river, No. 99. Dashed lines indicate talik zone boundaries.

an increasing discharge downstream can appear “out of nowhere” due to groundwater seepage (Fig. 1). Often, there is a combination of both phenomena. It is obvious that when the water level in the river changes, such channels can become completely dry or merge together with larger channels. In many small streams, secondary channels are partially or even completely closed and shaded by forest stands.

A rational alternative to the use of still imperfect quantitative methods is a visual assessment of branching intensity with a division into a number of well-distinguishable types. This approach was used to determine the sinuosity coefficient of river channels. In the study [*Chebotarev, 1975*], 9 types of channels forming 12 characteristic patterns were described. The intensity of river braiding can be found by comparing the actual channel pattern with these characteristic patterns and choosing closest pattern.

Examples of branching channel patterns, characteristic for the four identified types (A–D) are shown in Fig. 2 (branching index increases from A to D). Two examples are given for type D: the largest river and a stream of minimum discharge required for talik development. Figures 2, *c* and 2, *d* demonstrate a complexity of various branch combinations.

Considering the above challenges, it does not make sense to apply quantitative estimates; they are considered impractical for the foreseeable future. In addition, it remains unclear what numerical criteria should be used to distinguish between channel branching types even with the most scrupulous and correct calculations of the branching indices. That is, a quantitative approach is just as subjective as a qualitative description.

MATERIALS AND METHODS

To measure the width of the taliks, sections of branching rivers and streams with the length of about 10–30 times larger than the expected talik width (depending on the degree of homogeneity of the site) were studied. However, the choice was limited to those small areas where Google Earth satellite images have a resolution of up to 0.35 m, allowing to distinguish even separate shrubs. For large rivers with catchment areas of more than 20 000 km^2, resolution of 5–7 m (which is quite common for *Google Earth* service) is usually sufficient for delineation of taliks.

A total of 340 sites were selected in three large areas: catchments of the Indigirka and Kolyma rivers in their upper and middle reaches and river catchments near the seas of the Pacific and Arctic basins. The latter are further called marginal rivers, because the central mountainous part of the northeast of Russia belongs to large catchments of the Indigirka and Kolyma rivers.

Table 1. **Distribution of the studied areas by types of channels and river basins, %**

Basin	Total number of studied sites	Type of channel			
		A	B	C	D
Marginal	122	$\frac{15}{28}$	$\frac{30}{37}$	$\frac{27}{46}$	$\frac{28}{51}$
Kolyma	120	$\frac{26}{48}$	$\frac{46}{41}$	$\frac{17}{28}$	$\frac{11}{19}$
Indigirka*	98	$\frac{16}{24}$	$\frac{45}{32}$	$\frac{18}{28}$	$\frac{21}{30}$
Total number of sites	**340**	**67**	**135**	**71**	**67**

Note: Numerator indicates the percent of the given type of channel in the basin, and denominator shows the percent of the given basin in the total number of sites with this type of channel.

[*] Including 8 sites from adjacent basins of the Yana (7) and Lena (1) rivers.

Quite often, sites on the same watercourse with a shift downstream were selected. The approach used is consistent with the principles of constructing a random sample. First, the criterion of high-resolution of *Google Earth* images is, in fact, irrelevant to the purposes of this paper. Second, the types of channels, even in the nearby sections of the rivers, are not actually interconnected. For example, incised channels can be replaced by the free development of channel deformations, and vice versa*. The same is true for the width of the thawed zones. Specific data about the studied sites are given in the appendix. Generalized data are given in Table 1.

The catchment area (*F*) is used as the main characteristic of the river. It is further used to estimate river discharge, or, more precisely, the average maximum flow, which has the greatest impact on the reshaping of the river channel during the year. Previously, a close relationship between these values was established, and the parameters of this dependence remain unchanged throughout the entire territory of the northeast of Russia [*Mikhailov, 2014*]. The measurements of *F* in the outlet sections of the selected areas were made using topographic maps. The plots were grouped according to *F* values arranged in a uniform logarithmic scale as follows:

F, km^2	<20	20–200	200–2000	2000–20 000	20 000–200 000
Share of plots, %	5.3	38	24	24	9.1

Method for determining transverse dimensions of thawed zones requires explanation. According to theoretical concepts, taliks usually occupy the entire zone of channel transformation affected by intense

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[*] A bright example is the Kolyma River valley in the area of Sugoi bend (64°09′ N, 154°27′ E) with deeply incised channel, whereas upstream and downstream sections are characterized by branching channels.

filtration flow. According to the results of field studies [*Kalabin, 1960; Ponomarev, 1960; Mikhailov, 2013*], taliks may extend beyond this zone and occupy not only the entire floodplain but also low terraces. The applied method is based on the principle of "not exaggerating" the area of taliks. The boundaries of talik zones were drawn predominantly along the lines delineating the zones of channel branching with the following adjustments:

1. Sections of rivers with large floodplain islands with a possible presence of permafrost were excluded from the plots selected for measurements. In particular, the most water-abundant areas in the Kolyma River valley with vast islands and numerous lakes of presumably thermokarst origin were excluded from the list of study objects.

2. The areas beyond the channel branching zone, where the vegetation cover significantly differed from that on the adjacent territories and unequivocally indicated the thawed zone, were incorporated into floodplain taliks. In particular, these were the areas with an increased density of forest stands and wide distribution of deciduous species.

3. If the nature of the vegetation cover changed sharply near the channel in the opposite direction, in case of rare occurrence or absence of forest stands, then the borders of the talik were drawn mainly along the shoreline or parallel to it with a slight deviation. Based on physical considerations, a minimum graphic interpolation was allowed, where the boundary line was broken (upon junction or disjunction of channels or in places of the sharpest turns).

4. The channel flow of the small streams at the low water level may be interrupted, sometimes for a considerable length, due to the infiltration of channel waters into highly permeable soil (Fig. 2, *d*). In such cases, the zone of the most intense channel deformations is marked by freshly deposited alluvium, which is clearly indicated by light color on the satellite images.

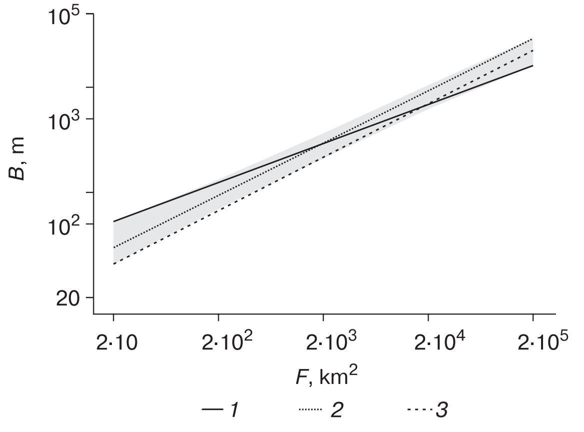

Fig. 3. The dependence of the average width of the talik zones from the catchment area $B(F)$ in the logarithmic coordinate system:

(*1*, *2*) Indigirka basin, types C and D, respectively; (*3*) Kolyma basin, type B. The area where all approximating lines of the $B(F)$ lie is shown by flood fill.

Next, the thawed area, its length along the axial line and the average width B were measured. The dependence $B(F)$ was approximated by the formula commonly applied in analogous cases [*Park, 1977*]:

$$B = \alpha F^{\beta}, \tag{1}$$

where α and β are dependence parameters; F is the catchment area, km^2; and B is the average width, m. The coefficient of determination R^2 was used to assess the degree of correlation.

RESULTS AND DISCUSSION

As can be seen from Table 1, the selected sites are more or less evenly distributed over the main basins and types of channels. However, the analysis of generalized data allows us to trace certain trends. Most of the intensely branching rivers of types C and D belong to marginal (coastal) areas (47 and 51 %, respectively), whereas types A and B predominate in continental parts. Almost a half of 216 watercourses of the two basins belong to the more branched type B. Thus, in general, the degree of channel branching and the associated width of taliks decrease from the marginal areas of the region to its central parts, although this trend is not clearly pronounced.

The results of statistical data processing are presented in Figs. 3 and 4 and in Tables 2 and 3. Figure 3 shows dependence graphs built (1) separately for each of the selected areas and types of channels (12 in total). However, the approximating lines lie so close to one another other that it is challenging to distinguish them even in color. Thus, Fig. 3 shows the region occupied by all these lines together, except for three extreme lines clearly defining area boundaries. For similar reasons, Table 2 shows only the extreme values of the dependence parameters.

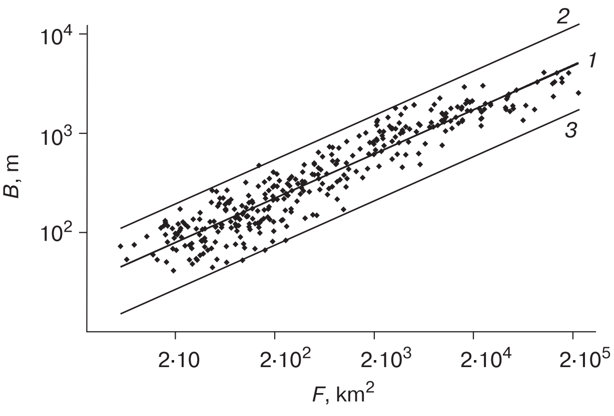

Fig. 4. Field of points (values F and B) for all considered sections:

(*1*) approximating dependence $B(F)$; (*2*, *3*) upper and lower envelopes

The dependence between characteristics B and F, as estimated by R^2, turned out to be much closer than expected from theoretical concepts, despite the heterogeneity of the studied samples and their small volumes. In this case, the ranges of values β and especially α (Table 2) do not fully reflect the actual picture, which is more adequately represented by the graph (Fig. 3). Figure 3 indicates that the variations in the desired value B are mainly determined by parameter β, which varies within relatively narrow limits. The role of parameter $\acute{\alpha}$ in the given case is rather “technical”, since it significantly affects B only beyond the considered range of catchment areas.

A clear representation of the statistically justified variations in the width of talik zones depending on the type of channel in each of the three basins is given in Table 3. It follows that the maximum values of B correspond to types C and D and the minimum values of B, to types A and B. For almost all values of F, except for the smallest streams, the largest transverse dimensions of taliks are confined to marginal basins.

Thus, despite the unconditional dominance of the flow size factor, the other two factors – the type of the channel and the marginal or continental type of the basin–play a significant role. If the first trend is theoretically expected (though weaker than expected), the second one requires additional investigation.

Figure 4 shows the area of all points considered for sections with an approximation line $B(F)$ obtained by calculation ($\beta = 0.4455$, $\alpha = 20.8$), and two lines parallel to it, which represent the top ($\alpha = 52.8$) and lower ($\alpha = 7.08$) enveloping the above area. The approximating line basically displays averaged widths of taliks near rivers of various discharges. However, it should be emphasized that we consider not the most probable value of B, but its most probable lower estimate. As noted above, measurements of the talik width are based on the principle of “no exaggeration”. Therefore, the values of B obtained from statistical calculations are often significantly lower than the actual values. The two examples are provided below.

1. The Buyunda River in the Seimchan–Buyunda basin with a catchment area of 20,700 km^2 (point No. 77, Appendix, p. l). Earlier, an inner delta with an area of more than 200 km^2 and a talik of comparable size were formed in this place. In that period, the river split into numerous small channels. At present, the branching zone of the river has significantly decreased and corresponds to type B. According to the modern landscape features, the width of the talik zone does not exceed 1.7 km, which is less than the results of calculations by formula (1). By substituting the value $\alpha = 52.8$ corresponding to the upper envelope of the area of points, B increases up to 4.4 km. The established width of the talik in the central part of the delta (along the highway) is 14 km [*Mikhailov and Bantsekina, 2001*]. However, at the upstream part of the delta, the talik width is limited by a relatively narrow branching zone (lightly more than 1 km). Downstream, talik areas are interspersed with expanding permafrost areas and then narrow down to the branching zone again. The talik zone within the inner delta is about 26 km long, and its average width does not go beyond the upper envelope in Fig. 4.

Table 2. **Maximum and minimum of parameters of dependence (1) and corresponding sample sizes (*n*) by channel types and studied basins**

Parameter	Values max/min	Channel type	Basin	n
α	33.4 11.0	D B	Indigirka Kolyma	20 55
β	0.500 0.404	B A	Kolyma Marginal	55 18
R^2	0.963 0.826	D A	Indigirka Indigirka	20 16

2. The Kubaka Creek, studied in detail over a 21-km-long segment [*Mikhailov and Ukhov, 1999*], where catchment area increases from 56 to 131 km^2 (outlet gate coordinates 63°40′08″ N, 159°58′34″ E). The channel is of type A. According to the landscape features, the maximum width of the talik (within a short segment) is 200 m. Calculations using formula (1) give $B = 151$ m. According to the results of instrumental measurements, the width of the talik varies from 140 to 510 m weakly correlating with F. The average value is about 330 m. According to G.N. Egorova [*1983*], geosystems, characteristic for the creek floodplain, are widespread in the basin of the Omolon River. This allows us to argue that a similar underestimation of the width of the talik is not an exception, but rather common, at least for one type of landscape. The key factor of talik development is the initiation of valleys along fault zones with increased fracturing of rocks [*Mikhailov and Ukhov, 1999*]. This allows us to assume that such extremely broad taliks are quite common in other river basins of the northeast of Russia. However, substituting into formula (1) the coefficient α calculated for the upper envelope, we obtain an ave-

Table 3. **Variations in *B* values calculated according to formula (1) for a number of fixed values of *F* in accordance with approximations of the dependence *B*(*F*) (Fig. 3)**

F, km^2	B, m max/min	Type of channel	Basin
20	126 50	C B	Indigirka Kolyma
200	316 166	C A, B	Marginal Indigirka, Kolyma
2000	832 457	C A	Marginal Indigirka
20 000	2290 1320	C, D A	Marginal Indigirka
200 000	6310 3470	C, D B, C	Marginal Indigirka

rage talik width of 384 m, which is even larger than the average value obtained by instrumental measurements.

So, the whole set of studied objects clearly reflects the diversity of transverse dimensions of floodplain taliks. Their *B* values with big probabilities lie within the limits outlined in Fig. 3 by lower and upper envelopes of the point area. In relation to the lower envelope, this statement is based on the applied method. The limiting position of the upper envelope is not just as obvious. Nevertheless, the latter was demonstrated using the above example of two taliks of outstanding transverse dimensions.

The data obtained also indicate the absence of the influence of climatic conditions on the size of floodplain taliks. Two regions most unfavorable for their development are the vicinity of the “cold pole” with the most severe winters and the Arctic coast with short and cold summers. The Agayakan River belongs to the first region, whereas the Ekiatap River belongs to the second region (nos. 3 and 331, respectively, see Appendix). According to the measurements, the widths of floodplain taliks of these rivers are greater than the values calculated by formula (1) by 15 and 27 %, respectively.

CONCLUSIONS

For the first time, statistically representative data on the width of floodplain taliks in river valleys within the region of their maximum abundance in the northeast of Russia and nearby areas obtained from the results of interpretation of remote sensing data on 340 valley sites are systematized. The sample used for the calculations represents the most diverse climatic conditions for the permafrost zone. Drainage areas of rivers in outlets of the selected sites vary widely, covering the entire range of floodplain talik areas from <20 to >200 thousand km^2. At the same time, they are quite evenly distributed over three large areas and among the distinguished types of river channels. The lower and upper limits of the transverse dimensions of thawed zones are 41.1 and 4100 m. Almost for the entire range of catchment areas, except for the smallest values, the minimum and maximum values of *B* at a fixed parameter *F* differ by less than tw times. The statistical dependence of the characteristics under consideration is approximated by a power function, and the parameters of this dependence are determined.

The width of taliks displays a tendency for a decrease from marginal coastal basins to central parts of mountain structures and directly depends on the degree of river channel branching. These tendencies are generally expressed quite distinctly. The results of the study indicate that it is possible to estimate the limits of variation in the width of thawed zones in river valleys for a given catchment and to determine the most probable minimum values of talik width. In the future, this approach in combination with field studies will contribute to the improvement of interpretation of remote sensing data. On this basis, it is planned to carry out the zoning of the northeast of Russia and adjacent territories according to the distribution of floodplain taliks and corresponding landscapes in river valleys.

References

Alekseev, V.R., 1968. On the role of geobotanical maps when studying frozen grounds. Dokl. Inst. Geogr. Sibiri i Dal’nego Vostoka, **17**, 20–26 (in Russian).

Chalov, R.S., 2017. Channel Processes (Riverbed Science). Moscow: INFRA-M, 569 p. (in Russian).

Chalov, R.S., 2019. On the morphological diversity and classification of braided river channels. Geomorfologiya, No. 3, 3–18 (in Russian).

Chebotarev, A.I., 1975. General General Hydrology (Land Waters). Leningrad: Gidrometeoizdat, 544 p. (in Russian).

Egorova, G.N., 1983. Morpholithosystems and the Landscape SPattern (by the example of the Omolon River Basin). Vladivostok: Izd. DVNTs Akad. Nauk SSSR, 164 p. (in Russian).

Egozi, R., Ashmore, P., 2008. Defining and measuring braiding intensity. Earth Surf. Process. Landf. **33** (13), 2121–2138.

Kalabin, A.I., 1960. Permafrost and hydrogeology of the northeast of the USSR. Tr. Vses. Nauchno-Issled. Inst.-1, vol. 18, 469 p. (in Russian).

Mikhailov, V.M., 2011. Morphodynamics of river channels in mountainous countries and lithology of bedrock. Geomorfologiya, No. 4, 11–21 (in Russian).

Mikhailov, V.M., 2013. Floodplain Taliks of the Russian Northeast. Novosibirsk: “Geo” Publ. House, 244 p. (in Russian).

Mikhailov, V.M., 2014. Variations and assessments of mean maximum water discharge in rivers of the Russian northeast. Byull. Sev.-Vost. Nauchn. Ts. Ross. Akad. Nauk, No. 2, 21–26 (in Russian).

Mikhailov, V.M., Bantsekina, T.V., 2001. Ground-filtration talik in the continental delta of the Buyunda River (Seymchan-Buyunda Depression). Kriosfera Zemli [Earth’s Cryosphere], **V** (2), 20–28 (in Russian).

Mikhailov, V.M., Ukhov, N.V., 1999. Peculiarities of geocryological and groundwater regimes of the large floodplain talik in the Omolon River basin and accompanying landscape indicators. Kriosfera Zemli [Earth’s Cryosphere], **III** (3), 50–58 (in Russian).

Nekrasov, I.A., 1967. Taliks in River Valleys and Regularities of Their Distribution on the Example of the Anadyr River Basin. Moscow: Nauka, 140 p. (in Russian).

Park, C.C., 1977. World-wide variations in hydraulic geometry exponents of stream channels: an analysis and some observations. J. Hydrol. **33** (1–2), 133–146.

Ponomarev, V.M., 1960. Groundwater in the Area of Deep Permafrost. Moscow: Izd. Akad. Nauk SSSR, 200 p. (in Russian).

Timofeev, D.A., 1981. Terminology of Fluvial Geomorphology. Moscow: Nauka, 1981, 268 p. (in Russian).

Voskresensky, S.S., 1985. Geomorphology of Placers. Moscow: Izd. Mosk. Gos. Univ., 204 p. (in Russian).

Vtyurin, B.I., 1964. Geocryological conditions of the Markovo Depression. In: Geocryological Conditions of the Western Siberia, Yakutia, and Chukotka. Moscow: Nauka, p. 115–133 (in Russian).

Zelenkevich, A.A, 1964. Hydrogeological structures and water-bearing complexes in the northeast of the USSR. In: Materials on the Geology and Mineral Deposits of the Northeast of the USSR, **17**, 200–208 (in Russian).

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Translated by E.S. Shelekhova

Appendix. **Data on the studied sites. Sheet 1**

No.	Name of watercourse	Geographic coordinates, N. Lat.–E. Long.	Catchment area, km^2	Talik width, m	Channel type
1	2	3	4	5	6
1	Agan	60°20′35″–150°54′02″	58.3	121	B
2	Agan	60°19′16″–150°56′31″	82.4	115	B
3	Agayakan	67°11′36″–135°40′56″	7630	1280	D
4	Adycha	67°11′36″–135°40′56″	55 000	2720	B
5	Amguema	67°53′22″–177°43′34″	26 700	1990	D
6	Anadyr	65°31′52″–168°52′54″	16 400	2920	D
7	Anadyr	64°52′00″–168°36′17″	47 300	2920	B
8	Anadyr	64°47′06″–169°28′44″	50 500	1660	B
9	Apuka	60°58′29″–170°27′33″	9780	1590	C
10	Apukavayam	61°01′31″–170°32′06″	5880	1210	C
11	Arga-Tirekhtyakh	66°31′02″–143°08′54″	560	348	D
12	Arga-Tirekhtyakh	66°32′25″–143°15′38″	555	642	D
13	Arkagala	63°14′30″–146°46′33″	506	382	D
14	Arkagala	63°08′30″–146°54′44″	831	487	D
15	Arkagala	63°02′29″–146°57′39″	1062	502	D
16	Arman	60°42′46″–150°38′56″	843	492	B
17	Arman	60°35′44″–150°39′38″	1070	825	D
18	Arman	60°32′45″–150°37′56″	1460	696	C
19	Arman	60°27′04″–150°32′22″	2090	678	B
20	Arman	60°13′35″–150°16′51″	2480	886	C
21	Arman	60°09′01″–150°15′53″	3030	1110	C
22	Arman	60°07′39″–150°14′19″	3100	1120	C
23	Arman	60°00′11″–150°16′45″	3620	1270	C
24	Arman	60°44′11″–150°13′46″	4170	1800	D
25	Arman	59°40′01″–150°09′18″	7590	1720	D
26	Achaivayam	61°01′24″–170°32′30″	3900	1080	B
27	Ayan-Tyryakh	62°25′17″–147°41′16″	14 300	1260	A
28	Ayan-Tyryakh	62°18′33″–147°44′22″	24 100	1400	A
29	Ayan-Tyryakh	62°50′32″–146°34′52″	4610	1100	B
30	Ayan-Tyryakh	62°44′17″–146°45′39″	12 300	1120	A
31	Bol. Anyui	66°45′02″–164°49′35″	16 920	1990	C
32	Balagannakh	65°46′19″– 145°47′10″	163	221	B
33	Balagannakh	65°42′14″–145°40′44″	81.2	76	A
34	Balagannakh	65°46′05″–145°42′32″	136	124	A
35	Balygychan	63°51′28″–154°15′54″	17 400	2140	B
36	Nameless	66°03′47″–164°44′41″	33.4	53	B
37	Nameless	63°17′17″–146°56′29″	21	95	B
38	Nameless	64°54′02″–143°50′29″	16.4	50	B
39	Nameless	64°54′05″–143°47′58″	25.2	74	B
40	Nameless	64°59′48″–143°38′57″	15.9	131	D
41	Nameless	65°00′14″–143°39′55″	16.8	117	C
42	Nameless	65°00′51″–143°40′10″	15.4	104	C
43	Nameless	65°05′05″–143°47′15″	14.4	111	C
44	Nameless	65°05′04″–143°47′46″	7.76	75	D
45	Nameless	65°06′27″–143°48′42″	6.52	53	D
46	Nameless	65°07′42″–143°39′06″	5.64	73	D
47	Nameless	65°21′47″–143°39′16″	50.8	80	A
48	Nameless	65°23′06″–143°41′13″	35.8	59	A
49	Nameless	65°25′43″–143°56′12″	20.6	66	B
50	Nameless	62°26′02″–155°32′38″	9	104	B
51	Nameless	62°26′36″–155°33′20″	15	108	A

Appendix, contined. Sheet 2

1	2	3	4	5	6
52	Nameless	62°31′53″–155°31′32″	40	82	C
53	Nameless	62°32′57″–155°32′24″	30	69	B
54	Nameless	62°38′21″–155°49′01″	28	563	D
55	Nameless	62°46′04″–155°49′05″	49	129	C
56	Nameless	60°15′58″–151°46′08″	40	109	B
57	Nameless	60°08′42″–151°46′59″	16	127	B
58	Belaya	65°31′54″–173°17′37″	44 700	2330	B
59	Belichan	63°01′48″–147°14′53″	128	123	A
60	Berelekh	63°35′27″–146°56′54″	917	341	B
61	Berelekh	63°28′25″–147°01′44″	1080	350	B
62	Berelekh	63°24′48″–146°05′38″	1230	595	B
63	Berelekh	63°21′40″–147°56′34″	1330	412	A
64	Berelekh	63°18′28″–147°17′20″	1550	357	A
65	Berelekh	63°18′40″–147°27′01″	1830	806	A
66	Berelekh	63°18′20″–147°40′00″	2540	750	B
67	Berelekh	62°58′08″–148°03′21″	5390	1040	B
68	Berelekh	62°28′52″–147°41′48″	9810	756	A
69	Berelekh	63°37′54″–146°56′34″	709	277	B
70	Bol. Keperveem	67°51′55″–166°13′49″	2790	1440	B
71	Bol. Peledon	65°31′23″–168°50′04″	3770	1540	B
72	Burgagchan	66°00′06″–164°44′15″	408	139	B
73	Burgagchan	66°01′26″–164°44′26″	488	151	B
74	Burgagchan	66°05′07″–164°42′07″	860	216	B
75	Burgagchan	66°12′21″–164°41′59″	2270	464	A
76	Burgagchan	66°17′16″–164°43′51″	3890	455	B
77	Buyunda	62º28′49″–153º26′48″	20 700	1590	C
78	Bergendya	60°39′06″–150°23′14″	138	293	A
79	Bergendya	60°38′01″–150°27′25″	271	310	A
80	Velikaya	63°53′37″–175°34′30″	25 200	3010	B
81	Vost. Khandyga	62°31′59″–135°37′49″	9950	1550	B
82	Vostochnyi	60°34′56″–150°51′52″	37.4	82	C
83	Gedan	60°12′51″–150°15′53″	482	387	B
84	Gedan	60°17′05″–149°59′30″	178	350	B
85	Goluboi	62°25′25″–155°42′05″	67	287	A
86	Dalnii	66°14′24″–161°40′11″	295	173	D
87	Debin	62°29′14″–149°41′27″	3460	616	B
88	Delyankir	63°48′50″–145°34′40″	3070	830	B
89	Dzhagun	62°46′46″–155°30′28″	40	88	B
90	Dzhana	54°41′00″–135°08′55″	3950	1020	B
91	Dich	60°28′55″–150°40′14″	26.9	114	B
92	Dondychan	60°31′48″–150°52′12″	89.6	136	A
93	Dondychan	60°34′10″–150°51′37″	105	145	A
94	Dukcha	59°42′53″–150°53′18″	120	174	B
95	Eemyu	63°40′00″–145°38′26″	2010	613	A
96	Elvat	66°04′25″–161°33′56″	86.8	140	A
97	Ermolaich	61°38′37″–144°45′56″	63.8	191	C
98	Eropol	65°15′23″–168°38′26″	10 700	1590	C
99	Echenka	65°03′28″–143°47′16″	10.4	91	D
100	Echenka	65°05′00″–143°47′22″	21.9	102	D
101	Echenka	65°06′54″–143°47′36″	73	215	C
102	Echenka	65°09′44″–143°41′30″	103	319	B
103	Echenka	65°10′23″–143°39′02″	212	389	C
104	Igandya	60°35′10″–150°23′01″	159	323	C

Appendix, contined. Sheet 3

1	2	3	4	5	6
105	Igandya	60°36′21″–150°24′27″	195	406	B
106	Igandya	60°38′15″–150°29′06″	506	486	C
107	Igandya	60°42′05″–150°34′35″	556	448	C
108	Igandya	60°42′43″–150°38′15″	612	582	C
109	Indigirka	66°26′03″–143°09′11″	127 000	3170	C
110	Indigirka	66°28′45″–143°08′32″	157 000	3580	D
111	Indigirka	64°31′34″–143°00′26″	83 500	1730	D
112	Indigirka	64°11′08″–142°02′07″	51 100	1770	C
113	Indigirka	63°28′02″–142°47′54″	24 500	1420	B
114	In’yali	65°14′28″–143°07′58″	3310	917	C
115	Inya	59°24′48″–144°54′03″	19 700	2120	C
116	Iran	62°00′54″–155°40′08″	17.0	80	C
117	Iregin’ya	65°25′03″–144°00′44″	161	669	B
118	Kadykchan	60°02′36″–150°45′39″	64.9	172	A
119	Kakhovka	62°38′36″–155°00′36″	114	107	B
120	Kegali	64°26′43″–161°09′08″	10 600	1050	B
121	Kedon	65°37′37″–159°23′55″	10 300	1300	B
122	Ken’elichi	61°40′04″–144°49′23″	345	310	D
123	Ken’elichi	61°41′02″–144°45′57″	225	333	C
124	Kipchistan-Tirekhtyakh	65°51′03″–143°51′05″	504	501	D
125	Kipchistan-Tirekhtyakh	65°48′55″–145°52′39″	299	365	A
126	Kipchistan-Tirekhtyakh	65°37′01″–143°51′21″	108	146	A
127	Kipchistan-Tirekhtyakh	65°38′17″–143°55′22″	180	135	B
128	Kipchistan-Tirekhtyakh	65°40′31″–144°01′08″	296	161	B
129	Kirik	60°09′35″–151°51′19″	111	200	B
130	Kolyma	62°07′51″–148°23′06″	42 600	1813	B
131	Kolyma	62°45′19″–152°33′23″	104 000	4100	A
132	Kolyma	62°54′25″–152°28′18″	129 000	2340	A
133	Kolyma	63°07′44″–152°32′03″	133 000	3290	B
134	Kolyma	63°57′05″–154°04′47″	140 000	4050	B
135	Kolyma	64°03′47″–154°26′27″	158 000	3260	B
136	Kolyma	64°22′27″–154°10′55″	184 000	4050	B
137	Kolyma	64°42′15″–153°35′12″	231 000	2540	A
138	Kontrand’ya	63°15′28″–146°56′20″	66.6	266	D
139	Kontrand’ya	63°12′22″–146°49′21″	194	212	D
140	Kuvet	69°14′16″–175°00′56″	4220	1160	D
141	Kulu	61°52′13″–147°25′21″	10 300	1310	B
142	Kulu	62°17′27″–147°29′12″	15 600	1320	B
143	Kuob	64°55′21″–143°44′50″	97.9	160	B
144	Kuobakh-Baga	64°56′52″–143°46′49″	81.3	140	B
145	Kuobakh-Baga	64°54′45″–143°40′31″	241	265	C
146	Kyrchan	62°24′22″–155°08′16″	73	129	B
147	Kyrchan	62°21′02″–155°04′06″	117	77	C
148	Ken	62°40′06″–155°29′07″	66	72	B
149	Ken	62°39′39″–155°30′42″	39	61	B
150	Kyuente	63°44′25″–142°14′42″	43 800	2220	D
151	Kyurbelyakh	64°26′06″–143°57′21″	214	216	B
152	Kyurbelyakh	64°25′36″–143°56′46″	176	265	A
153	Kyurbelyakh	64°22′31″–143°55′40″	143	99	A
154	Kyurbelyakh	64°17′34″–143°51′49″	112	122	B
155	Lev. Kuobakh-Baga	64°54′03″–143°49′13″	79.3	172	B
156	Lev. Kuobakh-Baga	64°53′48″–143°51′07″	51.4	116	A
157	Lev. Kuobakh-Baga	64°54′25″–143°43′11″	119	208	B

Appendix, contined. Sheet 4

1	2	3	4	5	6
158	Lev. Intakh	64°46′50″–143°59′53″	32.7	109	B
159	Lev. Intakh	64°47′01″–143°58′56″	22.8	110	B
160	Lev. Kyrchan	62°23′53″–155°13′01″	19.0	41	B
161	Lev. Omchikchan	62°13′19″–155°46′47″	197	217	A
162	Lev. Omchikchan	62°12′32″–155°44′19″	143	126	C
163	Lev. Tirekhtyakh	64°48′59″–143°40′05″	35.8	158	B
164	Lesistaya	61°10′08″–151°18′31″	121	138	A
165	Leshii	65°24′24″–143°52′23″	25.3	121	D
166	Leshii	65°25′46″–143°55′23″	42.7	66	B
167	Lyukinde	66°09′09″–143°40′39″	52.3	259	D
168	Lyukinde	66°08′37″–143°40′05″	46.4	201	C
169	Lyunkindala	65°00′28″–143°38′43″	18.8	110	C
170	Magadaven	60°31′44″–150°58′42″	56.6	222	C
171	Magadaven	60°34′46″–150°51′54″	136	165	D
172	Magadaven	60°35′57″–150°39′57″	393	263	D
173	Main	64°09′43″–171°02′08″	18 600	2050	C
174	Mal. Anyui	68°08′52″–163°19′43″	43 100	1740	D
175	Mal. Anyui	68°11′12″–163°40′34″	30 000	1990	D
176	Maltan	60°45′26″–151°45′30″	450	257	C
177	Maya	54°29′55″–134°37′29″	15 300	1750	C
178	Maykan	60°05′22″–151°44′53″	1005	380	A
179	Mikurde	66°06′22″–164°40′04″	995	171	A
180	Mitrei-Ongontakh	65°08′44″–144°00′07″	107	146	D
181	Molandzha	65°08′38″–160°43′03″	4490	816	A
182	Moma	66°26′24″–143°11′38″	30 200	1920	B
183	Morozov	60°05′30″–150°50′56″	70	199	A
184	Mukul’chan	60°39′12″–150°22′49″	104	178	C
185	Myaundzha	63°01′46″–147°14′52″	386	306	A
186	Myaundzha	63°01′50″–147°14′15″	514	264	C
187	Myaundzha	63°00′42″–146°58′31″	1050	288	A
188	Myaundzha	63°00′25″–147°03′42″	686	241	B
189	Nalednyi	65°38′15″–143°55′32″	87.5	117	B
190	Nankala	60°19′14″–150°56′50″	45.0	128	A
191	Nankala	60°17′03″–150°56′24″	53.8	184	A
192	Nachal’nyi	62°37′36″–155°53′16″	23.0	171	B
193	Nachal’nyi	62°38′27″–155°48′48″	23.0	106	C
194	Nachal’nyi	62°38′25″–155°47′01″	19.0	69	C
195	Nachal’nyi	62°38′37″–155°46′27″	10.0	75	B
196	Nevskii	62°20′30″–155°41′15″	156	138	C
197	Nevskiiй	62°17′48″–155°30′09″	111	114	C
198	Nelkandya	60°12′35″–150°40′48″	140	503	D
199	Nelkandya	60°17′02″–150°56′44″	55.8	196	D
200	Nelkandya	60°16′30″–150°55′32″	110	236	D
201	Neponyatnyi	62°31′06″–155°31′20″	172	143	B
202	Neponyatnyi	62°32′02″–155°29′48″	128	69	A
203	Nera	64°33′44″–143°23′34″	24 400	1640	B
204	Nera	64°31′25″–143°38′38″	24 200	1190	A
205	Nera	63°48′36″–145°35′23″	6610	783	C
206	Nera	63°51′50″–145°28′26″	9680	1340	C
207	Neryuchi	61°54′58″–147°16′12″	2140	874	B
208	Nimfa	62°28′40″–155°41′05″	33.0	54	D
209	Nosagchan	61°06′38″–151°17′25″	366	244	B
210	Nukh	60°14′35″–151°45′14″	756	610	C

Appendix, contined. Sheet 5

1	2	3	4	5	6
211	Oktyabrina	62°47′07″–155°49′16″	38.0	107	B
212	Oktyabrina	62°46′32″–155°44′28″	20.0	88	A
213	Oktyabrina	62°47′28″–155°50′29″	94.0	186	C
214	Oktyabrina	62°50′28″–155°56′33″	140	113	C
215	Oktyabrina	62°51′06″–156°02′19″	382	328	A
216	Ola	60°06′36″–151°45′42″	2190	1350	D
217	Oloi	66°28′07″–159°29′55″	23 100	1780	C
218	Oloi	65°40′52″–162°18′08″	15 700	1360	C
219	Oloichan	66°14′43″–161°34′46″	1120	435	C
220	Omolon	66°37′39″–159°31′22″	88 700	3280	C
221	Omchikchan	62°20′45″–155°41′33″	767	290	A
222	Omchikchan	62°24′50″–155°41′48″	856	326	A
223	Omchikchan	62°33′11″–155°51′15″	1736	439	B
224	Omchikchan	62°36′23″–155°54′30″	1785	618	B
225	Orlovka	66°47′20″–164°49′05″	2440	947	B
226	Orlovka	66°50′42″–164°57′19″	1990	819	B
227	Okhota	59°24′07″–143°00′40″	19 100	1680	C
228	Palatka	60°05′06″–150°55′00″	258	167	A
229	Pegtymel’	69°37′57″–174°12′20″	17 600	1680	D
230	Pekarnyi	62°28′40″–149°37′05″	262	247	D
231	Peschanaya	63°17′01″–177°59′37″	266	240	D
232	Pikas’vayam	61°57′46″–172°46′39″	2300	1040	D
233	Prav. Kuobakh-Baga	64°59′29″–143°41′40″	64.8	167	C
234	Prav. Kuobakh-Baga	64°58′53″–143°47′58″	35.4	136	C
235	Prav, Tiretyakh	64°51′06″–143°41′01″	67.8	203	B
236	Prav. Omchikchan	62°10′38″–155°47′02″	236	132	D
237	Prav. Omchikchan	62°06′44″–155°41′24″	66.0	50	A
238	Prav. Omchikchan	62°06′07″–155°37′03″	48.0	45	B
239	Prav. Omchikchan	62°09′28″–155°30′23″	23.0	90	C
240	Prav. Tadleoan*	64°42′27″–179°38′14″	177	181	D
241	Prav. Erucha	61°48′13″–144°53′56″	59.3	120	D
242	Pritochnyi	60°12′33″–150°40′16″	47.3	265	A
243	Propushchennyi	60°33′16″–150°30′39″	29.5	78	A
244	Propushchennyi	60°30′42″–150°32′03″	54.2	102	B
245	Pryamoi	66°12′23″–164°42′17″	197	103	D
246	Pryamoi	66°11′54″–164°45′21″	192	81	A
247	Razin	64°38′02″–143°47′59″	51.1	114	B
248	Razin	64°38′56″–143°45′18″	24.0	128	B
249	Razin	64°39′31″–143°44′27″	13.2	53	A
250	Sartang	65°17′38″–132°52′48″	3725	997	D
251	Svetlyi	60°46′15″–150°31′13″	30.5	136	C
252	Svetlyi	60°44′19″–150°40′48″	61.0	222	C
253	Sev. Pekul’neveem	65°33′19″–173°31′18″	574	271	D
254	Seimkan	60°02′30″–149°11′53″	2900	1180	D
255	Seimchan	62°55′39″–152°27′42″	3600	803	D
256	Sol’veig	62°25′35″–155°46′41″	85.0	152	A
257	Sol’veig	62°23′19″–155°51′28″	46.0	69	A
258	Srednii	66°03′14″–164°45′13″	95.6	53	B
259	Srednii	66°03′23″–164°46′18″	52.8	54	A
260	Sugoi	64°14′52″–154°30′58″	26 100	1750	D
261	Sugoi	62°33′59″–155°59′36″	5680	624	A
262	Sugoi	62°40′17″–155°56′31″	5880	485	D
263	Suntar	63°20′19″–141°44′16″	7990	1160	D

Appendix, contined. Sheet 6

1	2	3	4	5	6
264	Suruktakh	65°20′00″–132°50′19″	610	310	D
265	Sukhoi	60°43′35″–150°39′22″	16.0	95	C
266	Tagargacha	64°31′43″–143°45′53″	338	207	B
267	Tagargacha	64°35′58″–143°36′20″	274	236	A
268	Tamnar	65°38′15″–143°24′32″	21.5	122	B
269	Tap	62°01′58″–155°44′06″	193	232	C
270	Tap	62°03′07″–155°48′55″	213	292	D
271	Tap	62°00′52″–155°59′08″	286	295	B
272	Taskan	62°45′02″–150°47′40″	8850	1200	D
273	Takhtayama	60°14′38″–154°44′46″	5110	1927	D
274	Tverdyi	64°37′03″–143°51′40″	29.9	48	B
275	Tingkalakh	65°06′24″–133°00′49″	863	5360	D
276	Tirekh	61°11′36″–151°17′42″	12.0	69	A
277	Tirekhtyakh	67°33′57″–137°08′33″	1430	938	D
278	Tikhon-Yuryakh	66°00′00″–145°23′20″	673	390	B
279	Tikhon-Yuryakh	65°54′03″–145°28′52″	552	385	A
280	Tikhon-Yuryakh	65°39′55″–145°25′19″	266	115	A
281	Tikhon-Yuryakh	65°38′33″–145°24′47″	243	134	A
282	Tangakhchan	60°30′15″–150°28′05″	20.1	98	B
283	Tangakhchan	60°30′34″–150°31′34″	35.3	95	A
284	Tangakhchan	60°29′44″–150°33′36″	95.8	153	B
285	Trezor	62°51′58″–155°46′20″	40.0	72	B
286	Trezor	62°51′27″–155°52′29″	197	128	A
287	Tymtei	63°47′05″–145°39′14″	4220	607	D
288	Tyry	62°21′58″–135°49′39″	14 000	1840	D
289	Tetemveem	67°49′44″–165°53′57″	3070	549	D
290	Teuterendzh	62°19′25″–155°01′26″	100	70	B
291	Teuteredhzek	62°20′08″–155°00′00″	261	80	B
292	Ugulan	60°27′06″–155º11′08″	2150	1200	C
293	Uda	54°40′01″–135°08′34″	46 000	2470	D
294	Uzelok	62°20′48″–155°02′18″	147	132	B
295	Ukelayat (Ugulan)	61°44′31″–173°30′11″	2150	1300	D
296	Ukelayat	61°57′17″–172°45′28″	3320	1790	D
297	Ulu-Tumul	65°06′37″–132°57′21″	405	324	D
298	Ul'beya	59°22′41″–144°25′12″	13 500	1450	D
299	Ul'ya	58°52′01″–141°50′00″	15 500	1830	D
300	Ulyagan	65°18′26″–160°47′24″	2010	778	B
301	Urak	59°17′39″–142°50′27″	10 700	1460	D
302	Utesnyi	60°31′53″–150°40′17″	36.8	83	A
303	Uchyugei-Yuryakh	64°45′43″–143°38′58″	91.0	90	A
304	Faraon	60°15′08″–149°43′20″	193	287	D
305	Final'nyi	60°30′01″–150°34′47″	58.9	112	A
306	Finish	60°33′40″–150°39′47″	73.6	112	A
307	Khasyn	60°09′37″–151°02′56″	199	296	B
308	Khasyn	60°07′40″–150°58′47″	283	344	B
309	Khasyn	60°05′36″–150°55′04″	327	344	B
310	Khasyn	60º04′55″–150º54′00″	588	430	C
311	Khasyn	60°05′18″–150°49′33″	718	731	B
312	Khasyn	60°03′22″–150°43′42″	892	710	B
313	Khasyn	60°03′55″–150°42′10″	773	720	C
314	Khasyn	60°02′06″–150°41′41″	1670	1010	A
315	Khasyn	59°44′28″–150°17′28″	3330	1110	A
316	Khatachan	60°17′46″–149°23′12″	346	310	B

Appendix, contined. Sheet 7

1	2	3	4	5	6
317	Khatys-Yuryakh	65°18′42″–143°47′40″	81.1	122	B
318	Khatys-Yuryakh	65°19′59″–143°39′13″	121	200	B
319	Kheta	61°06′23″–151°20′22″	773	525	C
320	Khilgalin	60°07′10″–150°13′35″	386	407	A
321	Khudzhakh	63°47′26″–145°39′49″	2390	658	D
322	Chalbyga	60°00′36″–150°32′41″	400	481	B
323	Chapchik	62°27′47″–155°40′43″	535	149	D
324	Chapchik	62°29′18″–155°36′06″	375	282	B
325	Chapchik	62°30′40″–155°32′05″	174	173	B
326	Charky	66°50′20″–137°02′33″	7330	1150	D
327	Chelomdzha	59°51′55″–148°12′50″	12 000	1780	D
328	Egelyakh	64°28′15″–143°51′57″	250	219	B
329	Egelyakh	64°24′39″–143°46′31″	158	169	B
330	Egelyakh	64°20′14″–143°38′22″	64.2	171	B
331	Ekiatap	69°07′21″–179°01′49″	5690	1240	D
332	Ekityki	67°40′02″–178°46′05″	10 300	1380	D
333	El’gi	64°16′28″–142°05′57″	68 200	1905	B
334	El’gi	64º18′25″–141°52′25″	64 100	1349	B
335	Emtegei	62°58′35″–146°52′34″	2160	847	A
336	Enmyvaam	66°16′52″–173°31′55″	11 900	1326	D
337	Yablon’	65°23′11″–168°32′21″	9280	2254	D
338	Yama	59°50′32″–153°18′04″	12 200	1550	D
339	Yana	59°46′27″–149°12′01″	8160	1946	D
340	Yana	60°22′47″–148°28′06″	2520	1040	C

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* Western Hemisphere.