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Teknillisen korkeakoulun tutkimuksia, No 1, 1949 s. 75−98

Eripainos Tekn. korkeakoulun tutkimuksia N:o 1

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HELSINKI 1949

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For a variety of practical purposes it is often necessary to estimate the run-off maximum in streams and rivers according to the area and other characteristics of the watershed. In addition to these features of the river basin, the calculations usually take into consideration the intensity of rainfall causing the maximum discharge. The estimation of the rainfall maximum often depends on the average annual rainfall, and similarly the estimation of the maximum depends on the mean annual discharge. In Norway (Soegnen 1942) and Sweden (Bergsten 1943) the latter factor has been considered in formulae for estimating the discharge maximum. In Finland the mean discharge varies very little in different parts of the country. On an average the mean discharge is 10 litres per square kilometre per second varying from 7 to 13 $1/km^2$.sec. (Renqvist 1935). But in spite of the smallness of these variations in the mean discharge the figures for the disharge maximum vary considerably in different parts of the country.

The melting of snow in springtime is the principal factor in the annual run-off maximum for the whole country. This factor has therefore been considered in the formulae for estimating the run-off maximum (Renqvist 1933, Hallakorpi 1934, Kaitera 1939). Apart from this factor, the discharge maximum depends on the area of the river basin and the percentage of lakes. Renqvist's formula is as follows:

$$MHq = 10 + \frac{8\,L_1}{1 + 0.02 \cdot P^2 + 0.01 \cdot \sqrt{A} + 0.0001 \cdot P^2 \cdot \sqrt{A}} \tag{1}$$

MHq = average discharge maximum (in litres per sq.km. per sec.)
A = area of the watershed (km^2)
P = percentage of lakes in the area of watershed
L_1 = maximum daily decrease of water content of snow (in mm).

This formula is based on observations of 46 streams and rivers during the period 1912—1926. The area of these watersheds varied from 240 km^2 to 60200 km^2. It has been proved that the formula can be considered satisfactory if the area of the watershed is greater than 200 km². For smaller watersheds the figures it gives are too low.

KAITERA's formula is based principally on observations of 50 smaller streams during the period 1934—1947. The areas of these streams varied from 4.5 km² to 195 km². The formula is as follows:

$$(2) \qquad MHq = \frac{3.5 \cdot \left(1 - \frac{P}{L_5 + 40}\right)^8 \cdot (L_5 + 40)}{\sqrt[6]{A + 1}} + c.$$

The letters signify the same factors as in Formula (1) except that L_5 is the maximum decrease in the water content of snow during 5 days (mm) and c is a factor that corrects the estimates for watersheds of less than 30 km², the influence of the area on the MHq having been proved not to be the same in smaller watersheds as in larger ones.

Now that we have more observations available about the snow melting and run-off, I have again taken up the study of this problem.

The maximum decrease in the water content of snow in different parts of Finland and on different types of terrain during 5, 10, 15, 20 and 30 days in 1934—1948 is given in Table 1. These results are based on measurements of about 100 snow courses per year. The depth of snow was measured on observation lines laid out in different types of terrain with varying topography and vegetation, the types of terrain being carefully defined and described. On each snow course the depth of snow was measured at 30 points at intervals of 5 metres, the total length of each course being 150 metres. Further, on some of the courses the density of snow was measured at 5 points 30 metres apart. As a rule, the measurements were taken at 5-day intervals, commencing on the 10th of March and continuing till the end of the melting season.

Type I: Open fields.

Type III—IV: Hardwood forest, sparse mixed forest or very sparse conifer forest.

Type V—VI: Dense mixed forest or conifer forest.

In calculating the decrease in the water content of snow in 5—30 days the difference of two measurements was taken and the maximum decrease during a certain period of days was noted. Figs. 1 and 2 illustrate the maximum decrease in the water content of snow during periods of different length in different regions and on different types of terrain. In addition to the absolute figures in mm, the corresponding relative ones, as compared with the spring maximum of water content of snow, are also given. The diagrams show that there was more snow in northern Finland than further south and more snow in sparse forest areas than in dense forest or in open fields. Since they depend on the quantity of snow at the beginning of the melting period, the absolute figures for melting-quantities during a certain period of days vary very much in different regions and on different types of terrain. But the relative figures in different parts of the country and

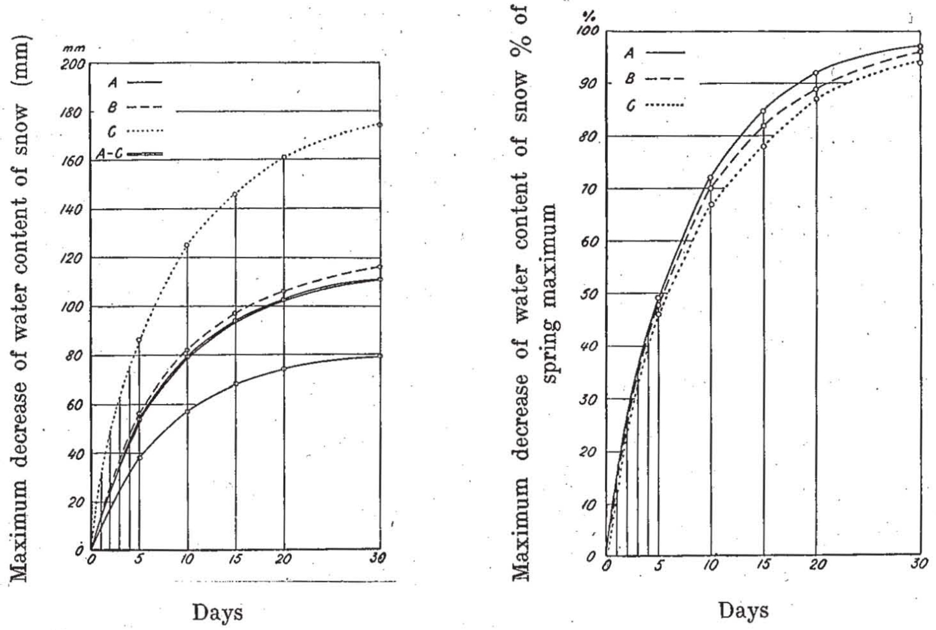

Fig. 1. Maximum decrease of water content of snow in different regions (A = South-West-Finland, B = Central Finland, C = North Finland) and over varying periods of time.

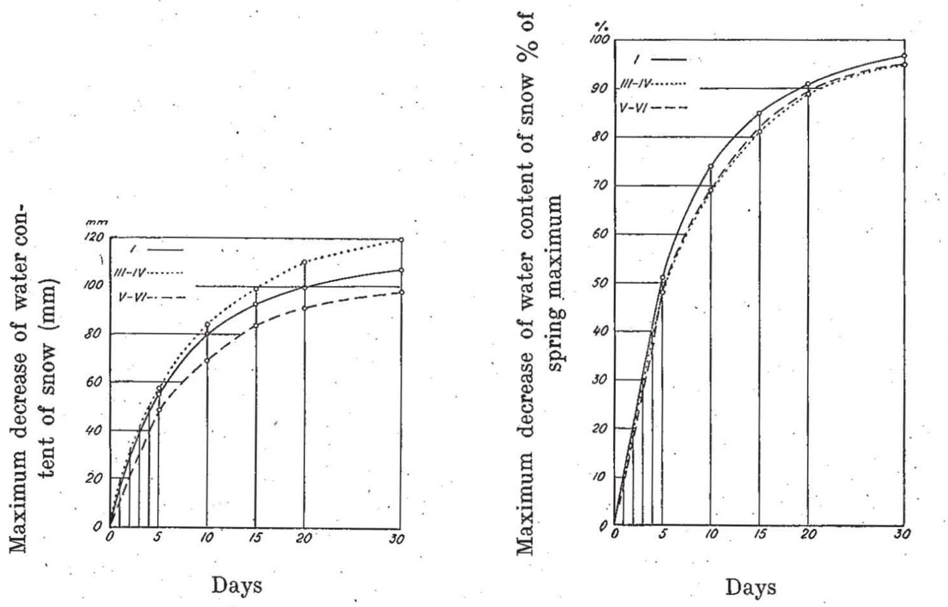

Fig. 2. Maximum decrease of water content of snow on different types of terrain (I = open fields, III—IV = sparse forest, V—VI = dense forest) and over varying periods of time.

Table 1. Average maximum decrease in the water content of snow during 5, 10, 15, 20 and 30 days in different regions and on different types of terrain (I = open fields, III—IV = sparse forest, V—VI = dense forest) in the years 1934—1948.

Type of ground	Average maximum decrease									
	mm in					percentage of the maximum quantity of snow in				
	5 days	10 days	15 days	20 days	30 days	5 days	10 days	15 days	20 days	30 days
	South-West Finland									
I	37	55	64	68	72	53	77	87	93	98
III—IV	40	61	73	80	86	46	70	83	90	97
V—VI	36	54	64	70	75	49	71	84	92	97
I—VI	38	57	68	74	79	49	72	85	92	97
	Central Finland									
I	58	84	98	106	113	51	73	85	91	97
III—IV	58	85	99	110	120	48	69	81	89	96
V—VI	50	72	87	94	102	48	67	80	87	94
I—VI	56	82	97	106	116	48	70	82	89	96
	North Finland									
I	91	127	144	156	168	52	72	82	89	95
III—IV	84	125	151	165	183	43	64	77	84	94
V—VI	81	118	147	164	179	45	65	80	88	96
I—VI	86	124	146	161	174	46	67	78	87	94
	The whole country									
I	55	80	93	100	107	51	74	85	91	97
III—IV	57	84	100	110	120	47	68	81	88	95
V—VI	48	69	84	91	98	48	68	82	89	95
I—VI	54	79	94	103	111	48	70	82	89	96

on different types of terrain vary only slightly in spite of the great differences in the absolute figures. Thus, regardless of the geographical location and the type of terrain, a single curve, representing the mean of the relative melting rate of snow during different periods of time as compared with the spring maximum of the water content of snow, can be used to illustrate the average melting rate of snow in Finland. In five days about half the maximum water content of snow is melted and in one day about one eighth of the spring maximum is melted. We can thus replace the factor $8\,L_1$ in Formula (1) by the factor L, which represents the spring maximum of the water content of snow, and in Formula (2) we can insert $L_5 = 0.5\,L$.

I have already calculated the melting intensities for the period 1934—1937. Comparison between these figures and those for the period 1934—1948 is as follows:

	Average percentage of water content of snow melted in				
	5 days	10 days	15 days	20 days	30 days
1934—1937	46 %	71 %	85 %	91 %	96 %
1934—1948	48 %	70 %	82 %	89 %	96 %

It will be seen that the differences in the figures for these periods are very small. KORHONEN (1926) took corresponding measurements over the period 1922—1926 and obtained roughly the same figures. Thus the figures in Table 1 can be regarded as the average normal figures for Finland.

KORHONEN has produced very comprehensive figures for the depth of snow in the middle of March since the year 1919. On the basis of these measurements he has compiled maps showing the depth of snow on 15 March, when it is at its winter maximum. (KORHONEN 1936). He has placed at my disposal the manuscript of a new map showing the average depth of snow on 15 March in sparse forest areas over the period 1892—1941. On the basis of this map I have constructed a map of the average spring maximum of the water content of snow (Fig. 5). The map has been constructed by taking the measurements for 1934—1938 and determining the ratio between the spring maximum of water content and the depth of snow on 15 March in sparse forest areas. This ratio averages out at 2.60. The values in different regions deviate from this ratio by an average of only ± 4 %. These deviations are so small that we can regard the figures in Fig. 5 as the normal values for the spring maximum of water content of snow in Finland.

The snowfall and rainfall in the whole country during the melting season averages 35 mm per 30 days. Taking this water into consideration and using Figs. 1, 2 and 5 as a basis, we can determine the quantities of water released by the snow during springtime.

The Hydrographical Bureau and the Engineering Office of the Agricultural Department have provided me with figures for the discharge maximum in different watersheds. The results appear in Table 2. Fig. 3 shows the locations of the watersheds. The table covers only those watersheds where observations have been made over a period at least five years. During springtime the ice cover makes the estimation of the run-off maximum extremely difficult. In order to correct possible errors, comparisons have been made with the run-off figures of near-by watersheds possessing a similar area and percentage of lakes to those of the watershed in question. The figures in Table 2 represent the run-off maximum during the springtime. If the highest run-off has occurred during the autumn or winter, these figures have not been taken into consideration.

Table 2 shows 184 watersheds, with areas varying between 4.5 and 61,300 km^2 and a percentage of lakes varying between 0 and 28.9 %. The average run-off maximum varies in different watersheds from 0.10 m^3/sec. to 2,870 m^3/sec. and the average discharge maximum from 11 litres per square kilometre per second to 210 litres/km^2 sec. In order to bring out more clearly the influence of the various factors, I have divided the observations into groups according to area and per-

Table 2. Average maximum (*HMQ*) and maximum (*HQ*) run-off in different watersheds in Finland.

N:o	Watershed: Name	Watershed: Area km²	Watershed: Percentage of lakes	Observation period	Maximum run-off: MHQ m³/sec	Maximum run-off: HQ m³/sec and year	HQ : MHQ	Average maximum discharge MHq l/km²sec.
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
	Vuoksi watershed (*Vu*)							
1	Lieksanjoki, Höpöttäjänvirta ..	8115	10.9	1911—48	228	390, 1924	1.72	28
2	Koitajoki, Lylykoski	4290	8.4	1911—48	116	203, 1924	1.75	27
3	Koitereenjoki, Hiiskoski	2125	12.4	1911—48	50	81 1920	1.62	24
4	Koitajoki, Siikakoski	6555	9.7	1911—48	178	301, 1920	1.69	27
5	Pielisjoki, Häihä	20950	12.9	1911—47	372	704, 1924	1.89	18
6	Pielisjoki, Jakokoski	21225	12.6	1911—48	368	634, 1924	1.72	17
7	Höytiäinen, Puntarikoski	1425	22.1	1931—45	28	39, 1936	1.39	20
8	Nerkoonjärvi, Nerkoonvirta ..	4715	6.1	1911—48	241	407 1927	1.69	51
9	Onkivesi, Viannonkoski	5565	7.6	1911—48	231	377, 1927	1.63	41
10	Syväri, Lastukoski	2455	19.8	1911—48	65	118, 1943	1.81	26
11	Vuotjärvi, Juankoski	4135	10.4	1911—48	122	230, 1943	1.89	30
12	Juojärvi, Palokki	2110	21.8	1931—47	36	59, 1938	1.64	17
13	Kallavesi, Konnus + Karvio ..	16270	15.3	1937—45	275	474, 1938	1.72	17
14	Vuoksi, Imatra	61280	19.9	1911—48	648	1107, 1924	1.71	11
15	Vuoksi, Myllykoski	61300	19.9	1911—40	670	1115, 1924	1.67	11
16	Valtimonjoki, Kuokkastenkoski	1045	4.5	1938—40, 1944—48	71	118, 1938	1.66	68
17	Yläkoski, Valtimo	253	6.5	1937—41	21	33, 1938	1.57	83
18	Matkujoki, Valtimo	568	3.0	1937—41	50	75, 1938	1.50	79
19	Tohmajoki, Tohmajärvi	190	8.0	1937—40, 1942—43	5.5	9.0, 1943	1.64	29
20	Hiitolanjoki, Ansalankoski	1370	13.9	1932—39	43	49, 1937	1.14	31
21	Sysmäjärvi, Kuusjärvi	129	9	1934—36, 1942—48	5.5	9.0, 1936	1.64	43
22	Kesselinpuro, Kuusjärvi	20	1	1934—48	2.0	3.3, 1936	1.65	100
23	Kuusjärvi, luusua	23	9	1934—43	1.5	3.0, 1936	2.00	65
24	Alasenjärvi, Rantasalmi	66	28	1931—48	0.7	1.1, 1944	1.57	11
25	Putkijärvi, luusua	37	21	1934—43	0.6	0.8, 1943	1.33	16
26	Rappusenjärvi, luusua	25	19	1934—43	0.41	0.6, 1943	1.47	19
27	Hirvosenjärvi, luusua	6.5	22	1934—48	0.13	0.2, 1945	1.54	22
28	Inkilänoja, Ruokolahti	4.5	0	1935—48	0.46	0.8, 1946	1.67	102
29	Latosuonoja, Ruokolahti	4.5	0	1935—48	0.49	0.9, 1946	1.84	109
30	Vehakonoja, Ruokolahti	10	1	1935—45, 1948	1.8	2.6, 1942	1.45	180
31	Huhtisuonoja, Ruokolahti	4.5	0	1935—48	0.67	1.11, 1945	1.66	149

1	2	3	4	5	6	7	8	9
	Kyminjoki watershed (*Ky*)							
32	Kolimajärvi, Kellonkoski	1500	15.4	1911—48	30	54 , 1922	1.80	20
33	Kivijärvi, Potmonkoski + Kämärinjoki	1820	13.6	1911—40	35	62 , 1922	1.77	19
34	Vuosjärvi, Huopanankoski	2275	13.7	1911—48	40	71 , 1922	1.77	18
35	Pääjärvi, Kouheroisenkoski ..	1230	7.8	1911—48	48	100 , 1922	2.08	39
36	Kalmarinjärvi, Kalmukoski ..	1775	7.7	1911—48	62	109 , 1922	1.72	35
37	Saarijärvi, Roikolankoski	2200	8.1	1911—48	82	172 , 1922	2.10	37
38	Kiimasjärvi, Kiimaskoski	3025	9.9	1911—48	108	235 , 1922	2.17	36
39	Kuhnamojärvi, Kapeekoski	9515	15.3	1911—48	165	343 , 1922	2.08	17
40	Vatiajärvi, Kuusankoski	9645	15.2	1911—48	169	341 , 1922	2.02	18
41	Konnevesi, Siikakoski	5780	21.3	1911—48	77	128 , 1924	1.67	13
42	Kynsivesi, Simunankoski	6880	20.7	1911—48	91	161 , 1924	1.77	13
43	Leppävesi, Haapakoski	17585	17.7	1911—48	272	467 , 1922	1.72	15
44	Jääsjärvi, Tainionvirta	1425	26.4	1911—48	22	31 , 1924	1.41	15
45	Joutsjärvi, Ammalankoski	1715	23.8	1911—48	24	40 , 1924	1.67	14
46	Päijänne, Kalkkinen	26475	19.5	1911—48	316	531 , 1924	1.69	12
47	Konnivesi, Vuolenkoski	28080	19.4	1937—45	282	360 , 1943	1.28	10
48	Arrajärvi, Kaurakoski	28600	19.3	1911—48	326	532 , 1924	1.63	11
49	Vahvajärvi, Ripatinkoski	3525	23.3	1939—47	34	65 , 1944	1.92	10
50	Puolakka + Jaala	5495	22.5	1911—45	69	106 , 1924	1.53	13
51	Karankakoski	430	6.5	1921—36	23	36 , 1922	1.56	23
52	Kyminjoki, Keltti	36075	19.5	1911—48	410	640 , 1924	1.56	11
53	Petäjävesi, luusua	665	5.4	1911—48	42	83 , 1920, 1922	1.97	63
54	Ala-Rääveli, Sulkavankoski	870	17.3	1911—48	19.5	34 , 1922, 1924	1.74	22
55	Kyminjoki, Perno	36530	19.3	1911—40	432	644 , 1924	1.49	12
56	Saarijärvi	100	9	1939—44	3.9	7.8 , 1944	2.00	39
	Southern coast (*Et*)							
57	Rokkalanjoki, Summanjoki	300	8.5	1931—33, 1935—39	8.8	17.1 , 1931	1.94	29
58	Rokkalanjoki, Salmensilta	225	11.3	1931—39	4.6	7.5 , 1931	1.63	20
59	Heinlammenoja, Jääski	13	1	1934—38	1.4	1.7 , 1937	1.22	108
60	Kilpeenjoki, Vakkila	177	2	1936—39	18.3	21 , 1938	1.15	103
61	Ihantalanpuro, Viipuri	12.5	8	1933—39	0.53	0.65, 1937	1.23	42
62	Kilpeenjoki, Runolampi	116	1	1935—39, 1943	12.8	14.0 , 1936	1.10	110
63	Pihkalanjärvenoja	45	0	1930—39 1943	4.7	5.8 , 1937	1.24	104
64	Myllykorvenoja	7.5	0	1934—39	1.3	1.5 , 1938	1.15	173
65	Rajaoja	13.5	2.7	1934—39	1.6	1.9 , 1938	1.19	118
66	Pankanoja	14.5	3.8	1934—39	1.3	1.6 , 1936	1.23	90
67	Ilolanjoki, Väfvarsbacka	225	3.3	1936—48	18	22 , 1945	1.22	80

1	2	3	4	5	6	7	8	9
68	Ilolanjoki, Ekenäs	100	2.6	1937—47	11	14 , 1941	1.27	110
69	Porvoonjoki, Ruha	780	1.4	1938—48	53	76 , 1944	1.43	68
70	Porvoonjoki, Napionkoski	915	1.6	1938—45, 1947—48	57	86 , 1941	1.51	62
71	Porvoonjoki, Henttalankoski ..	1115	1.7	1937—48	70	96 , 1945	1.37	63
72	Äväntöjoki, Järvelä	55	0	1939—44, 1946—48	4.8	6.1 , 1939	1.27	87
73	Immilänjoki, Ruuhijärvi	295	14	1937—48	4.9	11 , 1945	2.25	17
74	Kaartjoki, Loppi	70	17.3	1941—46	0.9	1.5 , 1944	1.67	13
75	Mäntsälänjoki, Ridanfors......	780	2.5	1932—47	74	99 , 1945	1.34	95
76	Vantaanjoki, Oulunkylä	1680	2.5	1921—47	121	225 , 1931	1.86	72
77	Vantaanjoki, Stenkulla	355	1.9	1913—27	40	60 , 1919	1.50	112
78	Mankajoki, Lapinkylä	20	21.8	1941—47	0.47	0.57, 1945	1.21	23
79	Mankajoki, Tampaja	5	28.9	1924—33, 1941—48	0.10	0.12, 1926	1.20	20
80	Vihtijoki, Saukonkoski	162	6.3	1939—48	10.7	16.4 , 1943	1.53	67
81	Vihtijärvi, luusua	28.7	18.5	1939—48	0.56	0.98, 1945	1.75	20
82	Karjaanjoki, Landsbro	1995	12.2	1911—48	40	73 , 1916	1.83	20
83	Aurajoki	727	0.2	1938—48	104	138 , 1948	1.33	143
84	Putaanjoki, Koski	94	1	1930—44, 1946—47	8.9	15.8 , 1942	1.78	95
85	Putaanjoki, Putta	79	2	1934—48	8.0	12.5 , 1942	1.56	101
86	Vihtjärvenoja, Vinkkilä	29	3	1931—48	2.5	4.1 , 1932	1.64	86
87	Mynäjoki, Karjala............	90	1	1934—44	7.9	11.1 , 1936	1.40	88
88	Mynähaara, Karjala	48	1	1934—44	4.9	7.3 , 1936	1.49	102
89	Raasinhaara, Karjala	37	1	1934—48	3.1	4.9 , 1936	1.58	95
90	Köyliönjoki, Voitoinen	195	8	1930—48	7.9	11.0 , 1937	1.39	41
91	Köyliönjoki, Ehtamo	150	10	1930—39	3.0	4.5 , 1937	1.50	23
92	Löytäneenoja, Kokemäki	7	0	1936—41	1.2	1.9 , 1937	1.58	172
93	Sirppijoki, Laitila	200	4.5	1935—38, 1944	10.2	13.0 , 1937	1.27	51
94	Lapinjoki, Lappi	287	3.0	1945—48	21	24 , 1945	1.15	73
	Kokemäenjoki watershed (*Ko*)							
95	Pääskylänjoki, Joenpolvi	240	17.0	1911—37	5.7	9.2 , 1927	1.62	24
96	Kukkiajärvi, Puutikkala	835	19.3	1911—33	11.7	17.0 , 1932	1.45	14
97	Uittamonjoki, Leppäkoski	1035	3.5	1911—37	37	53 , 1931	1.43	36
98	Puujoki, Lappilankoski........	420	5.4	1937—46	14.4	18.5 , 1945	1.28	34
99	Tarpianjoki, Viiala	805	6.7	1911—20, 1928—32	23	30 , 1916	1.30	29
100	Vanajavesi, Kuokkala	8680	14.4	1911—48	116	181 , 1924	1.56	13
101	Ouluvesi, Oulukoski	915	11.7	1911—36	27	47 , 1922	1.74	30
102	Toisvesi, Herraskoski	1475	10.9	1911—48	43	80 , 1922	1.86	29
103	Kituisjärvi, Kituiskoski	565	9.2	1911—48	21	37 , 1922	1.76	37
104	Sääksjärvi, luusua	660	9.8	1921—48	17.3	31 , 1926	1.79	26
105	Juupajoki	365	5.8	1911—21	18	34 , 1916	1.89	49
106	Haapaniemenjärvi	550	7.7	1911—20	23	30 , 1911	1.30	42

1	2	3	4	5	6	7	8	9
107	Tarpianjoki, Urjala	260	9.7	1937—46	7.3	10.2 , 1944	1.40	28
108	Hirvijoki, Juupajoki	60	11	1936—48	2.3	4.3 , 1936	1.87	38
109	Orijoki, Juupajoki	29	11	1936—48	1.7	3.1 , 1936	1.83	59
110	Valkeajoki, Juupajoki	16	10	1936—46, 1948	0.93	1.5 , 1936	1.61	58
111	Muhunjärvi, Juupajoki	9	18	1936—47	0.36	0.60, 1936	1.67	40
112	Pyhäjärvi, Nokia	16975	14.6	1921—47	240	379 , 1924	1.58	14
113	Parkanonjoki, Karjasillankoski	680	10.0	1931—47	25	35 , 1931	1.40	37
114	Aurejoki, Poltinkoski	490	10.6	1933—47	16.1	21 , 1943	1.30	33
115	Jämijärvi, Jämijoki	365	3.4	1913—30	24	40 , 1916	1.67	66
116	Kyrösjärvi, Kyröskoski	2705	10.1	1911—33	68	108 , 1916	1.59	25
117	Rautavesi, Vammaskoski	21045	13.7	1911—48	282	444 , 1920	1.58	13
118	Kokemäenjoki, Kiikka	21290	13.6	1911—48	288	442 , 1920	1.54	13
119	Loimijoki, Vesikoski	1250	7.1	1911—35	47	74. , 1919	1.58	38
120	Loimijoki, Maurialankoski	2650	3.5	1931—47	211	286 , 1926	1.36	80
121	Kokemäenjoki, Harjavalta	26025	11.8	1911—48	505	846 , 1936	1.68	19
	Pohjanmaa coast (*Po*)							
122	Karvianjoki, Pomarkku	1859	4.8	1926, 1941—48	106	138 , 1926	1.30	57
123	Jalasjoki, Pitkäkoski	955	1.2	1926—47	62	105 , 1926	1.69	65
124	Kyrönjoki, Lansorsund	4805	1.0	1911—48	287	527 , 1922	1.84	60
125	Lapuanjoki, Pappilankari	3710	3.0	1931—47	162	288 , 1936	1.78	44
126	Lapuanjoki, Keppo	3970	2.8	1931—47	173	314 , 1936	1.81	44
127	Lappajärvi, luusua	1510	11.6	1927—47	27	50 , 1944	1.85	18
128	Evijärvi, luusua	1715	11.9	1927—47	31	55 , 1922	1.78	18
129	Ekoluoma, Anttila	109	0	1933—44	9.5	14.0 , 1936	1.48	87
130	Ekoluoma, Huhtamäki	78	1	1931—48	7.7	12.2 , 1945	1.59	99
131	Ekoluoma, Vakkuri	59	1	1931—38	5.6	10.0 , 1936	1.79	95
132	Ekoluoma, Kuoppala	28	1	1933—48	3.4	6.4 , 1945	1.88	121
133	Halsuanjoki, Alajoki	686	3.1	1930—35	40	79 , 1931	1.98	58
134	Ullavanjoki, Kyminkoski......	472	4.2	1933—37	26	36 , 1936	1.39	55
135	Lestijärvi, luusua	380	28.8	1921—46	5.7	9.4 , 1922	1.65	15
136	Lestijoki, Kannus	1195	9.8	1911—21, 1925—40	120	199 , 1931, 1936	1.66	100
137	Kalajoki, Haapajärvi	1185	2.5	1930—47	81	125 , 1944	1.54	69
138	Kalajoki, Raudaskoski	2205	2.1	1912—44	190	290 , 1922	1.53	86
139	Kalajoki, Tynkä	1990	1.9	1911—48	247	469 , 1924	1.90	83
140	Pyhäjoki, Haapakoski	1985	7.7	1931—47	151	245 , 1944	1.62	76
141	Pyhäjoki, Pyhäkoski	3475	5.5	1912—21, 1924—40	225	450 , 1931	2.00	65
142	Myllyoja, Haapavesi	61	8.2	1939—46	1.8	3.8 , 1944	2.11	30
143	Siikajoki, Länkelä	4355	1.4	1936—47	301	437 , 1936	1.45	69
144	Siikajoki, Heikkilänkoski	1800	1.8	1936—47	246	353 , 1944	1.44	88
145	Kähtävänoja, Alavieska	67	2	1934—48	7.5	13.0 , 1936	1.74	112
146	Kähtävänoja, Kähtävä	60	2	1931—48	6.7	11.5 , 1936	1.72	112
147	Savonoja, Pulkkila	10.5	0	1931—47	1.6	1.9 , 1938	1.19	152

1	2	3	4	5	6	7	8	9
148	Liminganjärvi, luusua	110	4.1	1938—48	4.5	7.2 , 1943	1.60	41
149	Tuohinonoja, Kempele	13	0	1931—48	1.9	2.7 , 1943	1.42	146
150	Nurmonjoki, Nurmo	370	5.7	1938—46	15.7	22 , 1944	1.40	42
151	Närvijoki, Jurva	323	5.9	1938—47	15.0	20 , 1945	1.34	47
152	Jalas- ja Hirvijoki	880	1.3	1926—37	68	108 , 1926	1.59	77
153	Jänganjärvi, Perho	108	9.6	1937—39, 1943—46	6.1	9.2 , 1943	1.50	57
154	Ylipenninginjoki, Perho	80	10	1937—39, 1943—46	5.2			65
	Oulujoki watershed (*Ou*)							
155	Emäjoki, Kiantajärvi	3520	10.5	1911—40, 1946—48	157	288 , 1920	1.84	45
156	Hyrynjärvi, Kokkokorva	7015	8.4	1911—26, 1929—43	326	648 , 1943	1.99	46
157	Emäjoki, Kiehimä	8785	7.7	1911—48	452	997 , 1943	2.21	51
158	Änättijärvi, luusua	395	12.2	1931—48	22	44 , 1943	2.00	56
159	Lentua, luusua	1950	12.8	1911—48	75	142 , 1943	1.90	38
160	Lammasjärvi, luusua	3995	10.9	1911—48	132	268 , 1943	2.03	33
161	Ontojärvi, luusua	4930	11.6	1931—47	156	295 , 1943	1.89	32
162	Rehjanselkä, Kajaani	7430	11.6	1911—34, 1936—48	216	404 , 1943	1.87	29
163	Kalliojärvi, Sotkamo	48	6	1934—39, 1946—48	5.1	8.7 , 1936	1.71	106
164	Vihtamojärvi, Sotkamo	26	9	1934—48	2.7	5.0 , 1936	1.85	104
165	Jouhtenusjärvi, Sotkamo	4	8	1934—38	0.45	0.8 , 1936	1.78	113
166	Oulujoki, Vaala	19860	12.7	1911—48	447	771 , 1943	1.73	23
167	Kivesjärvi, Varisjoki	405	12.8	1913—47	13.8	24 , 1943	1.74	34
168	Oulujoki, Pyhäkoski	21480	12.1	1918—31, 1933—46	508	797 , 1943	1.57	23
	North-Finland (*P—S*)							
169	Kiiminginjoki, Haukipudas	3845	3.4	1937—47	281	540 , 1944	1.92	73
170	Kiiminginjoki, Juorkuma	1480	4.7	1939—48	74	135 , 1944	1.83	50
171	Nuorittajoki, Pitkäkoski	1045	3.1	1939—47	120	177 , 1944	1.48	115
172	Iijoki, Merikoski	14315	5.5	1911—47	772	1245 , 1934	1.62	54
173	Kuivajoki, Ahmosenkoski	712	4.1	1936—46	77	176 , 1943	2.29	108
174	Kuivajoki, ...	1330	2.7	1940—43, 1946—47	153	223 , 1940	1.46	115
175	Simojoki	3125	6.2	1941—43, 1946—47	394	623 , 1942	1.58	126
176	Kotioja, Ranua	15.5	0	1934—43, 1946—48	2.7	4.4 , 1934	1.69	175
177	Ylijoki, Ranua	76	2	1934—43, 1946—48	16	28 , 1934	1.75	210
178	Myllypuri, Ranua	9	13	1934—43	1.2	2.3 , 1934	1.92	117

1	2	3	4	5	6	7	8	9
179	Kemijärvi, luusua	27285	2.4	1921—43, 1946—47	1530	2107 , 1943	1.38	57
180	Kemijoki, Taivalkoski	50820	2.9	1911—48	2870	4131 , 1917	1.44	57
181	Ounasjoki, Marraskoski	12335	2.3	1931—44, 1946—47	773	1433 , 1934	1.86	66
182	Tornionjoki, Tornio	39785	4.7	1936—45	1928	2806 , 1936	1.46	52
183	Juutuanjoki, Saukkoniva......	5215	4.3	1922—43, 1946—47	285	418 , 1932	1.47	56
184	Patsjoki, Niskakoski	14395	12.4	1936—40	240	272 , 1940	1.13	18

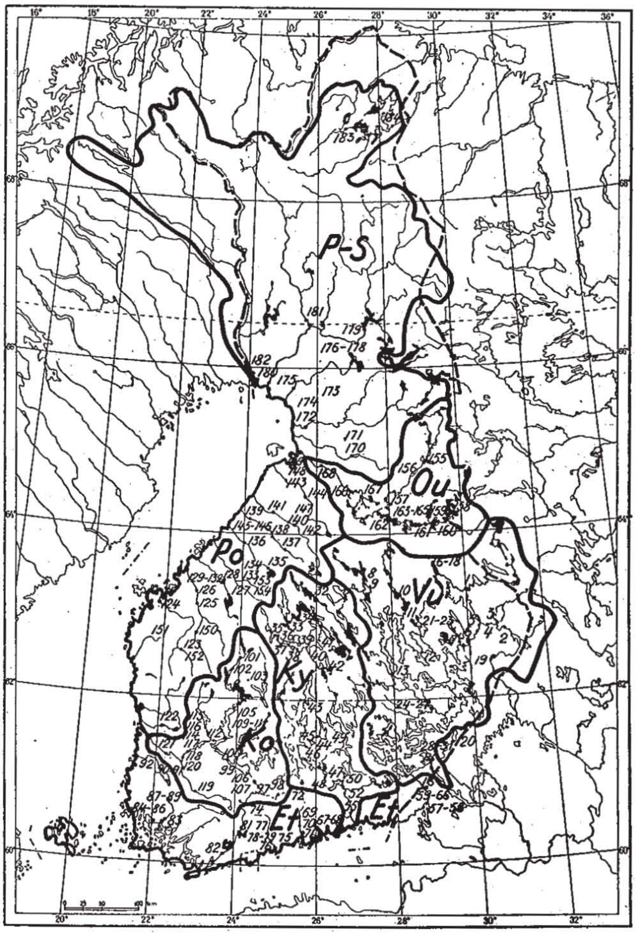

Fig. 3. Location of the watersheds in Table 2.

Table 3. Grouping of watersheds according to area and percentage of lakes.

Area km²	Percentage of lakes				
	0—3.0	3.1—7.0	7.1—12.0	12.0—18.1	18.1—28.8
	Number of watersheds in different groups				
1—30	15	—	7	—	6
31—100	13	—	5	—	3
101—300	4	5	8	2	—
301—1000	8	11	6	3	2
1001—3000	7	6	11	7	4
3001—10000	4	5	12	3	4
10001—62000	3	2	—	11	7

centage of lakes. These groups are shown in Table 3. The table also illustrates the number of watersheds in the different groups. In some groups, when only one watershed remains, I have carried it over into the next group.

Table 4 gives the average area and percentage of lakes, the average spring maximum of the water content of snow, and the average discharge maximum in the different groups. I have estimated the average spring maximum of water content of snow in the various watersheds from the figures in Fig. 5 and the relative quantities of snow during the observation period.

It will be seen that the discharge maximum depends upon the area and the percentage of lakes. The discharge maxima calculated by using Formula (1) are given in Table 4. It will be seen that the figures obtained by calculation are greater

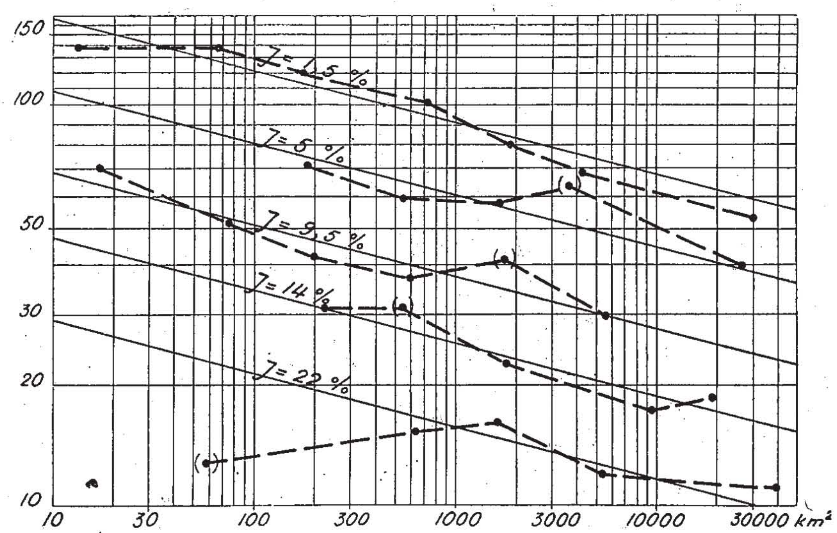

Fig. 4. Dependence of average discharge maximum caused by snow-melting on watersheds of varying size when the percentage of lakes is 1.5, 5, 9.5, 14, and 22 % and water content of snow is 130 mm.

than those based on observation. If in Formula (1) we substitute the number 5 for the addendum 10, the formula gives quite satisfactory results for watersheds with an area of over 200 km^2.

In order to obtain a method which will follow more closely the averages given in Table 4, and which can also be used for basins of less than 200 km^2, I have first of all corrected the figures in Table 4 so that the figures for the maximum discharge correspond to a 130 mm maximum water content of snow. In addition corrections have been made so that the MHq-values correspond to a lake percentage of 1.5 % in groups 1—7, 5 % in groups 8—12 9.5 % in groups 13—18, 14 % in groups 19—23, and 22 % in groups 24—29. The corrections have been made with the aid of Formula (1). We thus obtain five groups of figures, only the area of the watershed being different in each case. These results are shown in Fig. 4. The points in each of these five groups are connected by dotted lines. The average values of these five groups are indicated by straight lines. These straight lines are parallel, and according to these lines, when the area of the watershed increases, the maximum discharge diminishes in inverse proportion to the term $\sqrt[8]{A+1}$. In Formula (2) it is assumed that the discharge maximum diminishes in inverse proportion to the term $\sqrt[6]{A+1}$.

Some of the points in Fig. 4 deviate considerably from these straight lines. In Fig. 4 a bracket has been drawn around those points where the deviation is explained by the location of the lakes in one or two watersheds in the group. This question is discussed later.

I have previously produced evidence showing that the influence of the area upon the *MHq* is not the same in smaller watersheds as in larger ones (Kaitera 1939). Therefore the factor c in Formula (2) has been taken. It is obviously very difficult to describe the variations of the *MHq* by one formula for the whole country when the watershed areas vary from very small to very large (e.g. from 3 to 60,000 km^2). Such a formula would be so complicated that it would be very difficult to use in practice. I have therefore tried to describe the variations of the *MHq* by graph in Fig. 6. This graph has been drawn by considering the type of Formula (2) and by sketching the A-lines in accordance with the average figures given in Table 4 and in Fig. 4. In particular, the dotted line $A = 3$ km^2 has been drawn on the basis of some *MHq* figures in Table 2.

An example of the use of the graph will be found in Fig. 6, drawn with a dotted line. If the percentage of lakes is $P = 11.5$ and the watershed area is $A = 28$ km^2 and the maximum water content of snow is $L = 140$ mm, we get $MHq =$ 55 l/km^2.sec. Table 4 shows the average *MHq*-figures in the different groups estimated by graph in Fig. 6. The average deviation of these figures from those based on observation is only $\pm$ 4 units of discharge.

We should bear in mind that other factors, such as the maximum water content of snow, or the area and percentage of lakes of the watershed, also influence the *MHq*-figures. In averages of different groups the influence of these factors is less

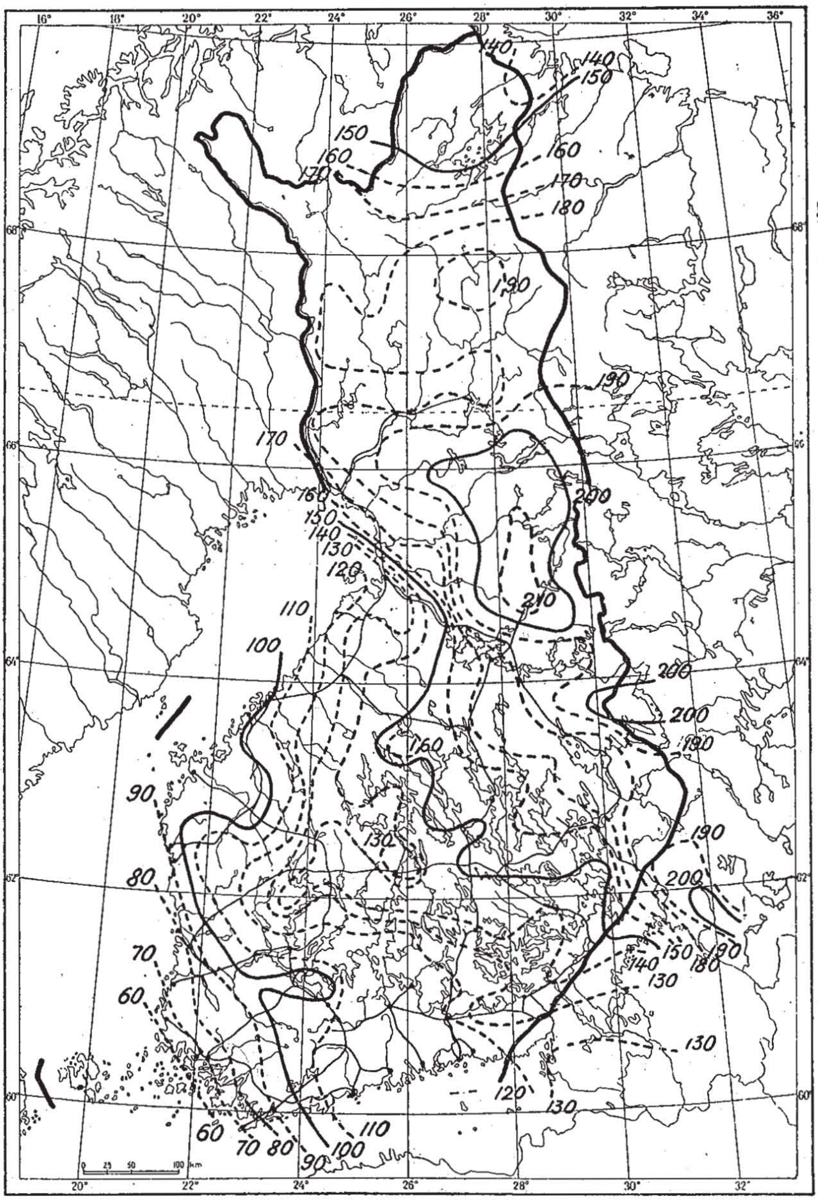

Fig. 5. Map of average maximum water content of snow in Finland in the winters of 1892—1941.

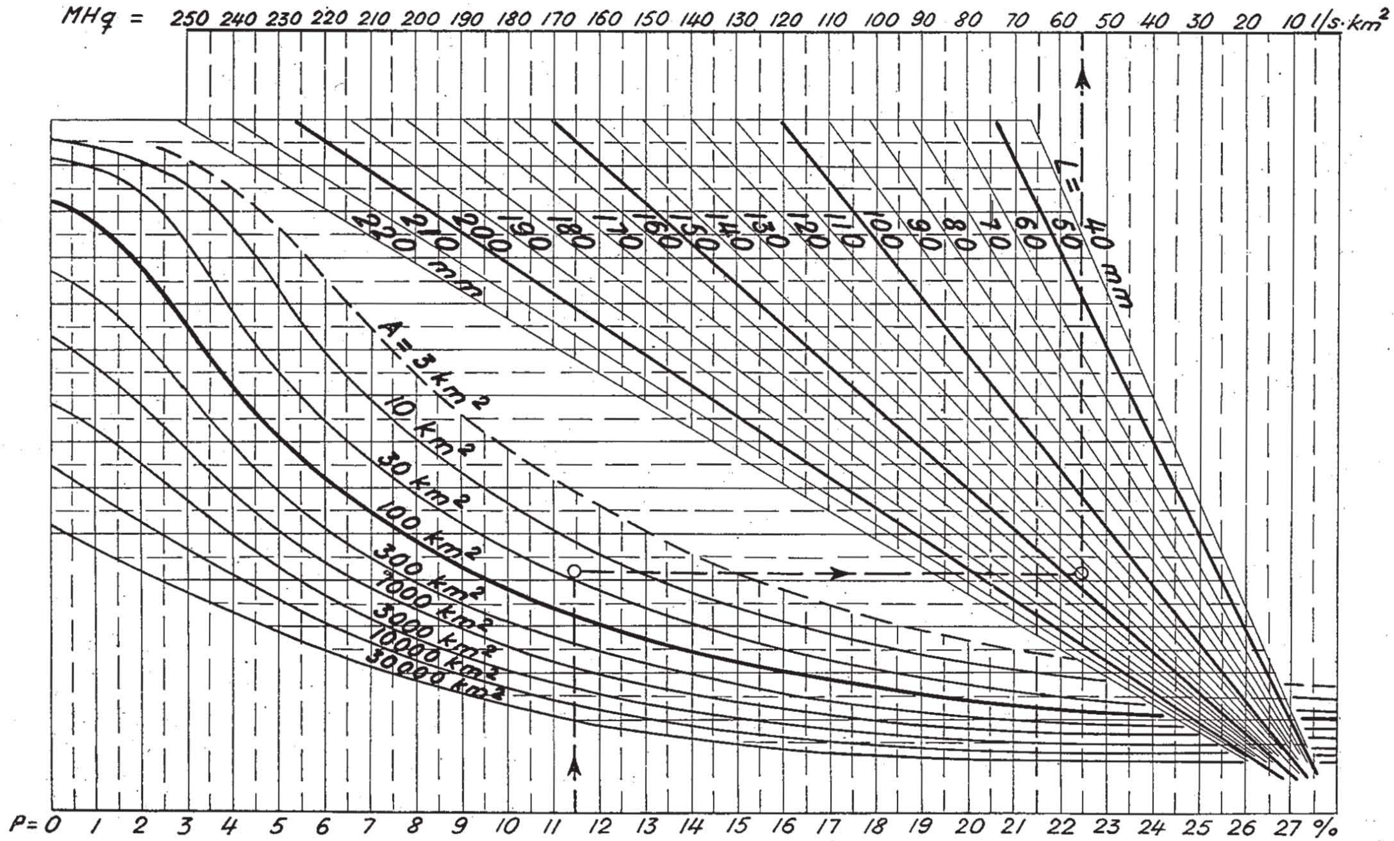

Fig. 6. Nomogram for estimating the average discharge maximum (*MHq*) according to the percentage of lakes (*P*) and the area of watershed (*A*) and also according to the average maximum water content of snow during the winter (*L*).

Table 4. Average figures in different groups.

N:o	Watershed: Area km²	Watershed: Percentage of lakes	Average spring maximum of water content of snow mm	Average discharge maximum l/km²sec.	Estimated average discharge maximum according to: Formula (1)	Estimated average discharge maximum according to: Fig. 6
1	13.0	0.9	117	130	130	113
2	68	1.4	100	109	99	107
3	175	1.5	100	93	95	93
4	745	1.6	111	88	93	87
5	1900	2.2	126	84	91	80
6	4200	2.1	105	54	70	58
7	30200	2.5	162	60	64	60
8	190	4.9	117	64	81	70
9	560	5.1	119	55	66	56
10	1650	4.3	134	66	83	65
11	3900	4.7	154	79	87	63
12	27000	5.1	187	53	62	55
13	17.2	9.7	153	79	62	78
14	70	8.8	131	56	59	59
15	200	9.6	106	34	44	37
16	640	9.3	112	34	45	36
17	1770	9.4	124	41	45	35
18	5500	9.8	170	35	49	37
19	267	15.6	102	21	25	23
20	555	14.1	154	37	37	34
21	1860	13.4	144	25	35	28
22	9520	14.8	125	16	25	18
23	19700	13.6	139	17	26	19
24	24.6	21.4	117	23	21	25
25	58	22.1	117	13	20	21
26	608	24.0	115	14	18	15
27	1670	23.5	135	16	19	16
28	5400	22.0	115	12	18	12
29	39700	19.5	133	11	17	11

marked. One factor in particular seems to have considerable influence, namely the location of the lakes on the watershed. This factor is very difficult to consider. Finnish watersheds usually contain dozens or hundreds of lakes. It has been calculated, that Finland has more than 50,000 lakes. But two types of location can be instanced. Fig. 7 shows the watershed of Lestijoki, which has one large lake at the upper end the basin. Measurements of the run-off have been taken in the stream close to the lake and about 60 km downstream (Watersheds 135 and 136 in Table 2). If we determine the *MHq* according to Fig. 6, we get the following comparison between observed and estimated figures;

	F	*P*	*MHq* 1/s.km²		
	km²	%	observed	estimated	corrected
Lestijärvi, Luusua	380	28.8	15	20	15
Lestijoki, Kannus	1,195	9.8	100	40	86

It will be seen that close to the lake the estimated figure is greater, but that down the stream it is much smaller, than the observed one. As a rule, if the lake is very large (e.g. about 10 % or more of the area of the watershed) estimation gives figures for the stream close to the lake that are about 10—30 % greater than those obtained by observation, the variations depending on the relative area of the lake and on the quantity of snow. But further downstream the graph gives figures which are as much as 60 % smaller than the observed figures. The discharge maximum in the latter watershed is due to the area without lakes bordering the stream. We can correct the estimated values by separating off the lakeless part of the stream basin determining the *MHq*-values for this part separately. In addition we must consider the run-off from the lake during the time of maximum discharge in the lakeless part of the stream basin. The corrected figures for Lestijoki are shown above.

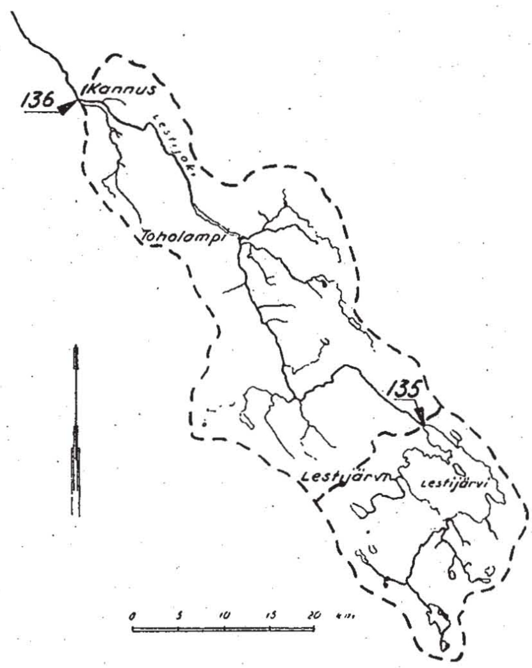

Fig. 7. Map of the watershed of Lestijoki.

I have estimated the *MHq*-values of different watersheds in Table 2 by using the graph in Fig. 6 and correcting these figures according to the location of lakes, where this is exceptional. The *L*-figures for the period covered by the *MHq*-values have been estimated approximately and I suppose the probable error in these figures may be about 10—20 mm. The deviations of the estimated figures from the observated *MHq*-figures are as follows:

The deviation is	less than	10 %	in	114 (80)	cases
» »	» from 11 to	20 %	in	39 (47)	»
» »	» » 21 »	50 %	in	27 (41)	»
» »	» greater than	50 %	in	5 (17)	»

The mean deviation of all the material is ± 15 (20) %. The figures in brackets show the deviations when no correction has been made.

I have previously produced evidence of the influence of the cultivated area upon the discharge maximum (KAITERA 1939). Observations were taken on 28 stream basins, varying in area from 4.5 to 116 km² and in percentage of lakes from 0 to 3. By calculation I obtained average figures for four groups, in which the *MHq*-factors corresponded except for the relative cultivated area, as follows:

Relative cultivated area	Relative *MHq*
2 %	100
15 %	82
30 %	86
43 %	119

Thus, when the relative cultivated area increases from 0, the *MHq*-values at first decreases. But when the cultivated area rises to 30 % or more, the *MHq*-figures become greater too. The explanation is that snow melts from the cultivated area before it melts from the forests, and the free water has discharged before the discharge maximum in forest ground occurs. In Fig. 8 an approximate curve has been constructed, showing how the relative *MHq*-value varies, when the relative cultivated area increases from 0 to 100 %. It has been assumed that for 100 % cultivated area the *MHq* is twice as great as for forest ground. The relative observed values above are also shown in the figure for some of the watersheds in Table 2 the observed MHq-figures are greater than the estimated ones owing to the exceptional size of the cultivated area. For purposes of correction we can use the curve in Fig. 8. The influence of lakes is so great, that it is only on watersheds without lakes, or when the lakes are situated at the upper end of the watershed or on a tributary, that the influ-

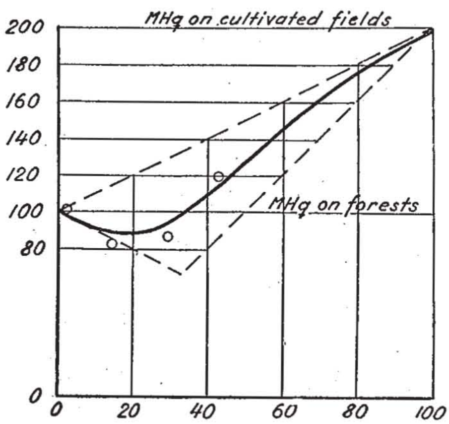

Fig. 8. The supposed influence of the relative area under cultivation on the discharge maximum, when the discharge maximum on forest terrain is 100 and on cultivated land 200 (the dotted lines show the limits of the variations).

ence of the cultivated area is evident. Apart from these factors there are other factors which should be taken into consideration when estimating the disharge maximum. HALLAKORPI (1934) has mentioned that permeability of the ground should be considered as a lake in the ground. The ground in Finland is usually very impermeable. The rocky ground is mostly granite or gneiss, in which only small surface cracks are found; the soil above the rocky ground can also be considered impermeable in Finland. There is very much clay, silt and moraine soil. Moreover the frost generated during the autumn and winter, when there is much moisture in the ground, makes the soil more impermeable during the springtime. Consequently it is only in some cases that the permeability of the ground has any noticeable effect on the discharge maximum in the spring. But there are some watersheds in Table 2 (e.g watersheds Nos. 97 and 98) where the smallness of the discharge maximum is caused by the good permeability of the ground.

The probable error above $\pm$ 15 %, is so small that this method gives a satisfactory estimate for most practical purposes. We shall assume that the variations of the average discharge maximum from one decade to another are as great as this probable error. This is clear from Table 5, which gives the decennial average *MHq*-values of some watersheds for the period 1891—1948. The values for the decade 1931—1940 have been given as 100 in each case. The table shows that the highest *MHq* was over 30 % greater than the *MHq* for 1931—1940, while the smallest was about 20 % lower. We can also see that during the current decade the *MHq*'s have been small throughout the country. On the other hand the figures for the decades 1891—1900 and 1901—1910 were relative by high. In taking the *L*-figures as shown in Fig. 5, which gives the figures for the period 1892—1941, we have taken into consideration the high values at the turn of the century.

The above refers to the average discharge maximum in different watersheds.

Table 5. Relative decennial *MHq*-figures of certain watersheds for the period 1891—1948.

Watershed			MHq-values in relation to the values of the period 1931—1940 during the period					
Name	Area km²	Lakes %	1891 1900	1901 1910	1911 1920	1921 1930	1931 1940	1941 1948
Pielisjoki, Häihä	20950	12.9	115	110	104	117	100	91
Vuoksi, Imatra	61280	19.9	109	104	94	114	100	80
Onkivesi, Viannonkoski	5565	7.6	124	111	90	115	100	93
Päijänne, Kalkkinen	26475	19.5	123	110	104	117	100	83
Vanajavesi, Kuokkala	8680	14.4	120	115	104	100	100	79
Pyhäjärvi, Nokia	16975	14.6	122	102	103	119	100	82
Emäjoki, Kiantajärvi	3520	10.5	—	134	123	111	100	88
Rehjanselkä, Koivukoski	7430	11.6	138	128	106	125	100	97
Oulujoki, Vaala	19860	12.7	—	116	102	107	100	89
Iijoki, Merikoski	14315	5.5	—	—	83	92	100	82
Kemijoki, Taivalkoski	50820	2.9	—	—	97	104	100	89

Often we should estimate the highest run-off values during a given period. The maximum discharge also depends on the length of the observation period. The ratio between the greatest discharge and the average maximum can be calculated. Table 2 shows these ratios during the corresponding observation period. It will be seen that only in some watersheds have the highest figures been more than twice as high as the *MHq*-figures. There is not a very great difference between different watersheds, when the observation period is the same. In smaller watersheds this ratio is little greater than in larger ones.

Table 2 also gives the years in which the highest discharge has occurred. It has often been pointed out that in the year 1924 the flood was exeptional. We find, however, that only in the greater watersheds with many lakes (Vuoksi, Kyminjoki, Kokemäenjoki) in Central Finland and in some smaller watersheds has the highest discharge occurdid in that year. Particularly in the north-west part of the Kyminjoki watershed the year 1922 was a flood-year, in which the discharge maximum was more than twice as high as the *MHq*. Similarly in the Oulujoki watershed some Hq-figures were relatively high in the year 1943. In smaller watersheds especially, the year of the highest discharge varies in different regions.

In the watersheds where observations have been made for longer than 40 years, a very high discharge maximum occurred in the year 1899. The ratio between the *Hq* and the *MHq* (1911—1948) in some watersheds was as follows:

Pielisjoki, Häihä	2.02
Onkivesi, Viannonkoski	2.11
Vuoksi, Imatra	1.79
Päijänne, Kalkkinen	2.35
Vanajavesi, Kuokkala	2.12
Pyhäjärvi, Nokia	2.36
Lammasjärvi, Luusua	2.06
Rehjanselkä, Kajaani	2.47
Oulujärvi, Vaala	1.97

In Vuoksi, for example, where observations have been made for more than 100 years, this flood was the greatest.

On an average it can be estimated that the highest discharge maximum in ten years is about 1.5 times as high as the *MHq*- and in 50 years about twice as high as the *MHq*.

It remains to compare the discharge maximum caused by snow-melting with the discharge maximum caused by rainfall. Table 6 gives the average maximum rainfall during 1, 5, 10, 15 and 30 days in any one year from 1934 to 1948 in the regions covered by the figures for snow-melting (Table 1). The maximum rainfall during 1—30 days, and the maximum decrease in the water content of snow (taking into consideration the rainfall during the melting season) are also given in this table.

Table 6. Maximum rainfall during 1, 5, 10, 15 and 30 days in 1934—1948 and the quantity of water released during the melting season, in different regions of the country.

Region	Average maximum rainfall 1934—1948, when the observation period is					Maximum rainfall 1934—1948 when the observation period is					Quantity of water released during the melting season 1934—1948 when the period is				
	1	5	10	15	30	1	5	10	15	30	1	5	10	15	30
	days					days					days				
	Rainfall in mm					Rainfall in mm					Water quantity in mm				
South-West Finland	30	53	71	85	121	59	89	105	135	177	11	43	68	84	104
Central Finland	29	52	68	84	121	51	90	114	131	183	15	61	93	115	151
North Finland	28	52	70	84	120	60	93	120	139	187	23	91	135	163	209
The whole country	29	52	70	84	121	57	91	113	135	182					

We discover that both the average maximum rainfall and the maximum rainfall are practically equal in different regions. Thus we can, for purposes of comparison, use the average values of the country. Fig. 9 shows these averages and also the figures for snow-melting in different regions. It will be seen that the figures for the average daily rainfall are higher than those for snow-melting. But when the period is from 5 to 30 days the figures for snow-melting in Central and North Finland are greater than the average rainfall maximum. In South-West Finland the figures for average snow-melting and average rainfall are nearly equal in size if the period is 5—20 days, but during a longer period the figures for rainfall are greater. During this 15-year period the rainfall maximum was greater than the average maximum of snow-melting in South-West and Central Finland. Only in North Finland is the average maximum quantity of water released during the melting season even greater than the maximum rainfall in 5—30 days.

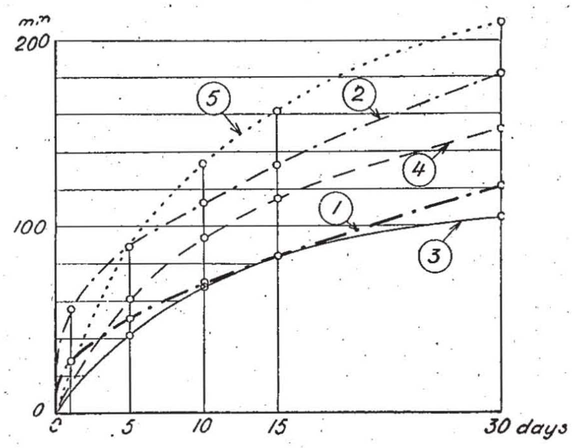

Fig. 9. Maximum (2) and average maximum (1) rainfall during 1, 5, 10, 15 and 30 days 1934—1948 in the whole country and the quantities of water released during the same days in the melting season in different regions of the country, (3) = South-West Finland, (4) = Central Finland, (5) = North Finland.

Renqvist has stated that the average discharge maximum can be considered as the upper limit of the discharge maximum caused by rainfall. If we consider the curves in Fig. 9 we shall understand why the ratio between the discharge maximum caused by rainfall and that caused by melting snow should be greater in South Finland than in North Finland. In the Vantaanjoki and Karjaanjoki watersheds, for example, the maximum discharge caused by rainfall during the period 1911—1948 was only about 5 % smaller than that caused by snow melting. In North Finland the discharge maximum caused by rainfall is not even as great as the average discharge maximum caused by snow melting. But this relation also depends on the area and lake-percentage of the watershed. In the Kyminjoki and Vuoksi watersheds, for example, this relation in the period 1911—1948 depended on the *MHq*-values as follows:

Number of the watersheds in the group	Average *MHq* in the group l/km². sec.	*Hq* caused by rain in relation to *MHq* caused by snow melting
6	42	1.05
5	27	1.13
6	18	1.28
9	12	1.35

We can see that, when the *MHq*-figures caused by snow-melting become small, the relative values of *Hq* caused by rainfall increase.

In very small stream basins without lakes the discharge maximum is caused by short and heavy rainfalls. For example when the discharge maximum for sewage works in cities is calculated, the values are estimated on the strength of the maximum rainfall in a space of 15 minutes over a period of two years. The calculations take note of the fact that the discharge maximum is restrained depending on the permeability of the watershed. On the natural watersheds, even when the area is only 3—4 km² the average run-off maximum is dependent on snow-melting, even in South Finland. The elevation of the ground is so great that short showers cannot occasion a high run-off maximum as easily as in cities with level and impermeable roofs and streets. The maximum rainfall usually occurs in July, August and September. At the beginning of the rainy period the ground can usually retain more water than at the beginning of the melting season.

A discharge maximum caused by rainfall occurs in streams in South Finland, on an average, once in four years. This also depends on the average *MHq*-figures, which in Central Finland are as follows:

	When the *MHq*-figures are 11-20 l/km².sec.	21-40 l/km².sec.	41-60 l/km².sec.
	the discharge maximum for the year is caused by rain		
In the Kokemäenjoki watershed ...	25 times	15 times	10 times
In Kyminjoki and Vuoksi watersheds	20 »	12 »	7 »
		in a hundred years	

The Vuoksi river is exceptional, a discharge maximum caused by rainfall occurring there about 50 times in hundred years. These figures are approximate averages for the period 1911—1948. During the last 20 years a discharge maximum caused by rainfall has occurred more frequently than before. In the Oulujoki watershed a discharge maximum caused by rainfall occurs only 2—3 times in a hundred years, and in North Finland during the period 1911—1948 all maximum discharges in rivers have been caused by rainfall.

The influence of the watershed on a discharge maximum caused by snow melting during the sprintime deviates in some respects from one caused by rainfall.

When the area of the watershed increases, the intensity of the rainfall per square kilometre decreases. But the melting of snow occurs with the same intensity on large areas as on small ones. Thus when the watershed increases, for example, from 100 km² to 1000 km², the discharge maximum caused by snow-melting does not show such a large relative decrease as the discharge maximum caused by rain.

Reference has been made above to the influence of cultivated land on the discharge maximum caused by snow-melting. When the percentage of cultivated land is, say 15 %, the discharge maximum is smaller than on forest land. The most important factor here is that snow melts from open fields more quickly than from forest ground. Probably this feature is not so marked in the discharge maximum caused by rain.

The hills on the watershed hasten the discharge of water into the river basin. Therefore in hilly regions the discharge maximum caused by rain is usually greater than on flat terrain. A frequent contributory factor is that it rains more on hilly regions than on flat country. In Finland the hills are so small that they do not in general cause large falls of snow. But during the springtime snow melts from southern slopes more quickly than from northern ones. Thus the intensity of snow-melting in hilly regions is not so great as on level ground. Moreover the water released from the snow begins to run away on hill terrain early in the melting season, wheres on level terrain the melted snow stays in the river basin in the form of water until the end of the melting season, and the whole water content of the snow runs off at the same time, when the melting intensity is at its greatest. It would appear, therefore, that in spite of the rapid discharge from hills the discharge maximum caused by snow-melting is not greater on hill terrain than on level terrain in Finland. On the coast of Pohjanmaa and in North Finland, particularly, there is flat terrain with large open Sphagnum swamps, where the discharge maximum is relatively great.

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