Rainfall in the upper catchment of Jhelum

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1. Introduction

A study has been made of the rainfall in the upper catchment of the river Jhelum. The rainfall data of 5 raingauge stations (Fig. 1), Durroo, Anantnag, Kulgam, Pulwama and Srinagar lying along the river between its origin and Srinagar have been considered. The raingauges at the first four stations are under the supervision of either the medical officers or the revenue authorities. The one at Srinagar is in the meteorological observatory at the station.

The data for the above stations have been taken from the records available at the Srinagar Observatory and relate to the following periods—

Station	Period	Total No. of years
Durroo	1925 to 1954	30
Anantnag	1901 to 1951	51
Kulgam	1903 to 1954	52
Pulwama	1901 to 1947	47
Srinagar	1901 to 1954	54

2. Normal Rainfall

The mean rainfall for the 5 stations in the catchment is given in Tables 1(a) and 1(b). These tables show that the annual rainfall of the catchment varies from about 24 inches at Pulwama to about 48 inches at Durroo. The mean annual rainfall of the catchment as calculated from the data of the 5 stations is 31·98 in. out of which about 49 per cent is experienced during the 4 months January to April accompanied with the winter disturbances and about 29 per cent during June to September under the influence of the monsoon. Durroo recorded the highest annual rainfall of 77·50 inches in 1948 and Pulwama had the lowest annual rainfall of 4·02 inches in 1945.

3. Distribution of rainfall during July to September

As most of the floods in river Jhelum have occurred during July to September, the daily rainfall of each station for these three months only has been examined.

This daily average distribution of rainfall during July to September is shown in Table 2. It is seen that—

(a) The daily average rainfall of more than 0·25 inch occurs only once at Kulgam on 22 July and three times at Durroo on 1, 2 and 25 September.

(b) Durroo records the highest monthly average in all the three months, these being 3·29, 3·47 and 3·42 inches in July, August and September respectively.

(c) The mean daily rainfall, worked out from the mean of the 5 stations, does not show any significant variation from July to September. The daily mean of more than 0·1 inch occurs only on 6 days in July, 10 days in August and 5 days in September.

4. Mean intensity of daily rainfall

The mean intensity per rainy day for each date was obtained by dividing the total rain that fell on that date during the period under study by the number of times the date had some rain. The mean intensity of the daily rainfall during July to September is shown in Table 3. It is seen that —

(a) The occasions of mean intensities of more than 0·50 inch in 24 hours are 15 in September, 6 in July and 3 in August.

(b) The highest average of 1·14 inches is on 12 September and the lowest of 0·17 inch on 12 July.

(c) The extreme values of the daily mean intensity are 3·01 inches on 12 September and 0·05 inch on 12 July at Durroo (except on 30 September when Durroo has not recorded any precipitation during the period under study).

5. Distribution of rain according to different intensities in 24 hours

The distribution of 24-hour rainfall according to different intensities during July to September is shown in Table 4. It will be seen that —

(a) The frequency of the occasions with intensities upto 0·50 inch in 24 hours is highest in July. It is 77 per cent of the total number of cases in July, 75 per cent in August and 70 per cent in September.

(b) The frequency of rainy spells having intensities of more than 3 inches in 24 hours is highest in September and lowest in August.

(c) The highest rainfall of 8·55 inches in 24 hours has been recorded at Durroo on 25 September 1954.

6. Duration of spells of rainfall

The duration of continuous spells of rainfall lasting for 1, 2, 3, 4, 5, 6 and more than 6 days at a stretch at the various stations in the catchment is shown in Table 5. It will be found that —

(a) Rainy spells of more than 6 days at a stretch have been less frequent. A rainy spell at Kulgam for a maximum period of 15 days at a stretch occurred during 27 August to 10 September 1909 giving a rainfall of 13·88 inches.

(b) A comparison of the lengths of the longest spells at the different rain-gauge stations in the catchment shows that —

(i) Durroo has a spell of 9 days in July, 7 days in August and 4 days in September.

(ii) Spell of 9 days in July, 6 days in August and 8 days in September have occurred at Anantnag.

(iii) Kulgam has the longest spell of 15 days in August, 8 days in July and 4 days in September.

(iv) Pulwama has a spell of 10 days in August and 6 days in both July and September.

(v) Srinagar has experienced the longest spell of 11 days in September, 9 days in July and 8 days in August.

A spell which started in one month and extended into the other has been counted in the month in which it commenced.

7. Longest rainy spells

Table 6 shows the details of the longest spells experienced at the five stations of which the data have been considered in this paper.

27 August to 11 September 1909—During this period there were continuous rainy spells for 15 days at Kulgam and 10 days each at Pulwama and Srinagar. The rainfall recorded at these stations during the spells are — Kulgam 13·88 inches, Pulwama 10·99 inches and Srinagar 6·99 inches.
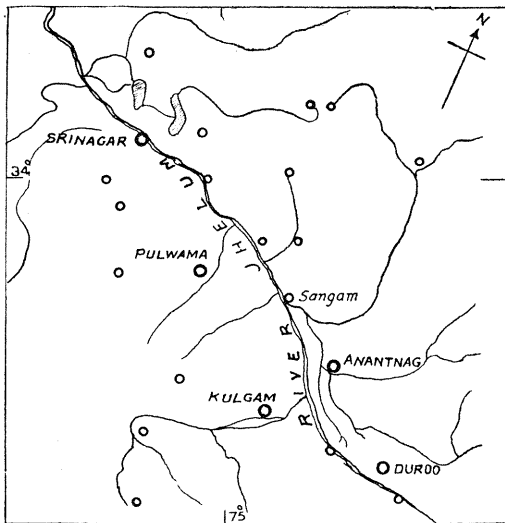
Fig. 1

TABLE 1(a)

Seasonal mean rainfall (inches)

Station	Annual rainfall	Jan to Apr		Jun to Sep	
		Amount	% of annual	Amount	% of annual
Durroo	48·10	25·08	53	11·97	25
Anantnag	26·17	11·69	45	7·85	30
Kulgam	35·85	17·81	50	10·93	30
Pulwama	23·64	11·22	47	7·60	32
Srinagar	26·12	12·85	49	7·81	30
Mean	31·98	15·73	49	9·35	29

TABLE 1 (b)

Monthly mean rainfall (inches)

Station (No. of years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual normal	Highest rainfall (year)	Lowest rainfall (year)
Durroo (30)	7·04	6·97	6·63	4·44	3·84	2·14	3·34	3·46	3·43	1·45	1·50	3·86	48·10	77·50 (1948)	29·98 (1927)
Anantnag (51)	2·95	3·22	3·23	3·29	2·34	1·31	2·29	2·34	1·91	1·04	0·52	1·73	26·17	53·56 (1907)	11·28 (1927)
Kulgam (52)	4·90	4·14	4·55	4·22	2·70	1·66	3·01	3·56	2·70	1·18	0·70	2·53	35·85	56·61 (1923)	13·71 (1951)
Pulwama (47)	2·39	2·80	2·93	3·10	1·99	1·58	2·21	2·43	1·38	0·84	0·52	1·47	23·64	54·17 (1914)	4·02 (1945)
Srinagar (54)	2·72	2·98	3·73	3·42	2·37	1·39	2·08	2·59	1·75	1·11	0·50	1·48	26·12	40·68 (1936)	14·98 (1934)
Average	4·00	4·02	4·21	3·69	2·65	1·62	2·58	2·88	2·23	1·12	0·75	2·21	31·98		
%	(13)	(13)	(13)	(12)	(8)	(5)	(8)	(9)	(7)	(4)	(2)	(7)			

TABLE 2
Average daily rainfall (inches)

Date	JULY					Aver-age	AUGUST					Aver-age	SEPTEMBER					Aver-age
	D	A	K	P	S		D	A	K	P	S		D	A	K	P	S	
1	·11	·04	·05	·01	·07	·06	·19	·12	·14	·09	·09	·13	·34	·17	·16	·10	·17	·19
2	·10	·03	·06	·02	·04	·06	·18	·14	·18	·07	·13	·14	·33	·08	·10	·05	·13	·14
3	·05	·05	·03	..	·03	·03	·15	·12	·17	·08	·08	·12	·13	·07	·09	·02	·10	·08
4	·06	·10	·03	·07	·02	·06	·13	·10	·15	·11	·13	·12	·10	·05	·13	·06	·05	·08
5	·15	·06	·11	·10	·08	·10	·10	·06	·09	·11	·16	·10	·03	·02	·06	·06	·02	·04
6	·23	·04	·04	·02	·08	·10	·06	·03	·10	·13	·11	·09	·04	·03	·07	·05	·04	·05
7	·08	·03	·04	·04	·05	·05	·02	·10	·12	·03	·06	·07	·04	·06	·03	·04	·04	·04
8	·06	·04	·05	·06	·05	·05	·12	·04	·09	·15	·08	·10	·01	·05	·09	·04	·02	·04
9	·03	·05	·10	·12	·06	·07	·10	·06	·08	·06	·09	·08	·04	·04	·10	·10	·05	·07
10	·06	·08	·12	·06	·04	·07	·20	·06	·04	·05	·07	·08	·09	·08	·13	·09	·08	·09
11	·07	·04	·06	·04	·06	·05	·05	·11	·06	·02	·10	·07	·14	·17	·16	·15	·10	·14
12	·01	·02	·06	·01	·02	·02	·08	·06	·09	·04	·06	·07	·20	·16	·12	·06	·13	·13
13	·17	·06	·15	·08	·03	·10	·10	·07	·12	·18	·07	·11	·09	·07	·08	·05	·09	·08
14	·21	·19	·13	·14	·06	·15	·11	·07	·13	·06	·14	·10	·08	·01	·15	·08	·02	·07
15	·08	·08	·13	·04	·07	·08	·09	·06	·07	·12	·09	·09	·02	·11	·07	·06	·08	·07
16	·06	·06	·07	·10	·11	·08	·04	·05	·12	·09	·08	·08	·03	·13	·05	·04	·06	·06
17	·07	·03	·08	·03	·11	·06	·16	·10	·10	·12	·11	·12	·20	·10	·05	·01	·03	·08
18	·08	·06	·09	·03	·06	·06	·04	·03	·11	·11	·10	·07	·23	·08	..	·04	·04	·08
19	·09	·09	·13	·06	·08	·09	·12	·04	·05	·06	·05	·06	·19	·05	·04	·01	·05	·07
20	·18	·08	·12	·09	·05	·10	·05	·04	·11	·06	·06	·06	·09	·03	·12	·01	·05	·06
21	·23	·11	·11	·12	·15	·14	·12	·08	·08	·10	·06	·09	·06	·01	·09	·04	·03	·05
22	·16	·21	·28	·19	·09	·19	·02	·02	·01	·04	·05	·03	·04	·03	·02	·01	·03	·03
23	·06	·17	·21	·16	·09	·14	·02	·03	·07	·04	·02	·04	·07	·05	·04	·02	·04	·04
24	·14	·12	·17	·07	·07	·11	·09	·09	·09	·06	·05	·08	·23	·08	·15	·06	·05	·09
25	·13	·14	·13	·15	·04	·12	·05	·06	·09	·05	·07	·06	·36	·04	·16	·01	·08	·15
26	·14	·05	·06	·15	·09	·10	·18	·09	·07	·04	·09	·09	·12	·05	·07	·03	·07	·07
27	·15	·03	·10	·11	·12	·10	·11	·07	·08	·06	·06	·08	..	·03	·05	·01	·01	·02
28	·09	·04	·12	·04	·07	·07	·24	·12	·12	·13	·06	·13	·07	·01	·05	·03	·04	·04
29	·07	·04	·08	·07	·05	·06	·31	·09	·21	·06	·10	·15	·05	·02	·03	·01	·01	·02
30	·06	·03	·04	·10	·04	·05	·09	·08	·19	·07	·10	·11	..	·01	·04	·03	·02	·02
31	·11	·14	·08	·08	·10	·15	·16	·19	·07	·07	·13							
Total	3·29	2·31	3·07	2·36	1·99		3·47	2·35	3·32	2·46	2·59		3·42	1·89	2·50	1·37	1·73	
Mean	0·11	0·07	0·10	0·08	0·06	0·09	0·11	0·08	0·11	0·08	0·08	0·09	0·11	0·06	0·08	0·05	0·06	0·07

D—Durroo;   A—Anantnag;   K—Kulgam;   P—Pulwama;   S—Srinagar

TABLE 3
Mean intensity of daily rainfall (inches)

Date	JULY					Average	AUGUST					Average	SEPTEMBER					Average
	D	A	K	P	S		D	A	K	P	S		D	A	K	P	S	
1	·66	·18	·23	·09	·24	·28	·64	·57	·41	·41	·25	·46	1·72	·97	·68	·58	·43	·88
2	·36	·23	·42	·33	·13	·29	·44	·39	·56	·30	·26	·39	1·11	·38	·46	·49	·41	·57
3	·38	·24	·22	·10	·12	·21	·57	·44	·51	·40	·15	·39	·50	·31	·40	·25	·38	·37
4	·48	·73	·25	·63	·11	·44	·38	·38	·60	·69	·34	·48	·95	·39	·52	·36	·17	·48
5	·78	·44	·54	·96	·38	·62	·59	·26	·35	·49	·36	·41	·31	·15	·36	·97	·12	·38
6	1·40	·27	·32	·31	·35	·53	·33	·13	·36	·60	·24	·33	·29	·31	·39	·32	·21	·30
7	·43	·12	·23	·16	·16	·22	·13	·38	·43	·18	·17	·26	·63	·56	·23	·41	·20	·41
8	·25	·32	·30	·50	·17	·31	·41	·23	·41	·63	·18	·37	·15	·46	·65	·25	·12	·33
9	·42	·30	·59	·71	·17	·44	·59	·27	·41	·50	·23	·40	·22	·45	·85	·51	·23	·45
10	·31	·42	·68	·31	·14	·37	·76	·29	·29	·22	·20	·35	·66	·41	·67	·67	·32	·54
11	·30	·12	·36	·22	·16	·23	·27	·37	·38	·30	·28	·32	1·39	·74	·95	1·40	·36	·97
12	·05	·15	·41	·13	·10	·17	·59	·23	·28	·26	·15	·30	3·01	·84	·86	·58	·43	1·14
13	1·06	·26	·50	·53	·12	·49	·36	·31	·47	·67	·22	·41	·93	1·26	·56	·72	·35	·76
14	1·07	·74	·34	·66	·21	·60	·43	·22	·65	·34	·39	·41	·39	·11	·98	·93	·10	·50
15	·42	·38	·60	·22	·28	·38	·33	·30	·38	·64	·29	·39	·33	·80	·96	·50	·28	·57
16	·86	·29	·35	·39	·30	·44	·23	·21	·51	·37	·21	·31	·96	·74	·39	·41	·25	·55
17	·41	·16	·55	·26	·36	·35	·67	·43	·43	·54	·31	·48	1·48	1·02	·40	·35	·16	·68
18	·42	·30	·38	·32	·19	·32	·42	·15	·55	·48	·29	·38	2·31	·47	·23	·24	·19	·69
19	·46	·29	·58	·99	·23	·51	·51	·25	·22	·31	·15	·29	1·45	·37	·26	·16	·32	·51
20	1·13	·27	·49	·60	·20	·54	·27	·21	·45	·39	·26	·32	·64	·21	1·05	·10	·26	·45
21	·79	·40	·45	·48	·42	·51	·51	·33	·41	·36	·24	·37	·47	·11	·92	·46	·11	·41
22	·51	·90	·13	·57	·24	·47	·20	·28	·12	·33	·22	·23	·37	·34	·14	·17	·18	·24
23	·25	·48	·61	·57	·54	·43	·30	·19	·76	·30	·12	·33	1·00	·38	1·17	1·17	·19	·78
24	·74	·35	·62	·31	·19	·44	·56	·34	·39	·52	·31	·42	1·17	·70	·84	·90	·22	·77
25	·45	·36	·39	·38	·13	·34	·23	·26	·33	·34	·19	·27	2·14	·31	·94	·10	·28	·75
26	·55	·17	·26	·55	·22	·35	·67	·39	·37	·29	·32	·41	·72	·34	·87	·44	·36	·55
27	·67	·09	·34	·63	·27	·40	·68	·34	·47	·29	·18	·39	·10	·38	·86	·27	·12	·35
28	·30	·29	·45	·20	·23	·29	1·83	·56	·56	·79	·22	·79	·49	·19	·50	·66	·21	·41
29	·34	·22	·36	·41	·15	·30	1·31	·47	·98	·34	·35	·69	·24	·25	·20	·15	·10	·19
30	·29	·21	·17	·59	·14	·28	·38	·25	·67	·39	·24	·39	..	·13	·77	·47	·20	·31
31	·43	·35	·36	·36	·33	·33	·58	·75	·57	·43	·20	·51						
Total	15·97	10·03	13·28	13·47	6·68		16·17	10·18	14·28	13·10	7·52		26·43	14·08	19·06	14·99	7·32	

D—Durroo; A—Anantnag; K—Kulgam; P—Pulwama; S—Srinagar

TABLE 4
Distribution of rain according to different 24-hour intensities

Station	No. of occasions with rainfall in one day					Total No. of spells	Highest fall in a day		Period of available data (years)
	<0·50″	0·51″ to 1·00″	1·01″ to 2·00″	2·01″ to 3·00″	>3·00″		Amount (inches)	Date	
JULY									
Durroo	133 (69)	34 (18)	17 (9)	3 (2)	5 (3)	192	4·64	6 Jul 1931	31
Anantnag	290 (81)	46 (13)	14 (4)	4 (1)	3 (1)	357	4·00	22 Jul 1903	51
Kulgam	249 (72)	56 (16)	27 (8)	10 (3)	2 (1)	346	4·05	22 Jul 1948	52
Pulwama	192 (74)	37 (14)	21 (8)	8 (3)	1 (—)	259	3·30	22 Jul 1903	48
Srinagar	462	41	14	2	Nil	519	2·61	5 Jul 1931	54
Mean	265 (77)	43 (14)	19 (6)	5 (2)	2 (1)				
AUGUST									
Durroo	129 (65)	48 (24)	19 (9)	2 (1)	2 (1)	200	6·25	29 Aug 1929	30
Anantnag	298 (81)	49 (13)	22 (6)	Nil	1 (—)	370	3·53	31 Aug 1909	51
Kulgam	265 (73)	56 (16)	32 (9)	3 (1)	5 (1)	361	4·88	29 Aug 1947	52
Pulwama	199 (72)	45 (16)	28 (10)	4 (1)	Nil	276	2·54	13 Aug 1921	48
Srinagar	485	70	15	3	Nil	573	2·68	11 Aug 1936	54
Mean	273 (75)	54 (16)	23 (7)	2 (1)	2 (1)				
SEPTEMBER									
Durroo	68 (59)	24 (21)	12 (11)	Nil	10 (9)	114	8·55	25 Sep 1954	30
Anantnag	146 (72)	35 (17)	11 (5)	8 (4)	4 (2)	204	5·88	1 Sep 1928	51
Kulgam	136 (64)	44 (21)	12 (5)	12 (5)	7 (3)	211	5·61	11 Sep 1905	52
Pulwama	98 (70)	22 (16)	16 (11)	1 (1)	2 (2)	139	4·12	11 Sep 1905	47
Srinagar	312 (86)	32 (9)	12 (3)	5 (1)	1 (—)	362	4·03	1 Sep 1928	54
Mean	154 (70)	31 (17)	13 (7)	5 (2)	5 (2)				

Figures in brackets are percentages of number of days with rain in each category to total number of days with any rain in the month; — denotes less than 1 per cent

The rainfall recording at Pulwama was discontinued in September 1947

TABLE 5

Duration of spells of rainfall

Station	Duration of spells (days)							Total No. of spells	Longest spells			No. of years
	1	2	3	4	5	6	>6		Dura-tion (days)	Period	Total rainfall (inches)	
JULY												
Durroo	67 (61)	24 (22)	12 (11)	2 (2)	3 (3)		2 (2)	110	9	22–30 Jul 1927 31 Jul–8 Aug 1933	3·21 } 3·80	31
Anantnag	133 (62)	50 (23)	20 (9)	5 (2)	3 (1)	1 (—)	3 (1)	215	9	31 Jul–8 Aug 1933	5·33	51
Kulgam	135 (64)	47 (22)	16 (8)	2 (1)	6 (3)	2 (1)	2 (1)	210	8	20–27 Jul 1914 17–24 Jul 1932	2·25 } 4·13	52
Pulwama	127 (73)	29 (17)	9 (5)	4 (2)	4 (2)	1 (—)		174	6	31 Jul–5 Aug 1908	1·07	48
Srinagar	122 (48)	65 (26)	40 (16)	12 (5)	8 (3)	3 (1)	5 (2)	255	9	21–29 Jul 1929	1·02	54
AUGUST												
Durroo	60 (57)	24 (22)	13 (12)	6 (6)	1 (1)	1 (1)	1 (1)	106	7	23–29 Aug 1929	12·81	30
Anantnag	147 (65)	51 (22)	13 (6)	15 (7)		1 (—)		227	6	27 Aug–1 Sep 1928	7·12	51
Kulgam	123 (60)	44 (22)	25 (12)	8 (4)	5 (2)		1 (—)	206	15	27 Aug–10 Sep 1909	13·88	52
Pulwama	106 (63)	41 (24)	12 (7)	4 (2)	3 (2)		2 (1)	168	10	31 Aug–9 Sep 1909	10·99	48
Srinagar	106 (41)	79 (31)	47 (18)	18 (7)	8 (3)	4 (2)	1 (—)	259	8	4–11 Aug 1909	0·91	54
SEPTEMBER												
Durroo	41 (61)	14 (21)	10 (15)	2 (3)				67	4	11–14 Sep 1941 17–20 Sep 1950	13·60 } 14·09	30
Anantnag	97 (72)	28 (21)	2 (1)	6 (4)	1 (—)		1 (—)	135	8	2–9 Sep 1909	8·21	51
Kulgam	92 (69)	26 (20)	8 (6)	6 (4)				132	4	9–12 Sep 1905 2–5 Sep 1908 22–25 Sep 1917 4–7 Sep 1927 12–15 Sep 1941 3–6 Sep 1944	1·89 1·52 3·97 } 1·36 19·11 3·39	52
Pulwama	69 (79)	11 (13)	4 (4)	1 (1)	1 (1)	1 (1)		87	6	17–21 Sep 1911	1·69	47
Srinagar	96 (52)	53 (29)	19 (10)	10 (5)	2 (1)		3 (1)	183	11	1–11 Sep 1909	6·99	54

Figures in brackets are the percentage of the total number ;— denotes less than 1 per cent

TABLE 6

Rainfall during longest spells

Period		No. of days	Station having the longest spell	Rainfall (inches) at					Mean rainfall (inches)
				Durroo	Anant-nag	Kulgam	Pulwa-ma	Srina-gar	
9—12 Sep	1905	4	Kulgam	—	7·81	10·89	6·26	3·38	7·09
31 Jul—5 Aug	1908	6	Pulwama	—	1·85	0·29	1·07	1·32	1·31
2—5 Sep	1908	4	Kulgam	—	1·15	1·52	2·63	0·70	1·50
4—11 Aug	1909	8	Srinagar	—	0·93	0·64	1·61	0·91	1·02
27 Aug—10 Sep	1909	15	Kulgam	—	11·15	13·88	12·96	6·94	11·23
31 Aug—9 Sep	1909	10	Pulwama	—	10·94	11·43	10·99	5·29	9·66
2—9 Sep	1909	8	Anantnag	—	8·21	8·28	8·66	5·24	7·60
1—11 Sep	1909	11	Srinagar	—	7·41	12·15	10·64	6·99	9·30
17—22 Sep	1911	6	Pulwama	—	0·69	0·70	1·69	1·18	1·07
22—29 Jul	1914	8	Kulgam	—	2·86	2·25	2·61	0·99	2·18
22—25 Sep	1917	4	Kulgam	—	4·15	3·97	3·15	2·14	3·35
22—30 Jul	1927	9	Durroo	3·21	1·33	1·61	1·15	1·28	1·72
4—7 Sep	1927	4	Kulgam	0·02	0·28	1·36	0·35	0	0·40
27 Aug—1 Sep	1928	6	Anantnag	4·38	7·12	7·35	2·42	5·42	5·34
21—29 Jul	1929	9	Srinagar	1·17	0·59	1·57	0·86	1·02	1·04
23—29 Aug	1929	7	Durroo	12·81	5·99	8·91	4·57	4·96	7·45
17—24 Jul	1932	8	Kulgam	1·73	0·42	4·13	0·19	1·91	1·68
31 Jul—8 Aug	1933	9	Durroo & Anantnag	3·80	5·33	4·27	1·85	1·73	3·40
11—14 Sep	1941	4	Durroo	13·60	6·74	8·40	4·00	2·74	7·09
12—15 Sep	1941	4	Kulgam	3·60	4·64	9·11	2·90	2·38	4·53
3—6 Sep	1944	4	Kulgam	1·90	1·25	3·39	0·86	0·95	1·67
17—20 Sep	1950	4	Durroo	14·09	7·79	7·47	—	3·65	8·25

— indicates data not recorded

TABLE 7

Occasions of heaviest rainfall in one day

Date	Rainfall (inches) recorded at					Mean rainfal (inches)
	Durroo	Anantnag	Kulgam	Pulwama	Srinagar	
22 Jul 1903	—	4·00	3·24	3·30	0·08	2·65
11 Sep 1905	—	2·74	5·61	4·12	0·78	3·31
31 Aug 1909	—	3·53	0·17	0·35	0	1·01
13 Aug 1921	—	0·85	0·36	2·54	0·93	1·17
1 Sep 1928	3·93	5·88	0	1·45	4·03	3·06
29 Aug 1929	6·25	0	0	1·80	2·65	2·14
5 Jul 1931	3·78	2·42	2·93	1·00	2·61	2·55
6 Jul 1931	4·64	0	0	0	2·25	1·38
11 Aug 1936	0·41	0·14	0	0	2·68	0·65
29 Aug 1947	2·00	0·96	4·88	0·10	0·11	1·61
22 Jul 1948	2·30	1·87	4·05	0·80	1·39	2·08
25 Sep 1954	8·55	—	4·53	—	2·19	5·09

— indicates data not available or not recorded

During this period the daily rainfall figures for the available stations have shown that the continuous heavy rainfalls of more than 2 inches have been recorded from 31 August to 2 September at Anantnag, Kulgam and Srinagar. Pulwama had recorded 1·98 inches of rain on 1 September.

22 to 30 July 1927—During this period a continuous spell of 9 days was experienced at Durroo causing a rainfall of 3·21 inches. Kulgam, Anantnag, Srinagar and Pulwama recorded 1·61, 1·33, 1·28 and 1·15 inches of rainfall respectively during this period.

31 July to 8 August 1933—Durroo and Anantnag both had a continuous spell of 9 rainy days and recorded 3·80 and 5·33 inches of rainfall respectively during the spell. Kulgam recorded 4·27 inches, Pulwama 1·85 inches and Srinagar 1·73 inches of rainfall.

River Jhelum showed an immediate rise in its level from 10·10 ft on 31 July to 16·12 ft* on 1 August. The water level in the river came to normal after 11 August, 3 days after the cessation of the rains in the catchment.

8. Occasions of heaviest rainfall in a day

The occasions of heaviest rainfall in 24 hours at a station during July to September have been shown in Table 7 giving also the details about the rainfall recorded at the other stations during this period.

11 September 1905—Kulgam and Pulwama had recorded on this date the heaviest amounts of 5·61 and 4·12 inches respectively. Data for Durroo are not available.

*The change in the water level in the river has been taken from the gauge readings of Sangam, 25 miles from Srinagar

S. N. BHAN

TABLE 8
Monthly averages of the gauge readings (in feet) at Sangam (Kashmir)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	7·0	7·2	9·9	10·7	11·8	12·1	11·1	10·3	9·6	8·6	7·5	7·1
2	7·1	7·2	9·2	10·8	12·0	11·6	11·3	10·2	10·3	8·4	7·6	7·1
3	7·1	7·3	9·6	10·3	12·1	11·6	11·3	11·0	9·9	8·4	7·5	7·2
4	7·2	7·3	9·4	11·1	12·2	12·0	11·1	10·5	10·2	8·5	7·5	7·1
5	7·2	7·3	9·2	11·0	11·9	12·1	11·0	10·8	9·7	8·3	7·5	7·1
6	7·2	7·3	9·3	11·0	11·6	11·6	11·0	10·8	9·4	8·2	7·4	7·1
7	7·2	7·3	9·5	11·1	11·6	11·7	11·2	10·9	9·2	8·1	7·5	7·0
8	7·1	7·4	9·5	11·6	11·8	11·7	11·0	10·4	9·1	8·0	7·5	7·1
9	7·2	7·4	9·3	11·1	11·9	11·6	11·0	10·3	9·0	8·0	7·4	7·1
10	7·2	7·4	9·4	11·1	12·0	11·6	11·0	10·5	8·9	8·0	7·4	7·2
11	7·1	7·4	10·7	11·3	12·1	12·3	11·0	10·5	9·1	7·9	7·4	7·2
12	7·1	7·4	9·5	11·1	12·3	12·2	10·9	10·4	9·3	7·9	7·3	7 1
13	7·1	7·4	9·7	11·3	12·2	12·1	10·7	10·4	9·7	7·9	7·3	7·1
14	7·1	7·6	9·6	11·3	12·3	12·7	10·8	10·7	9·4	7·9	7·3	7·1
15	7·1	7·7	9·7	11·8	12·0	12·6	10·8	10·5	9·2	7·8	7·3	7·1
16	7·1	7·5	9·9	11·5	12·1	12·1	10·7	10·3	9·4	7·8	7·3	7·1
17	7·1	7·9	9·5	11·8	12·2	11·7	10·5	10·5	8·8	7·8	7·2	7·1
18	7·1	7·7	10·7	11·8	12·7	11·7	10·7	10·7	9·9	7·7	7·7	7·1
19	7·3	7·9	10·2	11·9	12·1	11·5	10·8	10·4	9·6	7·6	7·2	7·1
20	7·2	8·0	10·1	11·9	12·3	11·3	10·6	10·1	9·5	7·7	7·2	7·0
21	7·1	8·0	9·6	11·7	12·1	11·3	10·9	10·0	9·5	7·7	7·2	7·1
22	7·1	7·9	9·6	11·5	11·7	11·7	11·3	10·0	9·2	7·6	7·2	7·1
23	7·0	8·0	10·3	11·6	11·8	12·0	11·5	10·0	9·0	7·6	7·2	7·1
24	7·0	8·2	10·4	11·6	12·1	11·5	11·7	9·9	8·9	7·6	7·1	7·1
25	7·0	8·3	10·5	11·8	11·3	11·5	11·6	9·6	9·6	7·6	7·1	7·1
26	7·1	8·3	9·9	11·9	12·1	11·7	11·0	9·4	9·8	7·5	7·2	7·1
27	7·1	8·5	11·7	11·8	12·2	11·5	11·2	9·3	10·0	7·6	7·2	7·1
28	7·1	8·7	11·1	11·9	12·0	11·4	11·0	9·1	10·0	7·6	7·2	7·1
29	7·2	9·5	10·9	11·8	11·7	11·5	10·6	9·6	8·9	7·7	7·2	7·0
30	7·3		11·0	11·8	12·2	11·5	10·3	9·5	8·8	7·6	7·2	7·0
31	7·2		11·0		12·5		10·2	9·7		7·6		7·0
Average	7·1	7·7	10·2	11·4	12·1	11·7	10·9	10·2	9·1	7·9	7·3	7·1

TABLE 9

Yearly averages of the gauge readings (in feet) at Sangam (Kashmir)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1935	6·5	7·8	9·6	10·6	12·1	12·3	12·7	11·2	8·1	7·7	7·3	6·9
1936	7·2	7·8	11·7	11·3	13·8	12·4	11·0	10·3	8·4	7·5	7·3	7·1
1937	7·1	7·5	8·5	10·5	11·9	11·3	9·9	8·7	8·0	7·5	7·7	7·3
1938	7·6	8·1	12·2	13·6	14·6	12·2	10·4	9·9	8·0	7·7	7·2	7·0
1939	7·0	7·6	9·8	10·5	12·6	12·3	10·8	10·1	8·6	7·6	7·6	7·1
1940	6·9	7·3	7·4	10·0	11·9	11·3	9·2	9·9	8·2	7·7	7·4	7·1
1941	7·1	7·1	8·9	10·4	10·8	9·6	8·7	8·5	11·2	7·9	7·4	7·2
1942	7·3	8·5	10·7	11·9	12·0	12·0	12·5	11·7	9·6	8·1	7·6	7·5
1943	8·3	8·1	11·2	10·9	11·7	13·8	12·9	11·1	9·3	7·8	7·3	6·9
1944	7·0	7·7	12·0	11·3	11·5	10·3	9·9	10·6	8·6	7·7	7·5	7·2
1945	7·2	7·3	10·2	11·2	10·7	12·3	11·4	9·8	8·1	7·5	7·6	6·9
1946	6·9	7·0	7·6	11·4	9·4	8·8	8·3	8·8	7·5	7·3	6·8	7·1
1947	7·3	7·0	10·0	10·4	10·0	9·9	8·7	8·7	9·8	8·4	7·1	7·1
1948	7·4	7·9	12·4	13·7	12·9	12·9	16·0	13·3	9·8	7·6	7·6	6·9
1949	6·6	7·2	9·9	13·5	13·5	11·6	11·5	10·5	8·5	7·7	6·9	6·3
1950	6·6	7·6	12·4	12·2	14·2	14·5	12·8	11·1	14·1	9·5	7·6	7·2
1951	7·1	9·1	10·0	12·4	13·1	13·3	11·9	11·1	7·7	7·4	7·1	7·1
1952	7·0	7·7	9·5	11·3	11·4	12·3	10·5	10·1	7·7	7·3	7·0	6·6
1953	6·8	7·0	8·5	11·0	9·9	10·4	9·5	10·1	10·8	8·0	7·4	7·2
1954	7·6	9·3	11·4	11·9	12·0	11·8	10·2	8·8	10·5	9·5	7·6	7·3
Average	7·1	7·7	10·2	11·4	12·1	11·7	10·9	10·2	9·1	7·9	7·3	7·1

1 September 1928—Anantnag recorded 5·88 inches of rainfall on this day and Srinagar also reported a fall of 4·03 inches. The heavy rainfall associated with a disturbance caused destructive floods in Jammu and Kashmir.

25 September 1954—A very unusual heavy amount of 8·55 inches of rainfall within 24 hours was recorded at Durroo on 25 September. Kulgam and Srinagar also recorded 4·53 and 2·19 inches of rainfall respectively on this day. This heavy rainfall in the Jhelum catchment raised the water level suddenly from 9.10 ft on 24th to 25·00 ft on the 25th, as recorded at Sangam gauge post. The level continued to rise till 3 October and the highest level recorded during the period was 29·10 ft, which is about 19·3 ft above normal.

9. Gauge readings at Sangam on the Jhelum bank

The gauge readings of river Jhelum at Sangam, about 25 miles from Srinagar (see Fig. 1), have been compiled for 20 years (1935 to 1954) and the averages have been calculated (Tables 8 and 9). These averages show that the Jhelum level at Sangam varies from about 7·0 to 12·7 ft, the lowest level

TABLE 10

Date	Rainfall (inches) recorded at			
	Durroo	Anantnag	Kulgam	Srinagar
17-9-50	3·80	3·98	0	0
18-9-50	5·87	2·97	0	0·81
19-9-50	4·20	0·84	3·68	1·54
20-9-50	0·22	0	3·59	1·30
21-9-50	0	0	3·06	0·03

being recorded during December to January and the highest during May. The contribution of more water to the river during May (or say April to June) can be attributed to the seasonal variations in April and May when the passage of the western disturbances are accompanied with rainfall and the increase in the temperatures causes the melting of snow layers on the mountains.

Comparing the rainfall and the gauge reading it is observed that the level starts rising just within 36 hours of the commencement of the rainfall in the catchment and likewise the decrease also starts within 24 to 36 hours of the cessation of the rains.

The highest record of 29·75 ft above zero at Sangam has been recorded on 20 September 1950 when widespread rains from 17 September were experienced. This resulted in floods and great destructions all round Jammu and Kashmir.

Table 10 shows the distribution of rainfall from 17 to 21 September 1950 at the 4 rain-recording stations.

It has been observed that the continuous rainy spells lasting for days together and rainfalls with heavy intensities at any of the 5 stations in the Jhelum catchment during July to September are caused as a result of the disturbances coming either from the Arabian Sea or from the Bay of Bengal or under the simultaneous effect of both. The rainfalls in the catchment directly affect the water level in the river and the rise in the river-level is observed just within 36 hours after the commencement of the rains.

10. Acknowledgements