A CALCULATION OF THE EVAPORATION AT DIFFERENT PLACES IN SOUTH-NORWAY

BY

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(Manuscript received March 9th, 1951.)

Preface.

The authors wish to express their sincere thanks to Norges Teknisk-Naturvitenskapelige Forskningsråd. This organization provided the necessary funds with which to carry out this work.

1. Introduction.

Very little has been published about the relation between run-off and precipitation in Norway. The study of this relation is, however, important, especially in connection with the utilization of our water power.

In the following we have studied the relation between run-off and precipitation in certain select regions in South-Norway. The aim of the investigation is a determination of the annual loss of precipitation which on the average is essentially caused by the evaporation.

The characteristic features of the Norwegian landscape with extended mountain wilds intersected by valleys are of basic importance for water power, and involve a pronounced inhomogeneity in the distribution of precipitation. A much more dense net-work of precipitation stations than that now at our disposal would be necessary to give a reliable value of the total precipitation over a region. That this is so appears from the fact that in many regions in Norway the annual run-off is larger than the annual precipitation measured at stations within the region. Since we assume that the run-off is fairly accurately measured, we are led to the conclusion that the actual precipitation is usually greater than the measurements indicate. The main cause of this discrepancy is probably that the bulk of the measuring stations are situated in valleys, whereas only few stations exist in the higher mountain areas where the precipitation is particularly great. It appears then that the measured precipitation cannot be used directly in the rainfall—run-off budget, as they do not give a correct value for the actual precipitation.

To be able to utilize the precipitation measurements we have to assume a certain relationship between the precipitation measured at a station and the true precipitation in a certain region near the station. In the following we shall make the simplest possible assumption of this kind, by considering the precipitation measured at a station as a correct relative measure of the total precipitation in a region near the station. In other words, we shall assume that the station is in a relative manner representative of the region.

Little more can be said to justify this assumption than that it sounds fairly plausible. But if local effects influence the measured precipitation in different ways in different weather situations, the assumption may lead to erroneous results. The hypothesis can therefore be judged only from the results which can be derived from it.

Let P be the measured annual precipitation, Q the annual run-off. Our assumption then leads to the equation

$$Q = \lambda P - \mu$$

where λ and μ are constants. It will be convenient to measure Q and P in percents of the normal values for the periods considered. If we express P and Q in millimeter (mm), we shall find

$$Q\,(\mathrm{mm}) = \lambda_r\, P\,(\mathrm{mm}) - \mu_r\,(\mathrm{mm})$$

where $\lambda_r = (v/u)\,\lambda$, $\mu_r = v\mu$, u and v are the average precipitation and run-off in mm. λ_r may be called the constant of representativeness, μ_r is the loss of precipitation. The annual loss of precipitation, μ_r, will consist mainly of the loss caused by evaporation and of the infiltration. The average loss of precipitation during the entire period studied will consist mainly of the loss caused by evaporation.

Applying our equation we have studied 14 regions in South-Norway with drainage areas ranging from about 200 up to about 700 km². But only 5 of them proved usable. At least three precipitation stations are situated within or in the immediate neighbourhood of each select region, and P was then taken as a mean of the measured precipitation at these stations. To avoid complications due to snow accumulation the annual run-off was defined as the discharge from September 1—August 31. At these times the water basins are also in general full.

There is always a certain time lag between precipitation and run-off. This time lag will vary from time to time, for instance due to the different infiltration conditions at different times. As a rough approximation we have tried to account for the time lag by defining the annual precipitation at a station as the total precipitation measured from August 26 till August 25, i. e. with a 6 days lag compared to the run-off. This choice is probably not too much in error when taken as an average, but for individual years it may be far from correct. Because of this we found it necessary to use a period of two years instead of one in cases with large abnormal precipitation in the last two weeks of August (using the average values for the years of precipitation and run-off).

We have also contracted consecutive years in some other cases. Fig. 2 indicates that the years 1925—26 and 1926—27, 1934—35 and 1935—36, 1938—39 and 1939—40 ought to be considered together. The justification of this procedure is further strenghtened by the fact that fig. 3 shows similar precipitation conditions for region 2 as fig. 2 for region 1. This behaviour is probably caused by the infiltration effects.

2. The Mathematical Method.

As mentioned in the preceding section we assume a linear relation between the quantities P and Q, i. e. we put

$$Q = \lambda P - \mu. \tag{2,1}$$

To determine the two constants λ and μ we apply the method of least squares.

The difference between the Q computed from (2,1) and the measured Q, $\triangle Q$, is

$$\triangle Q = \lambda P - \mu - Q.$$

If the equation (2,1) were exactly fulfilled for each measured set of P and Q, $\triangle Q$ would be identically zero.

We then obtain

$$\sum \triangle Q^2 = \lambda^2 A + n\mu^2 + C - 2\lambda\mu M - 2\lambda B + 2\mu N$$

where $A = \sum P^2$, $B = \sum PQ$, $C = \sum Q^2$, $M = \sum P$, $N = \sum Q$. n is the number of years. Making $\sum \triangle Q^2$ a minimum, we find two linear equations which determine λ and μ

$$\frac{1}{2}\frac{\partial}{\partial\lambda}(\sum \triangle Q^2) = A\lambda - M\mu - B = 0.$$

$$-\frac{1}{2}\frac{\partial}{\partial\mu}(\sum \triangle Q^2) = M\lambda - n\mu - N = 0.$$

From these equations we find

$$\lambda = \frac{nB - MN}{nA - M^2}, \qquad \mu = -\frac{AN - BM}{nA - M^2}. \tag{2,2}$$

If instead of equation (2,1) we start with

$$P = aQ - \beta \tag{2,3}$$

we find using the same procedure

$$a = \frac{nB - MN}{nC - N^2}, \qquad \beta = -\frac{CM - BN}{nC - N^2}. \tag{2,4}$$

The two straight lines obtained by introducing from (2,2) and (2,4) into (2,1) resp. (2,3) are the regression lines. Both of them pass through the center of distribution, M/n, N/n.

To get simpler expressions for λ and α, we displace the coordinate system without rotating the axis so that the origin coincides with the point M/n, N/n. If the quantities in the new coordinate system are denoted by primed letters, we must have $M' = N' = 0$. We then find

$$\lambda = B'/A', \quad \alpha = B'/C'$$

where $A' = \sum P'^2 = A - (M^2/n)$, $B' = \sum P'Q' = B - (MN/n)$ and $C' = \sum Q'^2 = C - (N^2/n)$.

The equation of the regression lines will be

$$Q' = (B'/A')\,P' \text{ and } Q' = (C'/B')\,P'.$$

The most probable line will lie between the regression lines and its equation will be

$$Q' = (C'/A')^{\frac{1}{2}}\,P'.$$

To have a measure for the degree of linearity, we introduce the coefficient of correlation, r, defined by

$$r^2 = \lambda\alpha = B'^2/A'C'.$$

By expressing the sum of the fluctuations by means of P' and Q', we find

$$\sum \triangle Q^2 = \lambda^2 A' + C' - 2\lambda B' = (1 - r^2)\,C'.$$

As $\sum \triangle Q^2 \geqq 0$, $C' > 0$ we must have $|r| \leqq 1$. Especially $r = 1$ if $\triangle Q = 0$ (i. e. all the points are lying on the same line).

We take the slope of the most probable line as the desired value of λ, i. e. $\lambda = (C'/A')^{\frac{1}{2}}$. The constant μ is given by $\lambda P - Q$, and the average value of $\mu = (\lambda M - N)/n$.

3. The Results of the Calculations.

On the map in fig. 1 we have plotted the precipitation stations together with the regions studied. The regions are numbered from 1 to 5, starting from south.

The results of the calculations for the separate regions follow.

Fig. 1.

Region 1.

Watercourse: Mosseelv.
Watergauge: Sponvika.
Drainage area: 690 km^2.

The precipitation measured at the stations: Haga in Eidsberg (85 meters above mean sea level), Enebakk (166 meters), Igsi in Hobøl (144 meters), Moss (30 meters) and Ås (95 meters).

The station at Haga in Eidsberg: Moved to the neighbouring farm in January 1927.

The station at Moss: The raingauge moved about 10 meters in the period 1922—31.

Average discharge per km^2 drainage area: $0.51 \cdot 10^6$ m^3/km^2. The drainage area lies about 100 meters above mean sea level.

Remarks.

The year 1930—31 is omitted because of the abnormal difference in precipitation at the different stations. We have here found it necessary to contract consecutive years. Because of the great precipitation in August we have contracted the years 1921—22 and 1922—23, and the two years are represented by a single point (point 22′) in fig. 2. As mentioned before we have contracted the years 1925—26 and 1926—27 (26′), 1934—35 and 1935—36 (35′), 1938—39 and 1939—40 (39′).

Table 1.

Nr.	Period	Eidsberg		Enebakk		Moss		Ås		Igsi		P %	Yearly discharge		Nr.	P	Q	P^2	Q^2	PQ
		Prec. mm	in %	Prec. mm	in %	Prec. mm	in %	Prec. mm	in %	Prec. mm	in %		10^6m^3	%						
21	1920–21	466	67	464	60	516	60	516	65	500	64	63	186	52	21	63	52	3 969	2 704	3 276
22	1921–22	563	81	568	73	651	75	582	73	568	73	75	180	50						
23	1922–23	501	72	503	65	685	79	563	71	591	76	73	248	69	22′	74	60	5 476	3 600	4 440
24	1923–24	828	120	942	121	1 141	132	1 088	137	958	123	127	548	152	24	127	152	16 129	21 104	19 304
25	1924–25	775	112	749	96	871	101	849	107	902	116	106	416	116	25	106	116	11 236	13 456	12 296
26	1925–26	692	100	723	93	943	109	805	101	829	106	102	339	94						
27	1926–27	891	129	1 059	136	1 262	146	1 087	137	1 131	145	139	617	171	26′	121	133	14 641	17 689	16 093
28	1927–28	682	99	759	98	835	97	749	94	750	96	97	347	96	28	97	96	9 409	9 216	9 312
29	1928–29	569	82	731	94	698	81	672	85	575	74	83	275	76	29	83	76	6 889	5 776	6 308
30	1929–30	1 030	149	1 127	145	1 259	146	1 152	145	1 165	149	147	608	169	30	147	169	21 609	28 561	24 843
31	1930–31	716	103	997	128	940	109	849	107	830	106	–	–	–						
32	1931–32	559	81	585	75	653	76	570	72	594	76	76	231	64	32	76	64	5 776	4 096	4 864
33	1932–33	681	99	793	102	769	89	768	97	765	98	97	313	87	33	97	87	9 409	7 569	8 439
34	1933–34	660	95	665	85	805	93	748	94	724	93	92	272	76	34	92	76	8 464	5 776	6 992
35	1934–35	667	96	754	97	778	90	728	92	725	93	94	358	99						
36	1935–36	878	127	1 106	142	1 166	135	1 094	138	1 035	133	135	485	135	35′	115	117	13 225	13 689	13 455
37	1936–37	694	100	852	110	910	105	820	103	763	98	103	405	113	37	103	113	10 609	12 769	11 639
38	1937–38	510	74	547	70	542	63	516	65	463	59	66	161	45	38	66	45	4 356	2 025	2 970
39	1938–39	969	140	995	128	1 176	136	1 093	138	1 059	136	136	479	133						
40	1939–40	499	72	644	83	654	76	637	80	672	86	79	368	102	39′	108	118	11 664	13 924	12 744
	Average	692		778		863		794		780			360		Sum	1 475	1 474	152 861	163 954	156 975
																		145 042	144 845	144 943
																		7 819	19 109	12 032

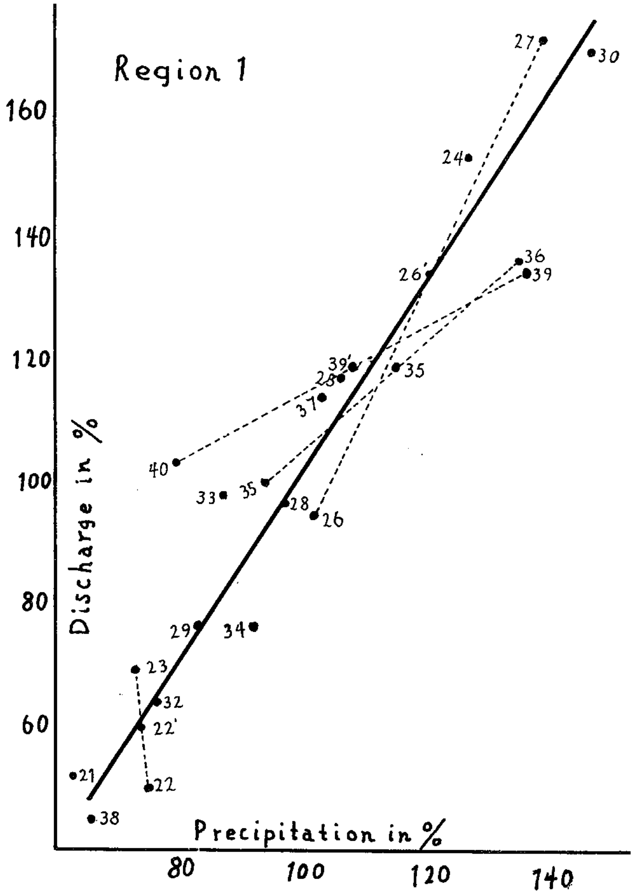

Fig. 2.

From table 1 we find

$$A' = 7819,\ B' = 12032,\ C' = 19109$$

and therefore $\lambda = (C'/A')^{\frac{1}{2}} = 1.56.$

The coefficient of correlation $r = 0.98$. The mean precipitation $u = 781$ mm. The mean run-off $v = 522$ mm. The constant of representativeness $\lambda_r = 1.04$. The mean evaporation $\mu_r = 290$ mm.

Region 2.

Watercourse: Leirelv.

Watergauge: Hombledal.

Drainage area: 348 km^2.

The precipitation measured at the stations: Eidsvoll Verk (180 meters above mean sea level), Katnosa (466 meters), Lunner (375 meters), Brandbu (420 meters).

The station at Eidsvoll Verk: The raingauge moved about 20 meters in October 1938.

Average discharge per km^2 drainage area: $0.76 \cdot 10^6$ m^3/km^2. The drainage area lies 4—500 meters above mean sea level.

Remarks.

The years 1925—26 and 1926—27 (26′), 1934—35 and 1935—36 (35′), 1938—39 and

1939—40 (39′) are contracted in accordance with what was done for region 1. 1940—41 and 1941—42 (41′) are contracted because of great precipitation in the end of August.

Table 2.

Nr.	Period	Eidsvoll		Katnosa		Lunner		Brandbu		P %	Yearly discharge		Nr.	P	Q	P^2	Q^2	PQ
		Prec. mm	in %	Prec. mm	in %	Prec. mm	in %	Prec. mm	in %		$10^6 m^3$	%						
25	1924–25	849	106	1 114	99	760	96	840	105	101	262	104	25	101	104	10 201	10 816	10 504
26	1925–26	926	116	1 212	107	872	111	951	119	113	276	110	26′	121	131	14 641	17 161	15 851
27	1926–27	1 017	127	1 450	128	1 028	130	1 054	132	129	379	151						
28	1927–28	734	92	1 028	91	723	92	789	99	93	226	90	28	93	90	8 649	8 100	8 370
29	1928–29	719	90	1 017	96	708	90	715	90	90	204	81	29	90	81	8 100	6 561	7 290
30	1929–30	1 079	135	1 601	142	1 095	139	965	121	134	379	151	30	134	151	17 956	22 801	20 234
31	1930–31	903	113	1 244	110	909	115	884	111	112	302	120	31	112	120	12 544	14 400	13 440
32	1931–32	612	76	736	65	522	66	604	76	71	149	59	32	71	59	5 041	3 481	4 366
33	1932–33	796	99	995	88	805	102	737	92	95	228	91	33	95	91	9 025	8 281	8 645
34	1933–34	734	92	1 017	90	752	95	781	98	94	223	89	34	94	89	8 836	7 921	8 366
35	1934–35	773	96	1 212	107	842	107	907	114	106	291	115						
36	1935–36	1 117	139	1 428	126	961	122	1 039	130	129	351	140	35′	118	128	13 924	16 384	15 104
37	1936–37	811	101	1 288	114	827	105	840	105	106	265	106	37	106	106	11 236	11 236	11 236
38	1937–38	627	78	887	78	603	76	604	76	77	152	61	38	77	61	5 929	3 721	4 697
39	1938–39	1 117	139	1 655	146	1 095	139	1 069	134	140	363	144						
40	1939–40	558	70	833	74	581	74	538	67	71	170	68	39′	106	106	11 236	11 236	11 236
41	1940–41	627	78	855	76	611	77	619	78	77	197	79						
42	1941–42	551	69	909	80	566	72	634	80	75	141	56	41′	76	67	5 776	4 489	5 092
43	1942–43	780	97	1 093	97	730	93	685	86	93	227	90	43	93	90	8 649	8 100	8 370
44	1943–44	681	85	985	87	671	85	626	78	84	190	76	44	84	76	7 056	5 776	6 384
45	1944–45	834	104	1 201	106	909	115	877	110	109	289	115	45	109	115	11 881	13 225	12 535
	Average	802		1 131		789		798			251		Sum	1 683	1 665	171 115	173 689	171 720
																166 617	163 072	164 835
																4 498	10 617	6 885

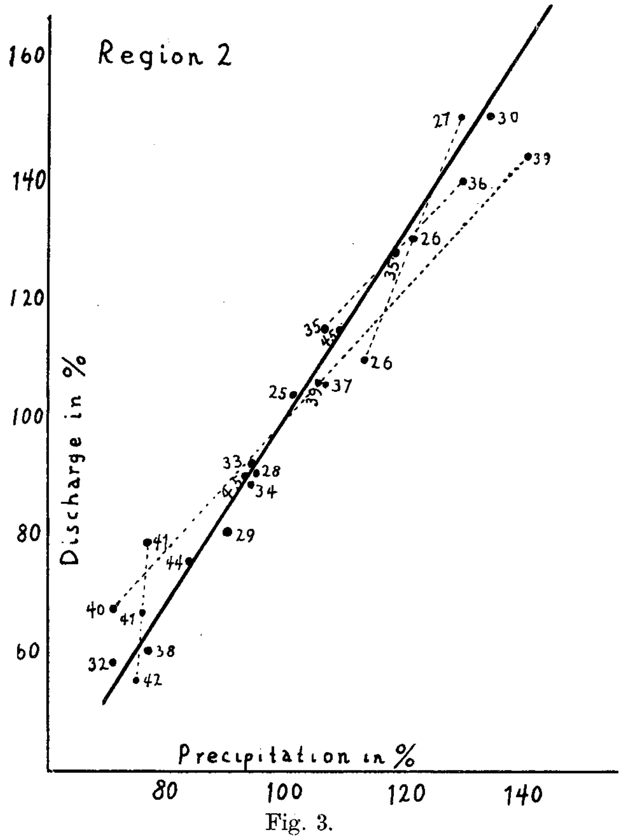

Fig. 3.

From table 2 we find

$$A' = 4498,\ B' = 6885,\ C' = 10617$$

and therefore $\lambda = (C'/A')^{\frac{1}{2}} = 1.54.$

The coefficient of correlation $r = 0.99$. The mean precipitation $u = 880$ mm. The mean run-off $v = 721$ mm. The constant of representativeness $\lambda_r = 1.26$. The mean evaporation $\mu_r = 390$ mm.

Region 3.

Watercourse: Austre Slidreelv.

Watergauge: Rudi Bru.

Drainage area: 676 km².

The precipitation measured at the stations: Beito (742 meters above mean sea level), Vollen in Slidre (403 meters) and Sikkilsdal (1011 meters).

The station at Sikkilsdal: The raingauge moved about 25 meters in June 1931.

The station at Vollen in Slidre: The raingauge moved about 10 meters in the summer 1927 and in October 1930.

Average discharge per km² drainage area: $0.69 \cdot 10^6$ m³/km². The drainage area lies 600—1600 meters above mean sea level.

Remarks.

The year 1930—31 has been omitted since, as mentioned above, the raingauge at the station Sikkilsdal was moved in June 1931.

Table 3.

Nr.	Period	Beito		Vollen		Sikkilsd.		Yearly discharge $10^6 m^3$	P	Q	P^2	Q^2	PQ
		Prec. mm	in %	Prec. mm	in %	Prec. mm	in %						
24	1923–24	900	120	831	133	1 031	150	629	134	135	17 956	18 225	18 090
25	1924–25	777	103	578	93	722	105	497	100	107	10 000	11 449	10 700
26	1925–26	959	127	778	124	850	123	570	125	123	15 625	15 129	15 375
27	1926–27	740	98	551	88	579	84	418	90	90	8 100	8 100	8 100
28	1927–28	959	127	787	126	810	118	615	124	132	15 376	17 424	16 368
29	1928–29	693	92	577	93	659	96	361	93	78	8 649	6 084	7 254
30	1929–30	954	127	777	125	861	125	605	125	130	15 625	16 900	16 250
32	1931–32	595	79	495	79	589	83	378	80	81	6 400	6 561	6 480
33	1932–33	559	74	475	76	522	74	305	75	66	5 625	4 356	4 950
34	1933–34	621	83	564	90	623	88	381	87	82	7 569	6 724	7 134
35	1934–35	731	97	625	100	764	108	519	102	112	10 404	12 544	11 424
36	1935–36	955	127	760	122	793	112	549	120	118	14 400	13 924	14 160
37	1936–37	646	86	625	100	645	91	490	92	105	8 464	11 025	9 660
38	1937–38	619	82	459	74	643	91	371	82	80	6 724	6 400	6 560
39	1938–39	1 060	141	938	150	1 028	145	724	145	156	21 025	24 336	22 620
40	1939–40	537	71	410	66	477	67	261	68	56	4 624	3 136	3 808
41	1940–41	568	75	480	77	571	80	313	78	67	6 084	4 489	5 226
42	1941–42	624	83	459	74	498	70	322	76	69	5 776	4 761	5 244
43	1942–43	805	107	651	104	789	111	492	107	106	11 449	11 236	11 342
44	1943–44	718	95	596	96	658	93	442	95	95	9 025	9 025	9 025
45	1944–45	827	110	687	110	807	114	534	111	115	12 321	13 225	12 765
	Average	753		624		710		465	2 109	2 103	221 221	225 053	222 535
											211 804	· 210 600	211 201
											9 417	14 453	11 334

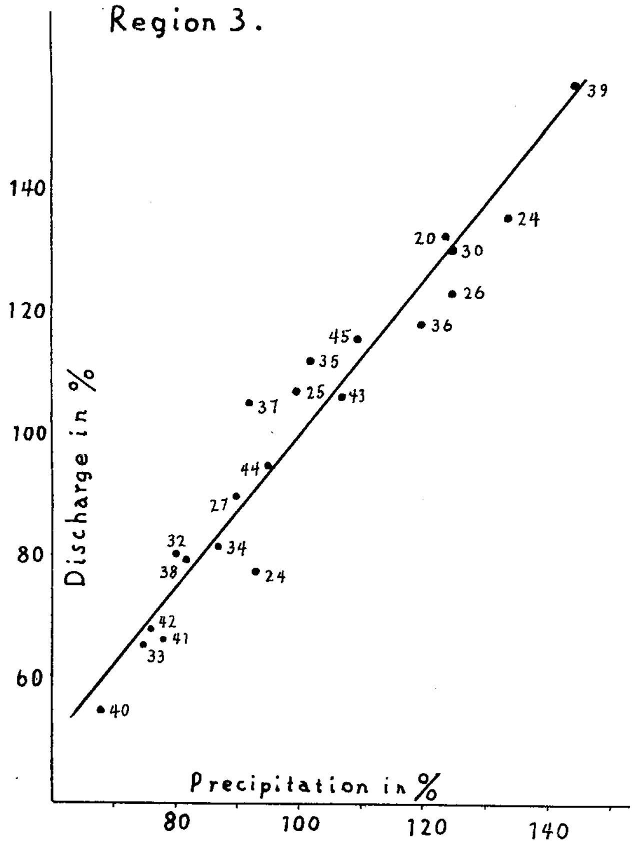

Fig. 4.

From table 3 we find

$$A' = 9417,\ B' = 11334,\ C' = 14453$$

and therefore $\lambda = (C'/A')^{\frac{1}{2}} = 1.24$.

The coefficient of correlation $r = 0.97$. The mean precipitation $u = 696$ mm. The mean run-off $v = 688$ mm. The constant of representativeness $\lambda_r = 1.23$. The mean evaporation $\mu_r = 170$ mm.

Region 4.

Watercourse: Vinda.

Watergauge: Vindevatn.

Drainage aera: 262 km^2.

The precipitation measured at the stations: Beito, Vollen in Slidre and Sikkilsdal.

Average discharge per km^2 drainage area: $0.55 \cdot 10^6$ m^3/km^2. The drainage area lies about 1000 meters above mean sea level.

Remarks.

The precipitation stations are the same as those used in region 3, and the period is the same. The year 1930—31 is omitted for the same reason as above (region 3). The values for P are therefore unchanged.

Table 4.

Nr.	Periŏd	Yearly discharge $10^6 m^2$	P	Q	P^2	Q^2	PQ
24	1923–24	205	134	144	17 956	20 736	19 296
25	1924–25	151	100	106	10 000	11 236	10 600
26	1925–26	182	125	127	15 625	16 129	15 875
27	1926–27	135	90	95	8 100	9 025	8 550
28	1927–28	196	124	137	15 376	18 769	16 988
29	1928–29	117	93	82	8 649	6 724	7 626
30	1929–30	208	125	146	15 625	21 316	18 250
32	1931–32	103	80	72	6 400	5 184	5 760
33	1932–33	90	75	63	5 625	3 969	4 725
34	1933–34	96	87	67	7 569	4 489	5 829
35	1934–35	152	102	106	10 404	11 236	10 812
36	1935–36	172	120	120	14 400	14 400	14 400
37	1936–37	133	92	93	8 464	8 649	8 556
38	1937–38	100	82	70	6 724	4 900	5 740
39	1938–39	229	145	160	21 025	25 600	23 200
40	1939–40	86	68	60	4 624	3 600	4 080
41	1940–41	93	78	65	6 084	4 225	5 070
42	1941–42	103	76	72	5 776	5 184	5 472
43	1942–43	141	107	99	11 449	9 801	10 593
44	1943–44	134	95	94	9 025	8 836	8 930
45	1944–45	175	111	123	12 321	15 129	13 653
	Average	143	Sum 2 109	2 101	221 221	229 137	224 005
					211 804	210 200	211 000
					9 417	18 937	13 005

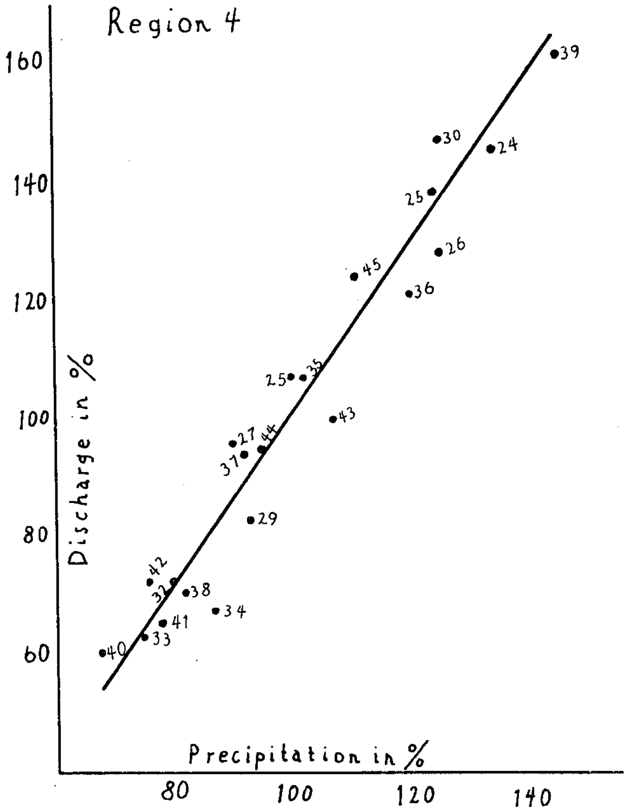

Fig. 5.

From table 4 we find

$$A' = 9417,\ B' = 13005,\ C' = 18937$$

and therefore

$$\lambda = (C'/A')^{\frac{1}{2}} = 1.42.$$

The coefficient of correlation $r = 0.97$. The mean precipitation $u = 696$ mm. The mean run-off $v = 546$ mm. The constant of representativeness $\lambda_r = 1.11$. The mean evaporation $\mu_r = 230$ mm.

Region 5.

Watercourse: Søa.
Watergauge: Rovatn.
Drainage area: 237 km².

The precipitation measured at the stations: Hemne (45 meters above mean sea level), Surnadal (45 meters), Rindal (231 meters) and Skjenaldfoss (84 meters).

The station at Surnadal: The raingauge moved about 16 meters in September 1940.

Average discharge per km² drainage area: $1.51 \cdot 10^6$ m³/km². The drainage area lies 0—500 meters above mean sea level.

Table 5.

Nr.	Period	Hemne		Surnadal		Rindal		Skjenaldf.		Yearly discharge $10^6 m^2$	P	Q	P^2	Q^2	PQ
		Prec. mm	in %	Prec. mm	in %	Prec. mm	in %	Prec. mm	in %						
24	1923–24	1 468	100	1 326	97	1 070	96	1 015	94	372	97	97	9 409	9 409	9 409
25	1924–25	1 560	106	1 464	107	1 130	101	1 105	102	382	104	100	10 816	10 000	10 400
26	1925–26	1 497	102	1 591	116	1 300	116	1 130	105	407	110	107	12 100	11 449	11 770
27	1926–27	1 359	93	1 268	92	1 080	96	1 115	103	370	96	97	9 216	9 409	9 312
28	1927–28	1 139	78	1 239	90	842	75	858	80	295	81	77	6 561	5 929	6 237
29	1928–29	1 204	82	1 293	94	1 010	90	970	90	337	89	88	7 921	7 744	7 832
30	1929–30	1 014	69	1 035	76	690	62	805	75	255	70	67	4 900	4 489	4 690
31	1930–31	1 356	93	1 262	92	1 105	99	1 050	97	352	95	92	9 025	8 464	8 740
32	1931–32	1 896	129	1 735	127	1 508	135	1 366	127	497	129	130	16 641	16 900	16 770
33	1932–33	1 482	101	1 219	89	1 130	101	1 125	104	364	99	95	9 801	9 025	9 405
34	1933–34	1 557	106	1 510	110	1 280	114	1 240	115	417	111	109	12 321	11 881	12 099
35	1934–35	1 528	104	1 421	104	1 171	105	1 193	111	419	106	110	11 236	12 100	11 660
36	1935–36	1 115	76	946	69	988	88	863	80	293	78	77	6 084	5 929	6 006
37	1936–37	1 170	80	1 093	80	865	77	797	74	296	78	78	6 084	6 084	6 084
38	1937–38	1 977	135	1 610	117	1 351	121	1 279	119	499	123	131	15 129	17 171	16 113
39	1938–39	1 439	98	1 338	98	1 181	105	1 051	97	394	100	103	10 000	10 609	10 300
40	1939–40	1 367	93	1 364	99	1 094	98	1 104	102	373	98	98	9 604	9 604	9 604
41	1940–41	1 262	86	1 290	94	950	85	920	85	335	88	88	7 744	7 744	7 744
42	1941–42	1 464	100	1 344	98	1 045	93	1 060	98	371	97	97	9 409	9 409	9 409
43	1942–43	2 239	153	1 880	137	1 502	134	1 455	135	536	140	140	19 600	19 600	19 600
44	1943–44	1 759	120	1 533	112	1 208	112	1 208	112	459	114	120	12 996	14 400	13 680
45	1944–45	1 412	96	1 415	103	1 095	98	1 030	96	371	98	97	9 604	9 409	9 506
	Average	1 467		1 372		1 120		1 079		382	Sum 2 201	2 198	226 201	226 748	226 370
													220 200	219 600	219 900
													6 001	7 148	6 470

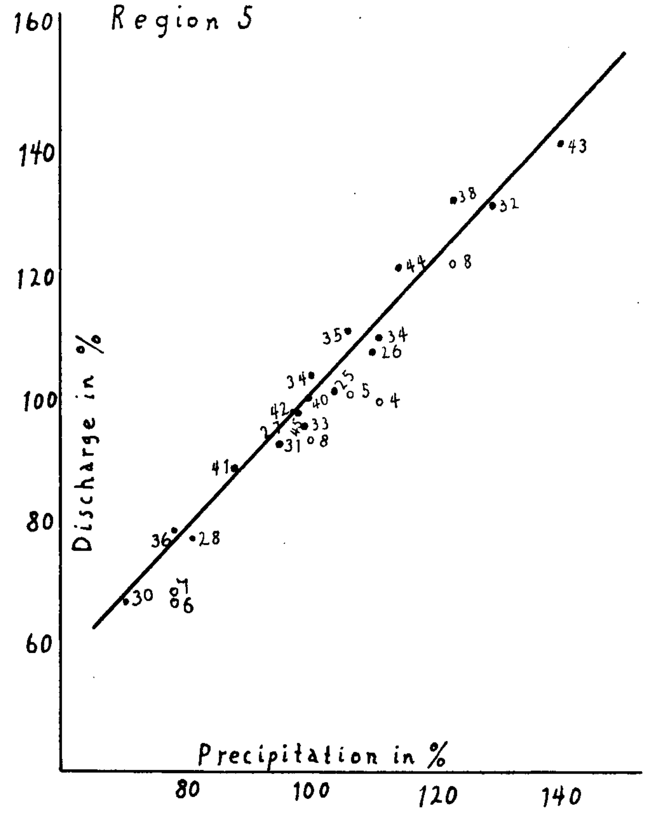

Fig. 6.

Remarks.

According to informations received from Norges Vassdrags- og Elektrisitetsvesen, the discharge was in the years 1934—39 calculated by another method than in the rest of the period. The points 4—9 on fig. 6 represent these years when we use the given values for the discharge. The run-off seems to have been estimated too low. We have found additional support for this conclusion from a comparison with the neighbouring regions Todalselv and Storvatn. From this comparison we have arrived at the result that in order to obtain similar precipitation and run-off conditions in all 3 districts, we must add $37 \cdot 10^6$ m³ to the calculated values of the run-off from Rovatn in the period mentioned. This procedure has been adopted in our calculations.

From table 5 we find

$$A' = 6001, \ B' = 6470, \ C' = 7148$$

and therefore

$$\lambda = (C'/A')^{\frac{1}{2}} = 1.09.$$

The coefficient of correlation $r = 0.98$. The mean precipitation $u = 1260$ mm. The mean run-off $v = 1612$ mm. The constant of representativeness $\lambda_r = 1.40$. The mean evaporation $\mu_r = 150$ mm.

4. Final Remarks.

The principal results from section 3 show that the evaporation varies on an average from 150 to 390 mm. It would of course have been of great interest to be able to discuss the parameters that concern the evaporation, but as our analysis was limited to only 5 suitable regions we feel that the area studied was far too small to warrant any such discussion. In addition the number of years available of observation is so small as to make any conclusion about the evaporation parameters subject to considerable uncertainty.

The introduction of the constant of representativeness λ_r can only be permitted when the drainage area is somewhat homogeneous. As to region 3 this is scarcely true as this region lies in close proximation to the continental divide and has a great east-west extension. Precipitation within this region will undoubtedly vary considerably with wind direction. The possibility of getting a high coefficient of correlation but an erroneous result should then be present. The precipitation stations used in the analysis of region 3 are the same as in region 4. Fig. 1 shows that these stations represent region 4 much better than region 3. The result 170 mm for the evaporation is therefore considered as probably too low a figure.

As mentioned earlier we have examined a total of 14 regions, but only 5 of them proved useful in our work. The others all displayed so small a coefficient of correlation as to lead to uncertain results when coupled with the few years of available data.

The reasons for discarding the 9 regions can briefly be summarized as follows:

1. Too few precipitation stations.
2. The precipitation stations are not representative.
3. Break in the observations.

Unfortunately there are no measurements of the evaporation in Norway with which to compare our results. A comparison of the results with those from Sweden, where more complete and reliable basic data are avaiable, definitely suggests that the results of this work are valid.

Printed January 24th, 1952.
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