

# Characteristics of long-term variability of precipitation in selected river catchment areas in India based on GPCC data for the years 1901–2010

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**Abstract:** *This study contains an analysis of mean monthly precipitation values, covering multiple profiles, in 13 Indian river catchment areas: Brahmaputra, Indus, Ganga, Mahi, Narmada, Tapi, Damodar, Brahmani, Krishna, Penner, Cauvery, Mahanadi and Godavari. The analysis covers data for the period 1901–2010 with a spatial resolution of 0.5°x0.5° of geographic longitude and latitude (GPCC data). The data is analysed in monthly and calendar year profiles. The periodical nature of precipitation is assessed and the trends in climate changes calculated. The characteristics of trend in climate changes are described by linear equations with indicated boundary values of coefficients determined at a 5% significance level. The analyses discussed confirm spatial and temporal variability of precipitation in the key river catchment areas in India, feeding the country's surface and underground water resources. The statistics contained in this study demonstrate the regional nature of water supply, indicate the need to complete regional analyses of temporal and spatial variations in the volumes of water feeding Indian resources, and confirm that regional and local plans must be developed to adapt to climate change, based on the accepted scenarios aimed to compensate climate change effects.*

**Keywords:** *GPCC data, monthly precipitation, annual precipitation, frequency analysis, climate trend in precipitation, territory of India.*

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## I. Introduction

This study aims at supplementing necessary information about the characteristics of long-lasting precipitation series, precipitation total and mean values in the areas of surface water catchment areas of key importance for the feeding of Indian water resources. The study is focused on regional analyses showing clear interrelations between precipitation structures and volumes and the resultant effects in parts of river basins, distinguished areas in a hydrographic system or local drainage areas. The need to complete such analyses is emphasised in the reports prepared under the United Nations Framework Convention<sup>2</sup> on Climate Change that provide a basis for scenarios developed to compensate climate change effects.

The detailed knowledge of precipitation volumes reaching the Earth land surface is particularly important for an assessment of the quantity of fresh water available, for water management as necessary to meet the demand for water and to mitigate the risks of floods and draughts. There is a growing body of scientific evidence confirming the hypothesis proposing climate changes caused by human activities. The intensity of those changes depends on the region and varies in time and space. The analyses of climate changes at a regional level demonstrate a strong correlation with anthropogenic impacts. The climate changes observed are characterised by shortened period of high-intensity precipitation and more frequent periods of long-lasting precipitation that cause great floods. Also the periods characterised by high temperatures and reduced precipitation have become longer. The polarization of extreme phenomena is an established fact, associated with the variations in and intensity of human activities. This study contains the results of my analyses of GPCC data for selected Indian river catchment areas. The approach used in the analyses enabled the author to characterize and estimate certain changes in the process of feeding the water resources available in selected Indian river catchment areas, resulting from variability of precipitation.

The water resources development programme implemented following India independence resulted in an increase in the available irrigation potential by five times, a progress was also reported in supplies of potable water and water for industrial purposes. However, the population growth rate, urbanization and industrial development have resulted in a significant increase in water demand and consumption. Extensive policies followed in some regions have led to excessive exploitation of available resources and consequently to durable

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<sup>2</sup> opened for signature on 5 June 1992 in Rio de Janeiro, ratified by Poland on 24 October 1994 (Journal of Laws Dz. U. No. 53 of 1996, item 238)

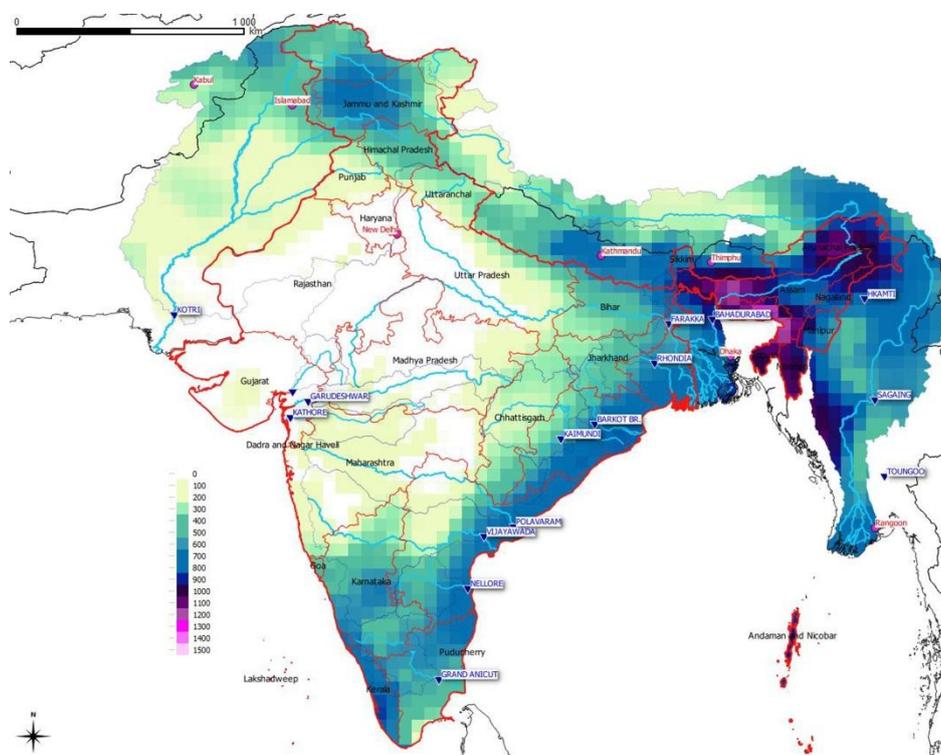
depletion of water resources. Additionally, the growth of the industrial sector and a rapid urbanization process resulted in contamination of surface water and groundwater. The low efficiency of use of water intakes represents another problem in water management.

The total estimated volume of available resources reaches 4000 BCM; taking into account losses due to evaporation, an estimated total annual volume of available water amounts to 1869 BCM. However, considering the geomorphological and hydrological conditions, only 1123 BCM may be effectively used, including 61% from surface water and about 39% from renewable groundwater resources. Attention should be paid to significant spatial and temporal differences in access to water. The Ganga and Brahmaputra river basins are characterised by the highest availability rates reaching about 60% of total annual volume of available water.

The government strategy implemented by the Ministry of Water Resources in India pays particular attention to an increase in the demand for water by about 20% over the next 10 years and by about 70% over the next 40 years, assessing the demand by the year 2050 at 1180 [km<sup>3</sup>] [BCM], compared to the current demand amounting to 700 [BCM]. These ambitious objectives, requiring considerable involvement of government and non-government institutions, open up another great growth opportunity to society of India. Social development achieved by education and qualification programmes carried out as part of the strategy may represent another desirable synergy outcome. Training programmes accompanying expenditures on infrastructure development are indispensable to improve the efficiency of use of water intakes.

**Table 1.** A statement of annual balances of water resources in India for the period 1901 – 2010

Drainage area	Stations	GRDC NO river basin ID	Area catchment [km <sup>2</sup> ]	Mean annual precipitation [mm]	Precipitation volume [km <sup>3</sup> ]	Trend [mm/year]	Trend [mln m <sup>3</sup> /year]	Mean outflow for the long-term period [m <sup>3</sup> /s]	Runoff coefficient for the long-term period []	Forecast change in precipitation volume [km <sup>3</sup> ]	
										15 years	25 years
BRAHMAPUTRA	BAHADURABAD	2651100	505270.6	1532.59	774.4	-0.1590	-80.36	2826.4	0.238	-1.205	-2.009
INDUS	KOTRI	2335950	1125733.6	450.61	507.3	0.0134	15.04	12111.8	0.409	0.226	0.376
GANGES	FARAKKA	2846800	901751.6	1118.70	1008.8	-0.0333	-30.05	384.3	0.435	-0.451	-0.751
MAHI RIVER	SEVALIA	2853150	35896.8	827.48	29.7	0.0601	2.16	1223.5	0.376	0.032	0.054
NARMADA	GARUDESHWAR	2853200	88075.9	1148.46	101.2	0.0436	3.84	491.9	0.293	0.058	0.096
TAPTI RIVER	KATHORE	2853300	64098.8	859.15	55.1	0.1356	8.69	298.3	0.381	0.130	0.217
DAMODAR RIVER	RHONDIA	2854050	20413.2	1284.36	26.2	0.0385	0.79	no data	no data	0.012	0.020
BRAHMANI RIVER (BHAHMANI)	BARKOT BR.	2854080	30090.1	1515.30	45.6	-0.0239	-0.72	1657.5	0.250	-0.011	-0.018
KRISHNA	VIJAYAWADA	2854300	255880.4	831.12	212.7	0.0648	16.59	74.5	0.067	0.249	0.415
PENNER RIVER	NELLORE	2854500	54737.8	663.07	36.3	0.0450	2.47	207.8	0.087	0.037	0.062
CAUVERY RIVER	GRAND ANICUT	2854800	70315.9	1014.09	71.3	-0.0138	-0.97	1883.4	0.323	-0.015	-0.024
MAHANADI RIVER (MAHAHADI)	KAIMUNDI	2855800	118002.2	1390.58	164.1	-0.0307	-3.62	3061.1	0.281	-0.054	-0.090
GODAVARI	POLAVARAM	2856900	309378.3	1145.78	354.5	0.0449	13.90	21545.2	0.697	0.208	0.347
INDIA			3287590.0	1126.68	3704.1	0.0206	67.72			1.016	1.693



**Figure 1.** GPCP gauge-based gridded monthly precipitation data for the territory of India, [mm] May 2010

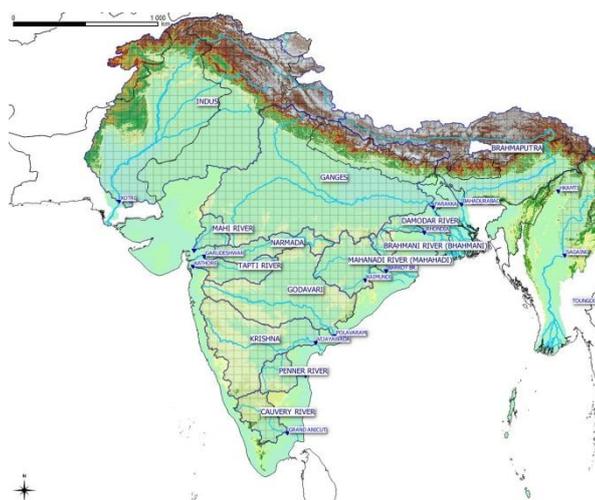


Figure 2. Analysed river catchment areas

## II. The role of GPCC Precipitation Climatology Centre in collecting and providing precipitation data

The Global Precipitation Climatology Centre (GPCC) was established in 1989 by the World Meteorological Organization (WMO). The Centre is supported and operated by the Deutscher Wetterdienst (DWD, the German Meteorological Office) as a German contribution to the World Climate Research Programme (WCRP). The main objective of the GPCC is a global analysis of monthly precipitation on Earth land surface based on data provided by “in-situ” precipitation stations. In 1994, GPCC was requested by the WMO to support climate monitoring activities carried out by the Global Climate Observing System (GCOS). The GPCC has joined the GCOS network (GSNMC) in 1999, focusing on atmospheric precipitation while temperature monitoring is conducted by the Japan Meteorological Agency (JMA)

The objective of the GPCC is to meet the users' demand for accurate analyses, current and readily available datasets. For example: The WCRP, as part of the Global Energy and Water Cycle Exchanges Project (GEWEX), requires high spatial resolution and accuracy of data for the last two decades while the priorities of the GCOS and IPCC focus on long-term uniformity of time series showing climate changes. All GPCC products represent gridded near and non-real-time datasets of precipitation on the Earth land surface. Only monthly data is made available in spatial resolutions  $0.5^{\circ} \times 0.5^{\circ}$  to  $2.5^{\circ} \times 2.5^{\circ}$  of geographic longitude and latitude. The datasets are made available on the Internet (<http://gpcc.dwd.de>). The products are developed based on complete sets of information from the world precipitation database originating from more than 97000 stations that provide protected and classified raw records.

## III. Characteristics of data for 1901-2010

The GPCC data representing total precipitation volumes in individual months in the period 1901–2010, with a spatial resolution of  $0.5^{\circ} \times 0.5^{\circ}$  of geographic longitude and latitude, are converted to the analysed Indian drainage basin and key analysed river catchment areas. Thus a sequence of monthly precipitation values was obtained that is analysed in this study. The GIS interpolation methods are used in the spatial analysis of data. The calculated sequence values were subject to a simple statistical analysis in order to determine the basic statistics: the minimum and maximum values, the mean value, standard deviation of the sample and the value of the coefficient of variation. The data is analysed in calendar year profiles. The analyses of monthly precipitation values cover the years 1901–2010.

## IV. An assessment of accuracy of the GPCC data for the period 1901-2010

An analysis of error in monthly and annual values of total precipitation for the entire territory of India was completed to verify the data. The period subject to verification based on comparative data includes the years 1901–2010. The results of the analysis are shown in a graphic format. The relative error in the analysed total monthly precipitation values amounted on average from (-1%) in July to 27% in November, resulting in a 4% mean value of relative error for the total of annual precipitation.

Table 2. Values of relative errors in the long-term period 1901–2010 in individual months, the territory of India

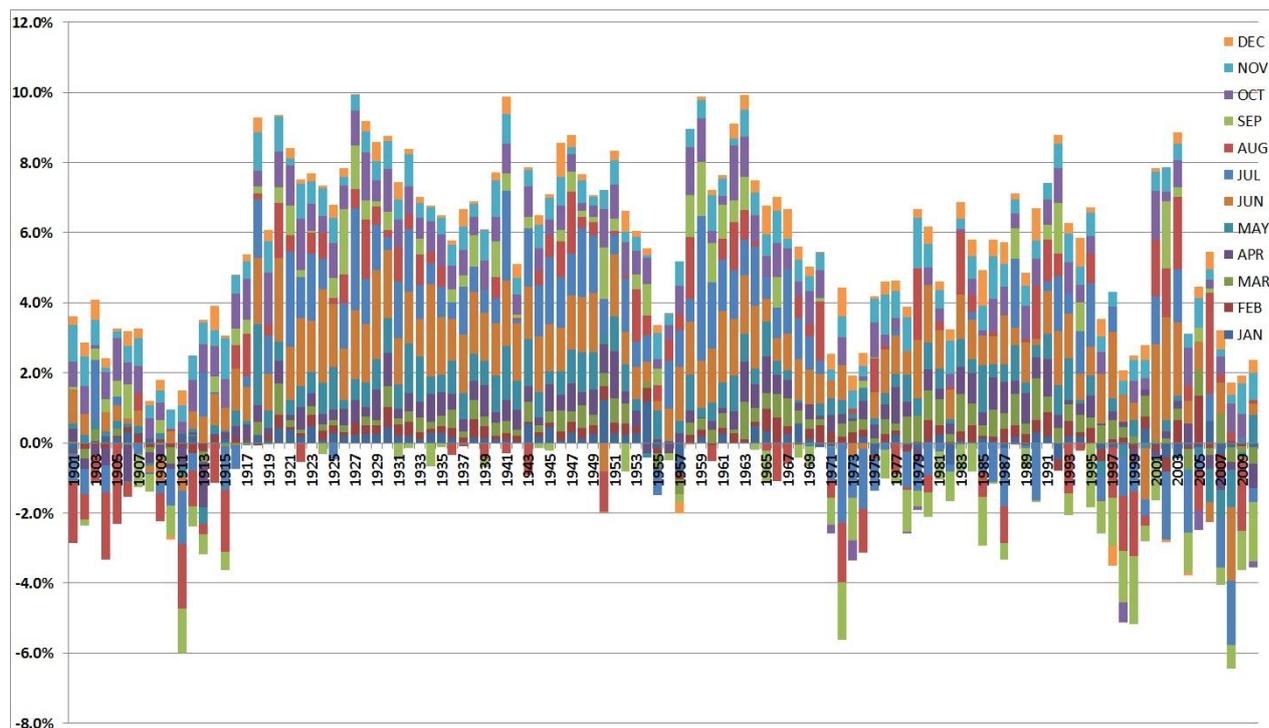
Months	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean relative error	4%	7%	11%	8%	8%	8%	1%	0%	-1%	11%	27%	22%

The positive value of error indicates underestimated totals of monthly precipitation published by the GPCC, compared to the precipitation values officially published in materials of the India Meteorological Department [2]

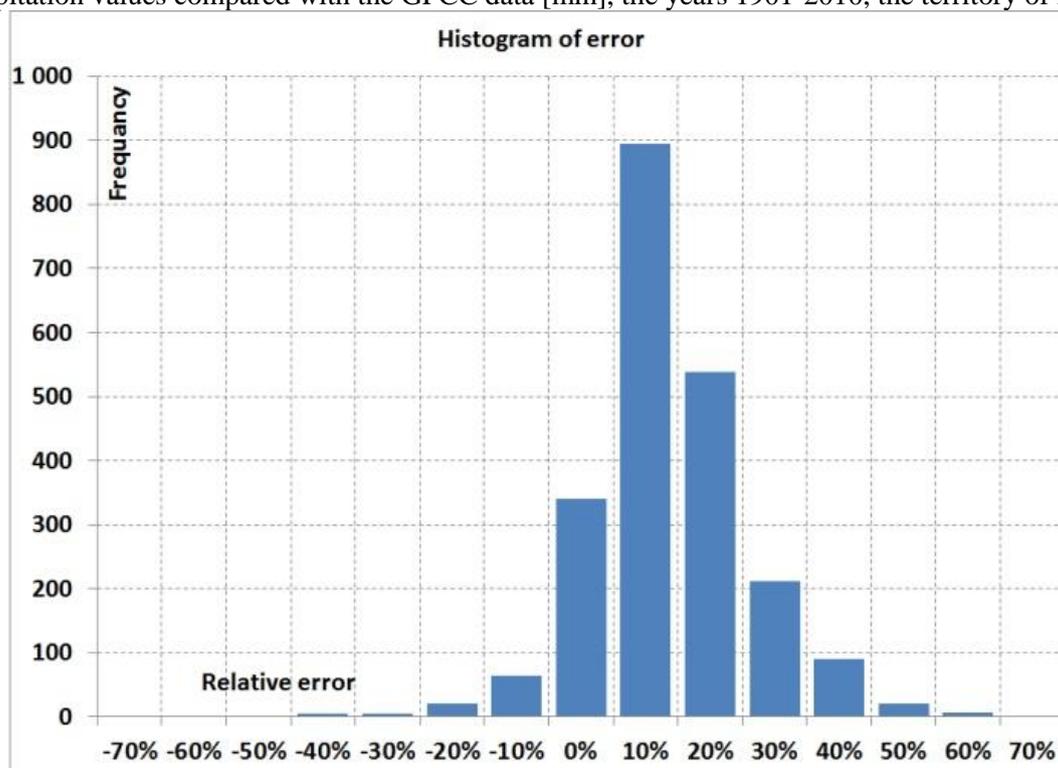
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**Table 3.** A statement of precipitation total values and selected statistics for the long-term period 1901–2010 in the territory of India

YEAR	[mm]												ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	37.20	39.02	17.63	34.99	48.91	103.17	249.83	289.80	123.94	45.08	27.83	5.73	1023.12	76.22	101.53	766.74	78.64	5.73	289.80	85.26	88.90	1.04
1902	7.60	5.73	21.93	47.15	46.51	105.40	292.32	208.48	202.18	54.15	20.68	21.18	1033.30	13.33	115.59	808.38	96.01	5.73	292.32	86.11	91.60	1.06
1903	16.06	9.10	27.31	20.10	56.70	120.97	272.16	194.08	118.40	31.61	11.29	1160.55	25.16	104.11	869.98	161.30	9.10	282.77	76.22	85.80	1.00	
1904	12.79	11.14	31.15	38.82	72.86	159.83	268.37	227.24	127.06	61.90	9.84	13.62	1034.62	23.93	142.83	782.50	85.37	9.84	268.37	86.22	85.80	1.00
1905	23.10	20.02	39.69	34.13	53.71	89.23	250.53	223.98	173.94	42.76	7.81	9.22	968.10	43.12	127.52	737.67	59.79	7.81	250.53	80.28	82.45	1.02
1906	18.04	48.22	32.05	27.66	35.93	175.22	286.95	256.11	172.73	43.61	12.12	21.38	1130.01	66.25	95.64	891.01	77.11	12.12	286.95	94.17	95.87	1.02
1907	15.87	43.34	37.66	61.42	30.66	148.52	228.53	302.97	150.23	15.08	15.01	9.88	1014.17	59.21	129.74	785.25	39.98	9.88	302.97	84.51	91.40	1.08
1908	18.63	18.28	9.91	24.53	46.09	127.81	320.90	305.88	156.19	32.21	2.95	6.02	1079.30	36.91	90.94	910.88	41.18	2.95	320.90	89.94	110.87	1.22
1909	28.06	14.05	6.95	65.00	49.23	124.02	305.99	274.00	131.72	60.00	31.72	6.00	1073.63	36.91	121.83	913.43	41.18	6.00	305.99	84.47	106.86	1.07
1910	13.63	11.48	19.31	30.88	40.74	208.01	259.66	283.03	196.00	107.88	27.91	6.62	1205.14	25.10	90.93	946.70	142.40	6.62	283.03	103.43	101.63	1.01
1911	37.72	6.40	43.15	29.25	50.93	195.49	178.72	228.67	191.88	68.04	37.50	8.72	1075.58	44.12	123.33	794.76	113.36	6.40	228.67	89.63	79.44	0.89
1912	18.25	24.64	19.54	37.13	42.61	101.76	331.72	270.20	120.20	48.63	44.21	5.43	1069.13	42.89	99.28	828.69	98.28	5.43	331.72	89.09	110.10	1.13
1913	6.18	40.70	26.96	39.37	77.80	206.90	256.54	195.87	115.78	59.87	10.39	22.25	1058.62	46.88	144.13	775.10	92.51	6.18	256.54	88.22	82.27	0.93
1914	4.57	25.24	25.25	42.04	64.84	146.44	341.49	253.28	185.86	35.22	15.48	13.18	1152.99	29.81	132.13	927.07	63.97	4.57	341.49	96.08	106.03	1.10
1915	18.49	37.20	45.05	31.72	63.43	147.74	241.98	246.83	177.55	81.26	32.28	7.26	1130.79	55.69	140.30	814.10	120.80	7.26	246.83	94.23	83.04	0.78
1916	4.93	18.49	11.49	30.53	53.36	216.30	273.99	193.34	125.96	39.55	2.68	1271.40	23.41	95.38	984.42	168.19	2.68	273.99	105.95	106.74	1.01	
1917	6.42	37.06	21.52	34.35	72.78	216.44	278.11	275.05	272.31	144.30	21.69	6.53	1386.55	43.49	128.65	1041.91	172.52	6.42	278.11	115.55	109.34	0.95
1918	9.54	4.68	32.76	30.98	80.06	192.87	166.73	239.21	109.82	14.81	33.63	11.18	926.27	14.22	143.80	708.63	59.62	6.48	239.21	77.19	77.90	1.01
1919	47.81	18.57	19.27	29.85	52.98	181.41	290.52	280.99	163.23	72.61	38.74	14.06	1210.03	66.38	102.10	916.14	125.41	14.06	290.52	100.84	97.71	0.97
1920	19.56	17.40	45.78	31.37	46.88	138.81	295.70	175.37	118.48	35.32	14.78	2.63	1193.84	38.96	124.00	728.24	121.76	6.63	295.70	78.50	54.14	1.07
1921	33.03	6.52	15.40	41.88	46.17	175.20	268.65	193.21	56.64	13.48	11.74	1122.09	39.55	103.44	877.24	81.86	6.52	268.65	93.51	96.53	1.03	
1922	26.86	3.56	13.16	25.17	41.68	181.26	300.84	225.38	197.50	44.49	43.44	13.10	1120.22	35.42	80.01	904.97	99.83	8.56	300.84	93.35	98.29	1.05
1923	16.05	35.23	18.38	26.58	51.43	85.04	315.71	266.13	173.17	49.01	10.43	11.92	1060.29	51.29	96.39	840.05	72.56	10.43	266.13	87.51	86.00	1.09
1924	20.06	18.42	12.12	26.85	50.37	103.43	317.92	246.15	242.47	59.99	47.10	13.52	1158.40	38.48	89.34	909.98	120.60	12.12	317.92	96.53	103.87	1.06
1925	9.57	8.77	13.44	40.39	86.50	183.29	306.55	232.49	133.38	55.32	32.81	11.71	1114.23	18.35	140.33	855.71	99.84	8.77	306.55	92.85	95.61	1.03
1926	25.83	9.10	53.36	33.33	54.91	80.70	301.13	320.37	187.30	48.94	7.87	7.32	1130.17	34.93	141.60	889.51	64.13	7.32	320.37	94.18	107.51	1.14
1927	10.38	30.25	25.20	28.36	42.76	153.44	310.28	246.23	140.41	56.91	51.55	10.20	1126.08	40.63	93.62	868.36	118.06	9.30	310.28	93.29	96.19	1.03
1928	17.91	37.22	18.20	31.16	46.22	158.99	287.77	208.66	137.38	111.47	14.43	20.77	1090.18	55.13	95.58	792.80	146.66	14.43	287.77	90.85	86.44	0.95
1929	26.55	12.58	44.12	55.37	164.07	281.31	234.75	123.49	85.76	15.07	33.67	1090.53	42.34	112.08	803.61	132.51	12.58	234.75	90.88	87.60	0.96	
1930	17.98	16.60	21.69	39.71	43.95	158.19	284.00	209.70	167.85	82.18	43.23	8.70	1093.79	34.58	105.35	819.75	134.11	8.70	284.00	91.15	87.28	0.96
1931	9.62	28.95	16.77	33.58	50.60	117.19	298.67	291.08	197.11	110.70	33.89	14.71	1202.89	38.58	100.96	904.05	159.31	9.62	298.67	100.24	101.84	1.02
1932	6.63	18.19	16.40	28.46	68.72	134.77	306.53	233.99	133.73	59.67	49.22	12.81	1193.84	24.82	109.88	847.39	121.76	6.63	306.53	91.99	143.74	1.09
1933	14.92	26.87	19.31	43.23	84.50	200.40	266.31	301.49	205.50	85.50	14.55	14.09	1237.68	41.79	146.04	873.71	114.14	14.09	266.31	90.49	102.70	0.97
1934	19.83	10.08	13.55	37.33	41.30	185.58	277.27	290.71	174.80	55.14	27.57	9.91	1143.04	29.91	92.17	928.35	92.62	9.91	277.27	90.21	95.25	1.02
1935	23.68	18.63	15.02	33.84	31.32	140.69	303.67	240.21	186.77	39.84	11.36	10.36	1056.01	42.31	80.76	871.35	61.57	10.36	303.67	88.00	98.64	1.12
1936	10.28	38.11	31.04	27.39	70.16	230.07	286.52	241.40	188.84	57.42	49.39	19.53	1250.14	48.39	128.59	946.82	126.33	10.28	286.52	104.18	97.05	0.93
1937	6.06	48.94	16.90	52.31	48.74	142.34	319.77	209.37	169.88	86.12	12.06	13.04	1125.52	54.99	117.95	841.36	111.22	6.06	319.77	93.79	93.63	1.00
1938	27.87	24.11	26.28	26.97	61.00	250.67	291.01	249.58	160.07	68.52	11.49	4.18	1201.75	51.97	114.26	951.33	84.19	4.18	291.01	100.15	102.64	1.02
1939	11.84	28.24	27.64	30.70	32.85	157.76	265.18	236.43	157.66	81.74	19.96	1.55	1051.55	40.07	91.19	817.03	103.25	1.55	265.18	87.63	88.80	1.01
1940	11.72	24.64	43.20	23.28	68.27	155.92	299.51	271.03	113.24	54.70	28.30	14.84	1108.74	36.36	134.84	839.70	97.84	11.72	299.51	92.40	95.61	1.03
1941	22.13	14.22	16.60	25.07	64.35	151.95	211.03	231.56	148.32	53.05	17.28	14.92	971.00	36.35	106.03	743.37	85.25	14.22	231.56	80.92	78.47	0.97
1942	21.12	43.58	18.55	37.42	53.34	70.40	338.54	286.15	211.31	27.23	11.63	18.57	1207.61	64.70	109.29	976.39	57.43	11.63	338.54	100.65	109.92	1.09
1943	49.70	9.16	25.48	42.22	77.05	148.86	287.88	240.19	207.33	77.87	10.95	4.24	1180.93	58.86	144.74	884.27	93.07	4.24	287.88	88.41	94.26	0.96
1944	25.28	36.19	52.37	20.03	81.63	134.76	330.09	281.49	158.16	84.23	20.68	11.90	1215.84	61.47	133.02	867.39	116.84	11.90	330.09	101.32	101.67	1.00
1945	28.78	8.62	16.01	37.87	48.96	142.72	309.92	139.13	117.29	74.90	13.86	10.60	1138.20	97.40	113.20	909.07	83.88	3.60	309.92	94.85	101.48	1.07
1946	3.40	15.88	16.44	41.90	62.24	197.47	299.09	282.52	140.78	74.93	65.30	22.70	1222.63	19.27	120.58	919.85	162.93	3.40	299.09	101.89	100.03	0.98
1947	18.72	14.70	22.08	29.27	44.02	110.94	299.72	268.53	232.99	63.54	4.92	18.05	1127.47	33.41	95.37	912.18	86.50	4.92	299.72	93.96	104.42	1.11
1948	23.61	24.85	30.78	37.38	76.09	143.22	321.28	278.12	175.75	58.09	62.44	7.64	1239.25	48.46	144.25	918.37	128.17	7.64	321.28	103.27	100.26	0.97
1949	9.40	25.60	20.31	43.89	75.57	142.96	296.08	238.46	224.89	90.97	74.47	10.71	1179.69	35.00	139.77	902.40	102.51	4.07	296.08	103.21	98.62	1.00
1950	21.02	20.85	32.33	18.92	46.09	145.38	319.75	249.07	185.27	44.85	21.14	7.97	1112.64	41.87	97.33	899.48	73.97	7.97				



**Figure 3.** The structure of error in monthly precipitation values relative to the annual total, monthly precipitation values compared with the GPCP data [mm], the years 1901-2010, the territory of India



**Figure 4.** Histogram of relative error in monthly precipitation totals, the territory of India

### V. Precipitation variability in the territory of India

A long-term mean annual total of precipitation based on the analyses is estimated at 1126 mm in India. The mean values in the analysed period of 110 years vary from 894 mm to 1387 mm, with the largest volume of precipitation in India amounting to about 11690 mm – in Mawsynram near Cherrapunji in the state of Meghalaya in north-eastern India (R. Kumar, R. D. Singh and K. D. Sharma, 2005). On the other hand, in Jaisalmer in the Thar Desert in Rajasthan, the annual precipitation volume is as low as 150 mm. 75% of total

annual precipitation is recorded in the period from June to September. 750 mm of rain p.a. falls on about 21% of the India territory, and the total of annual precipitation exceeds 1500 mm on about 15% of the territory. The areas characterised by low volumes of precipitation, below 500 mm, include the western region of Rajasthan, Gujarat, Haryana and Punjab, the interior of the Deccan Plateau east of Sahyadris and the region near Leh in Kashmir. The standard deviation of mean value of annual total precipitation reaches 10% and the coefficient of variation amounts to 0.08. The sum of mean precipitation volume in the long-term period amounts to 3704 km<sup>3</sup>, showing a positive trend of 68 [million m<sup>3</sup>/year].

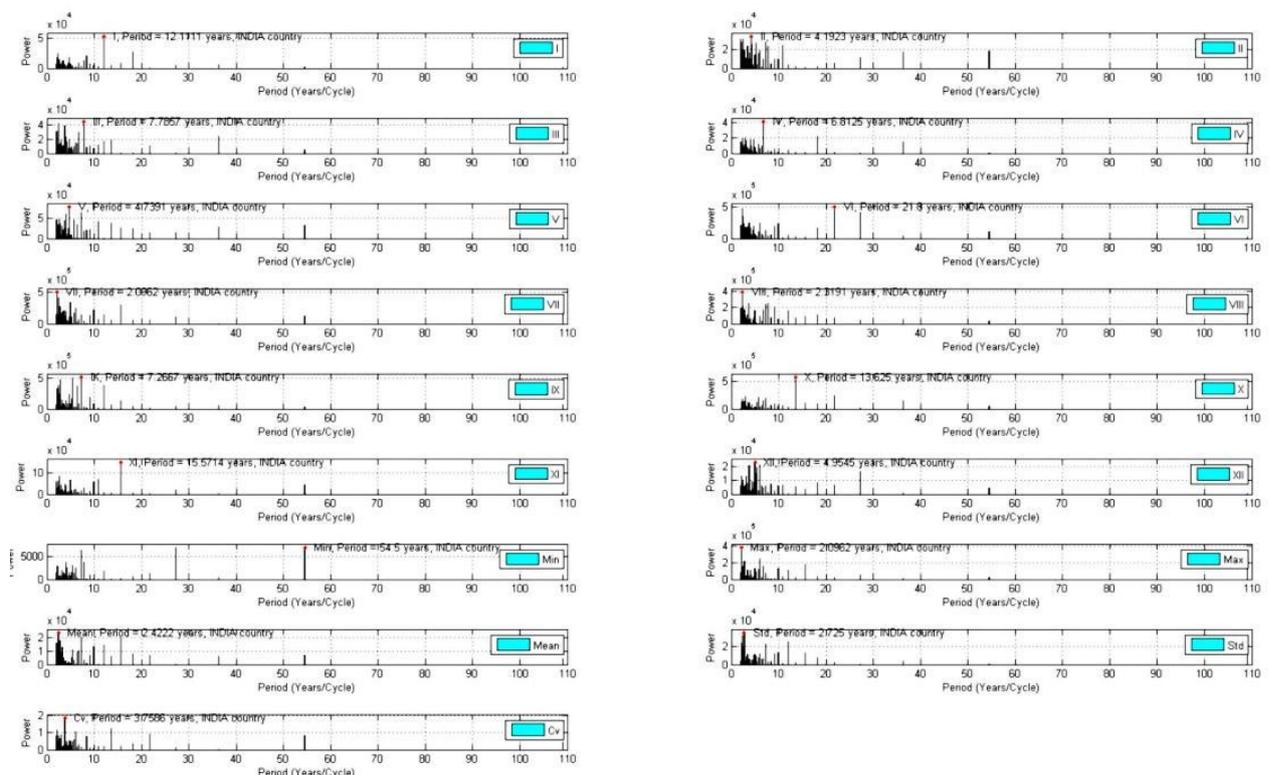
### VI. Precipitation periodicity in the territory of India

The periodicity of precipitation in the territory of India was assessed using signal processing theory with a harmonic analysis applied. The procedures necessary to calculate the values of predominating frequencies were developed in Matlab. The inverses of those values represent the predominating period of repeatability of an event. The analysis was completed for various profiles of the analysed dataset. The results are shown in graphic and tabular formats.

The periodicity of monthly precipitation, considered using monthly profiles of calendar years in the analysed period 1901–2010, may be described as follows: November is characterised by a long predominating period of repeatability: 16 years while predominating periods of repeatability for the remaining months amount to 2 to 14 years. Period of repeatability of minimum values: 55 years, maximum values: 2 years, medium values: 2.5 years

### VII. Premises for an analysis of climate changes observed in precipitation

The trend in climate changes considered using monthly precipitation profiles for the calendar year is described by linear equations with indicated boundary values of coefficients determined at a 5% significance level. The slope values are both negative and positive for the analysed period 1901–2010. The months of January, February, April, August and December are characterised by a decreasing trend in precipitation while the remaining months by a positive trend. The values vary between -0.035 in August and +0.098 [mm/year] in October.



**Figure 5.** Inverses of predominating frequencies of monthly precipitation values and their statistics for the territory of India

1. Analyses of selected catchment areas

1.1. GRDC data<sup>3</sup>

The GRDC has created and manages a large bank of hydrological data, including watercourses, their topology, flows in selected water-level gauge locations, and catchment area boundaries on Earth. The GRDC website makes available both hydrographic and hydrological data. Access to the database is regulated by the Policy guidelines for the dissemination of data. This analysis uses GRDC data describing the catchment areas of rivers located in whole or in part in the territory of India, with closing cross-sections indicated.

1.2. Application

The monthly precipitation values for selected river catchment areas in the territory of India area are calculated using GIS interpolation methods. The GPCP data representing total precipitation volumes in individual months in the period 1901–2010, with a spatial resolution of 0.5°x 0.5° of geographic longitude and latitude, converted to the analysed river catchment areas. A sequence of monthly precipitation values was obtained and is analysed below, like in the analysis covering the territory of India. The calculated sequence values were subject to a simple statistical analysis in order to determine the basic statistics: the minimum and maximum values, the mean value, standard deviation of the sample and the value of the coefficient of variation. The data is analysed in calendar year profiles. The analyses of monthly precipitation values cover the years 1901–2010.

The mean total of precipitation in the analysed river catchment areas in the long-term period varies from 1532 in the Brahmaputra catchment area to 450 mm in the Indus catchment area at coefficients of variation of 0.13 for the Brahmaputra river and of 0.17 for the Indus river. The greatest value of coefficient of variation in total annual precipitation in the analysed long-term period is observed in the catchment area of the Mahi river (0.28) at a mean total of precipitation amounting to 827 mm. The greatest mean values are recorded in the Brahmaputra catchment area and the lowest – in the Indus catchment area (about 314 mm).

Table 4. A statement of periodicity values (inverses of predominating frequencies) for mean monthly precipitation sequences in the period 1901–2010 by months in the territory of India

Analysed sequence profile	Months of the calendar year												Periodicity statistics of				
	'I'	'II'	'III'	'IV'	'V'	'VI'	'VII'	'VIII'	'IX'	'X'	'XI'	'XII'	MIN	MAX	MEAN	SD	CV
Predominating period in years	12.111	4.192	7.786	6.813	4.739	21.800	2.096	2.319	7.267	13.625	15.571	4.955	54.500	2.096	2.422	2.725	3.759

Table 5. Values of parameters of the linear trend in monthly precipitation in the analysed period for the territory of India

	Units	Months of the calendar year												Statistics of				
		'I'	'II'	'III'	'IV'	'V'	'VI'	'VII'	'VIII'	'IX'	'X'	'XI'	'XII'	MIN	MAX	MEAN	SD	CV
Slope value <i>a</i>	[mm/year]	-0.022	-0.011	0.006	-0.010	0.086	0.026	0.047	-0.035	0.065	0.098	0.000	-0.002	0.009	-0.015	0.021	-0.006	0.000
Lower limit at a 95% confidence level		-0.074	-0.075	-0.055	-0.061	0.004	-0.178	-0.156	-0.217	-0.142	-0.067	-0.088	-0.049	-0.011	-0.166	-0.026	-0.059	-0.001
Upper limit at a 95% confidence level		0.031	0.052	0.068	0.040	0.167	0.230	0.250	0.147	0.272	0.263	0.088	0.045	0.029	0.137	0.067	0.046	0.000
Coefficient value <i>b</i>	[mm]	60.42	43.16	11.81	54.60	-110.07	105.33	192.59	323.24	45.79	-122.87	23.29	16.05	-9.34	321.14	53.61	108.01	1.62
Lower limit at a 95% confidence level		-41.90	-80.65	-108.62	-44.49	-269.58	-293.92	-204.22	-33.24	-358.85	-445.69	-149.38	-75.92	-48.84	24.56	-37.55	5.02	0.92
Upper limit at a 95% confidence level		162.74	166.96	132.24	153.69	49.44	504.59	589.39	679.72	450.43	199.96	195.96	108.02	30.16	617.72	144.77	211.01	2.32

Table 6. Statistics of mean annual precipitation in the analysed river catchment areas in the period 1901–2010

Drainage	Station	GRDC_NO	AREA	MIN	MAX	MEAN	SD	CV
			[km <sup>2</sup> ]	[mm]			[]	
BRAHMAPUTRA	BAHADURABAD	2651100	505270.6	1206	2235	1533	199	0.130
INDUS	KOTRI	2335950	1125733.6	314	643	451	75	0.167
GANGES	FARAKKA	2846800	901751.6	860	1448	1119	129	0.115
MAHI RIVER	SEVALIA	2853150	35896.8	341	1480	827	229	0.277
NARMADA	GARUDESHWAR	2853200	88075.9	675	1690	1148	202	0.176
TAPTI RIVER	KATHORE	2853300	64098.8	409	1365	859	173	0.201
DAMODAR RIVER	RHONDIA	2854050	20413.2	743	1914	1284	226	0.176
BRAHMANI RIVER (BHAHMANI)	BARKOT BR.	2854080	30090.1	1054	2030	1515	199	0.131
KRISHNA	VIJAYAWADA	2854300	255880.4	561	1186	831	126	0.151
PENNER RIVER	NELLORE	2854500	54737.8	398	1084	663	141	0.213
CAUVERY RIVER	GRAND ANICUT	2854800	70315.9	697	1340	1014	134	0.133
MAHANADI RIVER (MAHAHADI)	KAIMUNDI	2855800	118002.2	885	1994	1391	197	0.142
GODAVARI	POLAVARAM	2856900	309378.3	645	1635	1146	167	0.146
INDIA			3287590.0	894	1387	1127	93	0.083

<sup>3</sup> The GRDC operates under the auspices of the World Meteorological Organization (WMO) and is hosted by the Federal Institute of Hydrology (BfG) in Koblenz, Germany

**Table 7.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the Brahmaputra river catchment areas

YEAR	Brahmaputra												MIN	MAX	MEAN	SD	CV						
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC											
1901	29.2	23.9	22.0	96.4	80.3	204.4	273.5	311.5	108.3	46.7	72.6	3.4	1272.2	53.1	198.7	897.7	122.7	3.38	311.46	106.01	102.50	0.97	
1902	8.5	13.0	71.3	108.9	91.8	270.0	306.8	434.6	433.5	41.9	9.4	2.4	1872.2	21.6	352.0	1464.9	53.7	2.39	434.64	156.02	167.48	1.07	
1903	14.7	15.3	56.3	66.4	95.0	304.9	239.0	142.1	124.7	24.6	2.5	2.5	1619.4	30.0	217.7	1129.9	151.8	2.54	333.93	134.93	156.67	1.16	
1904	13.2	28.2	46.6	233.3	162.3	169.7	266.4	332.5	104.3	70.9	27.0	5.9	1462.4	41.3	444.3	872.8	103.9	5.63	332.49	121.87	110.22	0.90	
1905	23.8	18.1	88.3	105.4	101.3	218.0	270.0	629.4	143.5	86.4	20.4	25.3	1700.0	41.9	295.1	1280.9	102.1	18.07	629.45	141.87	173.39	1.22	
1906	12.7	38.0	80.1	168.1	93.2	154.7	343.5	596.6	103.4	69.3	7.9	2.1	1649.8	70.7	341.4	1158.3	79.3	21.2	596.61	137.48	161.65	1.18	
1907	27.3	38.3	75.2	163.7	73.0	182.4	402.7	193.4	262.3	15.3	5.1	4.8	1443.5	65.6	311.9	1040.8	25.2	4.79	402.69	102.29	123.68	1.03	
1908	9.3	19.8	20.2	114.3	160.6	175.0	357.1	143.4	226.3	62.1	1.7	1.8	1291.6	29.2	295.1	901.8	65.5	1.68	357.07	160.64	110.58	1.03	
1909	28.6	9.1	8.9	165.5	128.9	439.1	210.9	384.1	130.8	54.0	7.5	7.9	1575.1	37.7	303.2	1164.9	69.3	7.49	439.10	131.26	148.89	1.13	
1910	8.9	27.0	128.4	81.5	83.0	387.2	255.9	150.9	189.7	9.1	16.6	19.0	1902.1	35.8	292.9	1357.9	21.4	8.86	387.20	158.51	171.06	1.08	
1911	40.8	15.6	61.6	147.0	223.3	309.5	534.3	282.3	222.9	152.3	26.4	3.7	2019.9	56.4	431.9	1340.0	182.5	3.74	534.26	168.33	157.17	0.93	
1912	12.1	44.5	60.0	118.5	85.7	213.2	419.4	364.1	143.3	101.9	68.0	11.2	1642.0	56.6	284.3	1140.1	181.1	11.19	419.43	136.83	152.14	0.97	
1913	11.9	74.2	76.4	236.2	225.1	328.0	261.4	236.5	195.3	108.7	5.4	60.7	1839.6	86.1	557.7	1021.0	174.8	5.41	328.00	153.30	109.22	0.71	
1914	4.8	74.6	50.5	91.6	113.9	169.7	235.5	449.3	199.3	32.8	20.9	3.5	1446.3	79.4	256.0	1053.7	37.2	3.50	449.27	120.53	128.81	0.70	
1915	5.4	32.0	31.7	65.7	238.3	164.5	465.4	461.5	175.1	36.7	6.5	7.5	1730.3	57.4	355.6	1266.5	70.8	5.44	465.40	145.86	165.64	1.14	
1916	21.2	24.1	41.6	133.2	164.0	392.1	319.7	399.8	211.9	189.3	92.0	10.9	6.0	1613.2	45.2	338.9	1120.8	108.3	5.99	399.83	134.43	128.63	0.96
1917	6.1	63.9	31.5	78.5	100.4	349.1	332.6	163.4	162.4	144.9	16.7	2.9	1452.9	70.0	210.7	1077.8	164.4	2.87	349.07	121.07	117.70	0.97	
1918	3.6	8.9	83.0	68.0	248.8	529.5	426.4	387.0	172.9	28.0	6.9	2.2	1969.5	12.6	401.8	1515.9	39.2	2.25	529.54	164.12	189.12	1.15	
1919	11.8	18.1	13.4	91.7	125.7	289.7	310.1	116.1	276.6	243.2	19.2	4.9	1520.5	29.8	330.8	292.6	267.2	4.20	116.10	120.71	121.30	0.96	
1920	6.8	55.6	219.8	98.5	87.0	277.7	166.9	294.9	209.1	53.0	1.9	3.3	1474.5	62.4	405.4	948.6	38.1	1.89	219.86	122.87	107.04	0.87	
1921	36.9	14.3	70.2	186.7	373.6	315.5	518.7	375.6	212.3	116.6	4.1	9.1	2235.4	51.2	632.3	1422.1	129.8	11.1	518.70	186.28	174.04	0.93	
1922	17.5	7.8	47.2	83.9	114.4	340.3	230.7	260.2	113.4	97.7	5.7	13.7	1352.6	25.3	245.5	964.7	117.1	5.70	340.30	112.71	112.52	1.00	
1923	2.6	64.5	11.7	97.4	202.0	189.5	356.8	114.3	265.4	35.8	4.9	4.7	1349.7	67.1	311.2	926.0	45.4	2.57	356.79	112.47	117.11	1.04	
1924	14.6	15.3	17.8	81.9	152.2	311.9	342.9	280.9	192.6	106.0	57.9	3.7	1577.6	29.9	251.9	1128.3	167.5	3.67	342.86	131.47	123.84	0.94	
1925	24.6	25.9	37.9	153.0	234.8	174.9	207.5	306.3	342.3	40.0	5.4	2.0	1534.5	30.5	425.7	1031.0	47.3	2.01	246.34	129.55	122.89	0.95	
1926	13.8	12.1	94.2	63.5	105.0	246.1	391.2	200.3	84.3	112.0	6.6	1.6	1345.5	25.9	262.7	921.9	135.1	6.59	391.23	112.13	115.64	1.03	
1927	21.6	68.7	46.3	119.6	90.0	316.8	236.2	210.8	417.5	134.3	28.3	5.8	1869.9	90.3	255.9	1181.3	102.4	1.81	417.48	140.82	129.81	0.92	
1928	7.7	25.4	32.5	64.7	176.4	295.2	225.6	340.1	291.5	21.2	12.8	3.7	1687.8	39.2	273.6	1152.4	228.6	3.88	340.12	140.65	129.17	0.94	
1929	76.6	7.9	50.7	18.2	253.4	392.1	268.9	228.1	139.3	186.0	24.9	45.5	1392.7	84.5	482.3	1269.6	238.4	2.93	392.09	149.39	133.60	0.96	
1930	16.5	21.4	65.7	130.7	39.0	254.5	140.0	289.7	196.1	132.0	55.5	6.9	1470.2	37.9	275.4	900.4	136.5	8.88	369.73	122.51	106.29	0.89	
1931	11.5	30.4	90.8	214.5	137.8	400.7	495.5	178.2	219.6	57.7	9.8	13.3	1839.7	61.9	403.2	1293.9	80.8	8.81	495.45	153.31	159.59	1.04	
1932	16.1	24.1	23.3	69.1	239.1	433.1	172.5	410.0	342.4	54.9	106.8	30.9	1822.4	40.2	331.6	1238.0	192.6	16.10	433.14	151.87	149.59	0.90	
1933	15.9	17.8	13.6	96.6	133.2	234.4	236.8	266.1	116.1	96.0	8.0	3.4	1237.7	33.6	243.4	853.3	107.4	3.36	266.06	103.14	97.57	0.95	
1934	21.0	46.2	19.7	188.9	171.7	380.0	309.5	193.8	169.6	85.5	30.2	9.8	1626.0	67.2	380.3	1053.0	125.5	9.80	380.04	135.50	121.62	0.90	
1935	8.4	43.1	40.1	47.5	122.5	392.0	214.8	402.5	233.0	9.9	14.7	6.3	1534.8	51.5	210.2	1242.2	30.9	6.25	402.45	127.90	147.99	1.16	
1936	21.0	30.3	39.1	111.4	156.6	224.0	395.2	271.0	189.5	69.1	31.0	36.3	1394.4	71.3	307.1	1079.7	136.4	20.98	395.19	132.87	117.68	0.89	
1937	3.3	48.2	14.7	59.6	144.0	138.7	222.8	336.9	123.1	116.8	5.8	6.3	1242.2	51.4	218.3	843.5	128.9	3.26	336.89	103.51	106.52	1.03	
1938	33.9	27.3	77.9	103.5	124.6	501.3	433.5	303.2	257.6	83.4	27.5	1.8	1975.5	61.2	306.0	1495.6	112.6	1.76	501.30	164.62	169.01	1.03	
1939	2.7	34.5	16.2	76.3	119.6	409.8	285.8	212.5	210.7	82.0	3.3	2.2	1455.6	37.2	212.1	1118.8	87.4	2.16	409.84	121.30	131.76	0.90	
1940	3.7	65.9	136.6	31.5	150.1	206.5	336.6	136.0	251.2	36.1	11.8	14.5	1382.5	69.6	316.2	932.2	62.4	3.66	336.61	115.20	107.79	0.94	
1941	8.0	21.2	32.6	81.4	249.5	193.7	236.9	239.1	253.4	45.9	11.1	13.7	1408.5	29.2	363.5	945.1	70.7	8.03	239.12	117.37	110.16	0.94	
1942	12.2	34.6	91.7	121.6	211.4	392.3	188.9	201.3	189.2	201.3	12.7	9.1	2.2	1447.8	46.8	424.7	951.6	24.7	2.89	392.28	120.65	115.13	0.96
1943	49.4	27.3	92.2	181.2	203.8	199.8	285.1	248.9	248.9	199.8	9.8	6.0	1541.2	76.7	427.3	972.5	59.6	5.95	285.08	128.43	103.20	0.80	
1944	28.4	21.8	50.2	66.5	241.1	284.0	190.9	142.1	307.8	90.1	8.2	11.5	1442.0	30.0	357.8	924.8	109.8	8.16	307.81	120.21	110.08	0.92	
1945	27.5	34.8	34.0	79.0	169.4	187.6	305.2	362.2	169.6	109.2	5.4	5.2	1489.1	62.3	282.4	1024.6	119.8	5.17	362.15	124.09	118.14	0.95	
1946	1.3	25.0	40.0	87.0	209.9	234.8	354.6	155.0	187.6	139.8	6.8	2.3	1444.1	26.3	336.9	932.0	148.9	1.34	354.63	120.34	112.72	0.94	
1947	6.2	10.3	56.7	128.9	149.6	184.2	426.2	146.5	209.5	127.6	2.1	7.8	1455.8	16.5	335.2	966.5	137.6	2.13	426.24	132.12	121.77	1.00	
1948	9.9	32.7	37.7	162.5	447.6	296.6	651.4	227.5	177.8	102.0	33.7	6.8	2186.0	42.5	647.8	1353.2	142.5	6.77	651.38	162.17	199.61	1.10	
1949	24.0	28.5	88.6	214.2	193.4	342.7	336.0	365.4	216.2	128.3	10.8	16.9	1964.8	52.5	496.1	1260.2	156.0	10.85	365.36	163.73	134.22	0.90	
1950	13.4	33.1	57.5	75.4	123.7	275.9	251.8	336.7	137.0	113.3	17.2	10.8	1448.4	46.5	256.6	1003.4	141.8	10.83	336.67	120.70	111.61	0.92	
1951	6.2	11.3	59.1	116.7	102.5	287.1	346.1	250.0	144.9	108.2	34.2	7.0	1473.2	17.5	278.2	1028.0	149.5	6.22	346.09	122.77	115.01	0.94	
1952	5.7	15.8	77.5	84.8	183.1	211.7	268.9	342.0	293.4	125.1	24.5	6.7	1639.2	21.5	345.5	1115.9	136.3	5.71	341.98	136.60	120.43	0.88	
1953	17.4	21.3	127.1	73.7	179.4	206.2	352.3	157.7	222.7	81.1	3.9	9.9	1452.8	38.8	380.2	938.9	94.9	3.92					

**Table 8.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the Indus river catchment areas

YEAR	Indus												ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	47.6	33.9	35.0	19.7	54.5	13.8	80.1	75.5	23.3	5.8	2.3	5.4	396.8	81.4	109.2	192.7	13.5	2.27	80.08	33.07	26.61	0.80
1902	4.6	8.4	36.3	35.2	26.6	42.6	59.8	39.4	35.6	11.0	9.4	4.6	333.5	13.0	98.1	197.3	25.0	4.62	59.77	27.79	20.22	0.73
1903	30.4	13.3	64.2	24.5	28.1	10.3	110.0	78.5	33.3	4.2	4.6	3.2	454.6	43.7	126.6	252.0	22.0	4.20	109.98	37.89	35.39	0.93
1904	46.8	9.8	79.8	19.3	25.9	18.0	61.4	65.1	28.9	12.0	10.1	22.1	399.6	56.6	125.0	173.3	44.6	9.82	70.84	33.30	23.94	0.72
1905	55.4	37.9	67.2	22.3	29.2	14.5	64.2	38.3	73.1	2.8	2.3	37.5	444.7	93.3	118.6	190.1	42.8	2.29	73.12	37.06	24.22	0.65
1906	14.2	85.4	50.3	19.1	21.2	26.2	55.6	96.2	80.3	3.2	2.1	14.9	468.8	99.6	90.6	258.3	20.3	2.11	96.21	39.06	33.36	0.85
1907	33.4	63.7	96.3	51.3	16.6	27.0	51.5	115.6	7.7	5.2	2.3	3.2	433.8	97.1	124.2	201.8	10.7	2.31	115.62	36.15	33.61	0.93
1908	36.1	22.5	14.8	69.4	20.8	19.0	124.5	184.2	46.4	3.9	3.3	20.1	564.9	58.5	105.0	374.1	27.3	3.29	184.19	47.07	54.82	1.16
1909	27.3	45.0	19.5	36.0	11.9	39.4	126.1	82.7	81.9	7.7	2.5	35.5	515.4	72.3	67.3	330.1	45.7	2.49	126.13	42.95	36.65	0.88
1910	46.5	25.0	25.5	36.6	16.0	61.7	97.4	129.4	31.1	16.3	2.8	20.2	508.4	71.5	78.0	319.6	39.3	2.76	129.37	42.37	37.14	0.88
1911	99.1	1.38	125.0	22.6	11.7	30.3	28.1	47.0	38.8	9.5	28.1	10.0	464.0	112.9	159.4	144.1	47.6	9.45	124.99	36.67	36.61	0.95
1912	55.0	19.5	24.1	38.8	27.3	12.2	97.1	91.7	22.0	3.6	8.4	12.7	412.5	74.5	90.2	223.0	24.8	3.64	97.08	34.38	31.30	0.91
1913	13.0	47.3	35.3	28.5	31.2	49.5	70.7	60.5	23.9	4.0	9.6	20.9	394.4	60.3	95.0	204.7	34.5	4.03	70.88	32.87	20.67	0.63
1914	17.8	59.9	42.8	51.4	25.4	37.6	166.6	66.4	71.0	42.1	16.6	22.3	619.9	77.6	119.6	341.6	81.0	16.63	166.59	51.66	40.64	0.79
1915	12.0	62.1	47.0	51.5	10.7	18.5	42.1	62.6	31.6	13.4	2.3	6.1	390.0	74.1	109.2	154.8	21.8	2.25	62.38	30.00	22.24	0.74
1916	14.8	35.4	21.6	27.6	23.1	44.1	130.1	43.1	10.1	12.5	3.6	3.6	442.6	50.3	72.4	339.4	21.6	2.61	150.38	40.33	43.38	1.08
1917	14.5	11.2	36.3	40.4	34.1	54.0	83.7	155.0	148.6	44.7	2.1	20.1	642.6	57.2	110.8	439.3	66.7	2.07	154.98	53.55	50.34	0.94
1918	8.7	11.7	84.9	59.7	6.6	25.6	33.2	96.2	14.3	4.4	10.9	20.5	332.7	20.3	147.2	129.3	35.9	4.43	84.90	27.73	25.27	0.91
1919	51.3	24.4	40.0	24.9	20.0	19.7	110.2	106.0	25.9	2.0	3.9	41.4	469.8	75.8	84.9	261.8	47.4	2.02	110.25	39.10	35.21	0.90
1920	29.2	29.7	64.7	27.7	32.2	23.3	74.5	38.4	16.0	5.7	2.5	6.5	330.4	58.9	124.5	152.2	14.7	2.49	74.52	29.20	22.15	0.76
1921	23.6	13.4	14.9	17.4	12.6	24.6	85.5	95.4	47.7	18.9	4.9	52.6	411.5	37.0	44.9	253.2	76.4	4.94	95.39	34.29	29.77	0.87
1922	24.3	30.2	28.3	20.3	17.5	30.6	83.4	77.6	91.2	6.4	2.8	19.4	432.0	54.4	66.1	282.7	28.7	2.83	91.20	36.00	30.33	0.84
1923	43.2	56.1	30.1	19.3	35.9	12.0	84.0	133.4	18.8	16.7	4.2	18.0	471.4	99.3	83.3	248.1	38.8	4.17	133.38	39.29	36.94	0.94
1924	26.8	59.2	29.9	30.6	48.6	6.5	89.8	73.2	121.5	10.1	6.2	31.2	533.7	86.0	109.1	291.1	47.5	6.19	121.53	44.47	35.71	0.80
1925	17.4	24.3	17.3	25.6	38.9	36.2	117.3	67.0	18.5	15.1	18.6	2.4	418.7	41.7	81.9	259.0	36.1	2.42	117.26	34.89	31.70	0.91
1926	14.7	20.8	73.5	44.5	47.5	9.7	81.3	137.9	45.6	2.3	6.4	11.5	495.7	35.5	165.5	274.5	20.2	2.34	137.90	41.31	40.22	0.97
1927	11.6	38.4	28.5	22.0	22.1	13.6	111.7	81.2	18.6	7.1	5.2	24.4	384.3	50.0	72.5	225.2	36.7	5.17	111.74	32.03	32.14	1.00
1928	26.3	55.9	45.4	30.9	10.6	14.4	62.1	78.4	31.3	2.8	32.5	31.2	421.7	82.2	86.9	186.1	66.6	2.83	78.39	35.15	22.03	0.63
1929	25.2	23.8	19.4	19.7	19.4	21.4	124.4	112.1	10.1	12.5	3.0	50.9	442.0	49.0	92.6	268.0	66.4	3.05	124.40	36.83	39.81	1.08
1930	39.6	29.0	35.9	61.0	17.5	29.0	132.6	51.1	23.0	9.1	3.7	7.2	438.7	68.6	114.4	235.7	19.9	3.88	132.62	36.36	39.41	0.95
1931	31.5	45.6	24.0	21.5	38.8	11.5	83.3	111.9	33.1	23.1	4.1	4.8	433.3	77.2	84.3	239.8	32.0	4.11	111.90	36.11	31.98	0.89
1932	24.8	19.5	45.9	11.4	22.0	16.4	119.6	88.9	23.4	4.4	2.3	22.1	400.7	44.3	79.3	248.3	28.9	2.33	119.55	33.39	35.90	1.06
1933	22.1	32.2	52.1	34.6	19.7	34.2	92.4	136.3	58.6	13.8	4.2	5.4	505.5	54.3	106.4	321.5	23.3	4.15	136.29	42.12	38.70	0.92
1934	25.8	11.4	40.5	28.3	21.0	33.1	80.1	90.5	13.0	2.9	2.7	27.9	377.1	37.2	89.8	161.7	33.4	2.65	90.47	41.43	27.78	0.88
1935	54.1	41.3	33.5	54.3	10.4	11.0	89.2	78.8	25.7	11.9	10.4	7.4	428.0	95.4	98.2	204.6	29.7	7.39	89.17	35.66	28.28	0.79
1936	14.2	62.0	60.4	28.2	15.3	54.4	80.9	79.6	30.1	6.0	13.3	41.7	486.3	76.2	104.0	245.1	61.0	6.00	80.00	40.52	26.52	0.65
1937	19.3	69.1	32.8	43.5	13.5	23.7	105.5	41.2	36.7	16.2	4.5	30.0	436.1	88.4	89.8	207.2	50.7	4.46	105.54	36.34	27.60	0.76
1938	58.0	40.1	38.8	25.4	7.7	32.6	66.8	63.2	9.0	6.5	4.0	11.5	383.5	98.1	71.9	191.5	22.0	4.00	66.79	31.96	24.15	0.76
1939	21.4	83.1	80.1	24.2	10.2	30.0	57.7	38.3	21.8	12.3	2.3	4.1	385.5	104.5	114.5	147.8	18.8	2.28	83.10	32.13	27.68	0.86
1940	46.0	31.7	41.6	24.2	21.0	37.1	67.2	88.3	19.2	3.9	3.1	5.9	389.1	77.7	86.8	211.8	12.9	3.13	88.30	32.43	25.90	0.80
1941	25.0	16.3	32.6	21.4	24.1	31.5	59.7	60.4	41.9	4.9	4.4	22.4	344.5	41.3	78.1	193.3	31.6	4.39	60.35	28.71	18.09	0.63
1942	59.8	72.9	18.1	29.7	25.8	26.2	123.5	102.0	37.0	5.8	4.9	23.8	549.5	132.7	72.6	368.8	34.5	4.92	72.32	45.79	37.92	0.83
1943	66.7	11.4	45.4	35.4	28.2	15.6	85.2	75.9	32.9	2.2	3.5	7.2	409.6	78.2	109.0	209.6	12.9	2.22	85.17	34.13	28.79	0.84
1944	39.1	59.7	44.3	39.5	15.4	19.9	117.8	139.5	25.7	10.2	8.0	21.9	541.1	98.8	99.2	302.9	40.1	7.97	139.55	45.09	42.11	0.93
1945	43.9	10.2	42.1	34.1	15.2	23.1	99.1	69.2	75.8	11.3	5.5	5.5	435.0	54.1	91.3	287.3	22.3	5.46	99.12	36.25	30.92	0.85
1946	17.4	28.7	24.9	13.4	17.5	40.7	71.2	81.7	10.8	15.1	15.3	21.0	357.6	46.1	55.8	204.3	51.4	10.81	81.67	29.80	23.33	0.78
1947	20.6	29.7	28.6	5.6	17.7	10.4	53.3	76.5	92.1	5.8	3.0	20.7	364.0	50.3	51.9	232.3	29.5	3.00	92.15	30.33	28.89	0.95
1948	16.2	57.7	80.7	26.1	8.8	20.5	112.5	104.5	25.4	4.6	1.8	27.7	486.5	73.8	115.5	262.9	34.2	1.84	112.55	40.44	38.82	0.96
1949	22.4	51.8	56.3	18.2	19.3	27.1	99.0	62.2	38.5	6.9	3.6	6.6	413.9	74.2	93.8	226.9	19.0	3.58	99.01	34.59	28.90	0.82
1950	68.2	23.2	41.9	32.1	21.3	16.1	104.9	94.5	100.9	3.9	2.0	2.7	511.6	91.4	95.2	316.3	8.6	1.98	104.89	42.63	39.33	0.92
1951	27.2	21.5	46.9	28.9	37.9	14.1	49.3	75.1	17.2	6.4	19.2	5.9	351.6	48.7	115.7	155.7	31.5	5.94	75.10	29.30	30.39	0.70
1952	21.7	34.7	55.3	14.5	17.2	33.2	85.0	93.9	7.5	2.2	1.9	12.1	379.0	56.4	87.0	219.6	16.1	1.86	55.90	31.59	31.07	0.98
1953	47.6	21.5	28.5	25.5	18.4	30.6	110.9	107.6	33.0	7.5	3.0	13.9	446.2	69.0	70.7	282.1	24.4	3.00	110.92	37.19	35.72	0.96
1954	57.4	78.0	27.6	13.2	16.1	16.1	65.2	81.3	31.2	15.3	3.7	6.6	489.3	135.4	62.6	251.3	29.4	3.74	62.39	39.11	32.90	0.84
1955	24.9	10.0	54.1	20.4	42.8	18.8	63.1	146.3	59.1	65.4	0.9	13.2	519.1	34.9	117.5	287.5	79.5	0.91	146.34	43.26	39.48	0.91
1956	30.5	22.6	79.3	41.9	5.5																	

**Table 9.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the Ganga river catchment areas

YEAR	Ganges												ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	57.3	31.4	18.4	8.8	36.5	54.9	257.5	368.1	136.2	9.0	2.9	7.5	988.5	88.7	63.6	816.8	19.4	2.91	968.11	82.38	116.05	1.41
1902	8.4	8.1	20.3	18.5	38.4	73.9	390.3	208.5	249.1	21.5	6.2	4.4	1047.7	16.4	77.2	921.9	32.1	4.42	390.31	87.30	126.05	1.44
1903	13.7	5.8	13.7	9.2	35.5	108.9	178.0	380.3	213.0	152.1	1.6	4.6	1086.3	19.5	60.4	838.1	158.3	1.80	300.25	91.38	113.93	1.25
1904	10.8	8.0	29.2	11.0	61.8	145.7	362.2	339.1	90.8	45.4	15.7	19.9	1189.7	18.9	102.0	957.6	81.0	6.05	362.20	96.64	130.94	1.35
1905	27.8	30.9	29.7	16.9	42.0	50.1	288.1	305.5	184.9	8.7	1.8	7.2	993.5	58.7	88.6	828.6	17.6	1.77	305.51	82.79	111.01	1.34
1906	9.9	61.9	19.7	7.2	28.8	158.0	344.4	313.8	211.4	9.9	2.1	5.5	1170.7	71.9	55.7	1025.6	17.5	2.00	344.38	97.56	106.93	1.30
1907	10.0	65.6	43.4	30.4	30.6	99.2	218.9	316.7	60.5	2.9	2.7	3.5	885.1	78.2	104.4	695.4	9.1	2.66	316.69	73.76	97.53	1.32
1908	21.0	25.8	13.6	11.0	28.7	97.6	329.0	316.8	98.7	10.6	2.0	4.3	999.1	46.8	53.3	862.1	16.9	1.96	336.77	81.59	121.88	1.49
1909	17.8	11.5	6.7	72.9	20.2	267.2	343.1	293.2	111.1	12.7	1.6	27.4	1185.5	29.3	99.9	1014.6	41.7	1.61	343.09	98.79	127.00	1.29
1910	9.8	8.7	11.5	12.3	36.1	195.5	293.8	330.6	218.6	101.6	18.4	4.2	1241.1	18.5	59.9	1038.5	12.4	4.21	330.60	103.43	122.73	1.19
1911	48.5	4.2	44.2	13.1	27.7	173.7	145.3	301.5	275.2	59.8	38.1	3.1	1134.5	52.8	85.0	895.7	101.0	3.05	301.45	94.54	104.86	1.11
1912	19.3	13.9	19.3	22.0	33.8	87.5	337.5	291.6	141.8	8.2	43.4	5.0	1023.3	33.2	75.1	838.3	56.7	4.99	337.46	85.27	114.39	1.34
1913	3.0	45.0	33.7	9.3	75.8	253.3	214.5	212.9	98.8	19.5	3.0	24.4	993.2	47.9	118.8	779.5	46.9	2.96	253.29	82.76	91.97	1.11
1914	2.3	25.0	53.1	26.3	57.6	87.7	403.3	344.5	151.6	8.7	9.4	3.7	1153.2	27.3	117.0	987.1	21.8	2.35	403.27	96.10	137.21	1.43
1915	16.2	36.8	46.0	16.7	41.1	109.3	264.8	374.8	201.9	66.9	9.3	5.4	1209.2	73.0	103.8	950.8	81.6	5.45	374.84	100.76	118.18	1.17
1916	2.2	21.3	6.5	21.8	24.7	255.6	329.1	345.7	224.7	76.1	8.3	3.0	1361.1	23.5	53.0	1192.4	67.1	2.24	329.10	88.49	143.24	1.27
1917	7.3	29.8	23.8	20.8	85.8	216.5	364.0	368.8	287.2	86.3	1.6	7.2	1448.4	37.1	129.6	1186.6	95.1	1.64	364.05	120.70	136.54	1.31
1918	5.2	4.0	20.1	27.0	32.9	172.5	166.9	315.6	111.8	3.8	7.5	5.3	892.6	9.2	100.0	766.9	16.6	3.75	315.64	74.38	98.82	1.33
1919	63.5	14.3	13.9	20.0	52.3	137.4	300.8	352.2	170.6	36.5	7.9	9.6	1219.3	77.8	66.6	1021.0	57.9	7.93	52.30	90.78	101.11	1.29
1920	7.2	14.4	28.6	9.6	37.2	142.2	303.7	201.8	120.7	4.7	1.6	3.2	965.0	21.6	75.4	858.4	9.5	1.58	303.71	80.42	118.90	1.48
1921	42.8	4.3	12.2	20.3	18.9	161.6	247.3	392.6	234.1	18.1	1.7	3.8	1157.8	47.1	51.4	1035.7	23.6	1.68	392.63	96.48	130.61	1.35
1922	29.3	8.2	7.5	11.7	18.3	185.2	303.1	363.1	247.5	6.9	8.9	20.3	1300.0	37.6	37.5	1188.8	36.1	6.89	303.10	108.34	148.64	1.37
1923	9.6	45.0	9.1	11.3	23.2	75.0	337.1	347.3	197.3	47.1	3.6	19.6	1125.2	54.6	43.6	956.7	70.2	3.60	347.29	93.76	127.49	1.36
1924	17.0	18.8	9.4	12.9	19.0	84.0	441.1	305.2	324.0	54.2	21.4	19.7	1326.6	35.8	41.3	1154.3	95.3	4.93	441.07	110.55	153.18	1.39
1925	9.3	5.0	7.6	33.7	36.1	191.7	383.6	261.0	150.7	11.7	23.3	2.9	1115.5	14.3	77.4	966.9	36.9	2.91	33.70	92.96	125.86	1.35
1926	15.1	9.4	57.3	22.8	45.2	36.8	364.2	357.7	228.1	27.8	4.6	5.5	1174.5	24.5	125.3	986.8	38.0	4.39	364.20	97.88	136.85	1.40
1927	8.6	36.4	26.6	13.0	36.6	96.7	310.3	329.5	150.1	50.1	65.1	12.9	1136.0	45.0	76.2	886.7	12.8	6.84	329.53	94.67	127.72	1.19
1928	28.4	64.4	9.0	20.4	33.9	130.9	336.5	199.5	63.9	79.7	7.1	21.3	965.1	92.8	63.3	730.8	108.2	7.12	336.52	82.93	97.79	1.18
1929	32.1	9.0	17.8	20.2	21.8	141.3	316.5	399.9	78.4	82.0	11.9	42.8	1079.5	41.1	59.8	845.3	126.7	1.87	316.53	88.49	111.69	1.25
1930	18.2	19.4	11.5	15.0	27.1	93.7	343.8	250.3	172.4	18.7	10.3	12.8	1038.9	37.6	58.5	899.2	62.0	1.86	250.30	85.67	115.71	1.31
1931	3.5	35.9	14.9	8.4	35.8	56.7	317.3	304.7	260.2	92.4	7.5	3.8	1141.2	39.4	59.1	938.9	103.8	3.49	317.27	95.10	123.37	1.30
1932	2.3	10.5	14.7	15.0	25.6	93.0	255.1	296.1	203.0	15.3	3.1	15.0	946.6	12.8	55.3	817.1	61.4	2.28	25.60	78.88	101.66	1.29
1933	20.6	23.2	11.0	48.4	73.4	206.2	304.8	312.9	197.1	82.5	5.8	4.3	1200.2	43.8	132.8	1021.0	92.6	4.34	312.90	107.52	116.43	1.08
1934	27.5	10.9	17.2	11.0	21.4	172.4	343.2	347.9	225.6	21.4	8.8	13.2	1220.4	38.4	49.6	1089.1	43.4	8.80	347.92	101.70	134.09	1.32
1935	29.4	21.6	9.2	17.5	16.4	77.4	331.0	304.2	225.0	6.8	3.3	15.5	1057.3	51.0	43.0	937.5	25.7	3.34	330.97	88.11	123.51	1.40
1936	6.2	25.6	18.8	15.8	57.5	239.3	420.5	306.4	252.5	27.9	22.0	25.4	1417.9	31.8	92.0	1218.8	75.3	6.15	420.51	118.16	144.83	1.23
1937	3.1	60.4	7.5	20.8	44.9	133.4	323.4	318.4	148.4	74.4	2.8	12.5	1150.1	63.5	73.2	923.7	89.7	2.75	323.44	95.84	115.79	1.21
1938	33.5	22.3	7.5	9.6	67.8	284.7	351.5	321.8	137.0	30.2	2.3	3.0	1271.2	55.8	84.9	1095.0	35.5	2.31	351.50	105.93	134.69	1.27
1939	13.4	29.2	16.6	8.5	24.7	162.5	303.8	225.4	196.4	26.7	1.7	3.0	1012.0	42.6	49.8	888.2	31.4	1.73	303.82	84.33	106.81	1.27
1940	15.8	39.1	11.6	14.2	29.6	104.6	317.9	313.6	105.6	10.3	4.0	20.6	1016.9	54.9	85.4	841.7	34.9	3.97	317.91	84.74	113.01	1.33
1941	26.7	15.8	9.5	10.6	30.2	136.6	172.2	314.0	129.4	16.4	3.4	5.9	890.7	42.5	70.3	752.2	25.7	3.37	314.00	74.22	96.08	1.29
1942	47.2	30.7	18.2	26.4	21.1	142.0	329.1	345.7	221.2	4.1	1.8	15.3	1270.6	97.9	65.6	1066.0	21.1	1.75	329.10	105.89	135.82	1.28
1943	38.1	19.4	11.5	16.6	29.9	127.8	229.4	325.8	172.4	18.7	10.3	12.8	1152.0	51.7	78.1	998.6	62.7	1.76	325.80	96.00	111.98	1.34
1944	30.7	39.5	62.7	27.6	22.9	125.0	325.7	303.0	142.8	38.4	2.5	5.8	1126.6	70.2	113.2	896.4	46.7	2.49	325.65	93.88	111.74	1.19
1945	30.8	8.5	10.7	27.5	27.1	133.9	305.6	294.6	258.8	76.9	1.7	4.9	1190.9	92.2	65.3	983.0	83.4	1.68	305.62	92.24	117.29	1.18
1946	1.8	27.1	9.5	39.8	59.3	163.4	371.5	326.8	148.9	71.2	30.0	13.1	1262.3	28.9	108.6	1010.6	114.2	1.75	371.49	105.20	125.40	1.19
1947	18.2	14.5	21.1	9.4	32.9	84.9	347.2	275.9	259.7	33.1	1.9	7.9	1106.7	32.7	63.4	967.7	42.9	1.90	347.23	92.23	125.26	1.36
1948	27.3	21.4	21.7	16.5	36.3	98.4	338.4	382.2	249.8	54.6	33.1	3.6	1303.2	48.6	74.5	1088.8	91.2	3.60	382.24	108.60	138.98	1.28
1949	7.7	44.2	11.1	25.4	52.5	95.4	344.7	306.4	231.6	61.9	2.5	3.3	1186.8	51.9	89.0	978.1	67.7	2.90	344.70	98.90	123.39	1.25
1950	22.8	13.2	29.7	7.0	30.1	157.6	321.6	357.4	133.2	5.8	1.5	13.4	1093.4	36.0	66.9	969.9	20.7	1.45	321.64	91.12	126.81	1.39
1951	18.6	13.7	27.6	14.2	24.5	120.3	210.8	279.7	146.3	16.7	15.4	23.3	890.1	32.2	66.4	757.1	34.4	2.30	279.74	74.18	99.01	1.25
1952	8.2	20.3	37.2	16.1	30.8	217.5	274.6	356.9	125.0	8.0	3.0	7.4	1105.0	28.5	84.1	974.1	18.4	3.00	356.92	92.08	123.29	1.34
1953	37.6	6.7	14.1	15.2	30.5	129.1	421.3	265.4	183.3	8.1	1.6	5.2	1118.0	44.3	59.8	990.0	14.9	1.00	421.27	93.16	133.80	1.44
1954	29.6	38.6	9.6	7.0	21.5	104.9	324.4	296.6	214.9	105.5	1.5	3.5	1091.8	68.2	38.2	939.9	45.5	1.51	324.38	90.98	118.82	1.31
1955	38																					

**Table 10.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the Mahi river catchment areas

YEAR	Mahi												JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV		
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC											
1901	2.7	0.0	1.1	0.7	4.6	37.7	178.8	212.0	12.9	4.3	0.1	0.0	454.9	2.7	6.4	441.4	4.4	0.01	211.99	37.91	74.66	1.97	
1902	5.7	0.0	0.1	1.7	5.0	20.1	214.5	235.0	289.5	9.2	0.3	12.0	793.4	5.8	6.8	759.3	21.5	0.01	289.46	66.12	110.12	1.67	
1903	0.4	0.2	2.0	0.0	9.1	21.2	341.4	183.3	253.9	1.7	0.1	0.0	813.2	0.6	11.1	799.7	1.8	0.03	241.37	67.77	120.61	1.78	
1904	0.7	10.9	17.0	0.0	30.0	71.0	178.7	59.3	100.6	1.3	0.2	3.8	482.7	11.6	96.1	408.7	5.3	0.04	178.73	40.22	54.91	1.37	
1905	0.1	0.3	2.6	0.1	1.1	26.0	421.7	40.7	120.2	0.4	0.1	0.1	613.3	0.4	3.7	608.6	0.6	0.06	421.68	51.11	121.83	1.38	
1906	0.0	16.1	0.1	0.0	0.1	105.1	297.4	255.4	205.9	1.6	0.1	0.2	882.0	16.1	0.2	863.8	1.9	0.00	297.41	73.50	113.84	1.55	
1907	0.1	7.3	0.1	3.5	3.0	21.4	241.3	308.5	19.8	0.4	0.1	0.0	605.5	7.4	6.6	591.0	0.5	0.04	308.46	50.46	106.06	2.10	
1908	6.2	0.3	1.6	0.0	0.2	69.8	351.0	296.4	30.5	0.9	0.1	0.0	727.0	6.5	1.9	717.7	1.0	0.04	350.99	60.59	119.07	1.97	
1909	0.0	0.3	0.2	16.3	2.8	122.4	206.1	269.8	114.1	1.6	0.1	4.8	828.4	0.3	19.3	802.6	6.5	0.00	206.07	69.03	109.36	1.58	
1910	0.3	0.0	0.1	0.1	0.2	259.9	277.1	326.8	67.0	29.5	11.4	0.0	972.6	0.4	0.5	930.8	41.0	0.01	326.82	81.05	127.13	1.87	
1911	1.6	0.2	11.6	0.0	0.1	142.0	48.9	60.4	88.7	1.7	8.3	0.1	363.6	1.7	11.7	340.0	10.1	0.03	142.05	30.30	45.99	1.52	
1912	0.2	0.0	0.1	0.3	1.7	73.5	384.1	275.7	27.3	1.5	24.9	0.0	789.2	0.2	2.1	760.5	26.4	0.02	384.08	65.77	127.34	1.94	
1913	0.0	0.0	0.1	0.0	43.9	294.7	505.4	204.0	130.0	0.5	0.5	0.8	1150.1	0.0	44.1	1104.1	1.9	0.00	505.41	95.84	158.32	1.65	
1914	0.0	0.7	0.1	0.0	7.3	139.2	310.2	113.3	215.4	9.9	6.0	0.0	802.2	0.7	7.5	778.1	15.9	0.00	310.19	66.85	105.05	1.77	
1915	20.1	11.7	14.8	0.9	3.8	78.3	62.0	644.3	129.6	30.3	5.5	0.6	59.8	31.8	19.5	224.9	163.7	0.00	163.20	42.48	51.23	1.21	
1916	0.0	0.1	0.1	0.1	8.4	176.3	156.5	434.6	141.9	2.8	22.1	10.8	0.0	951.4	0.1	8.6	909.7	33.0	0.00	434.65	79.28	131.42	1.66
1917	2.7	11.5	0.7	4.9	105.1	163.7	155.0	269.6	362.5	170.4	0.1	0.0	1286.1	14.2	110.7	990.8	170.5	0.03	362.50	107.18	124.79	1.18	
1918	0.0	0.0	0.3	0.0	9.8	45.1	48.6	220.5	15.1	0.5	1.0	0.0	341.1	0.1	10.2	339.3	1.6	0.01	220.48	28.42	62.98	2.22	
1919	5.7	0.0	0.2	1.1	7.0	123.7	218.6	534.1	75.9	12.5	25.4	1.5	1005.7	5.7	8.3	952.3	39.4	0.01	534.11	83.81	156.88	1.87	
1920	16.5	0.3	0.2	0.0	71.6	186.2	276.7	83.3	35.0	0.5	0.1	0.0	670.5	16.8	71.9	581.2	0.6	0.03	276.69	55.87	89.10	1.59	
1921	2.7	0.0	0.1	0.0	0.1	22.8	204.6	180.2	409.7	0.5	0.1	0.0	910.9	2.7	0.3	907.4	0.6	0.00	409.73	75.91	140.94	1.86	
1922	7.5	0.0	0.1	0.0	2.2	96.9	246.1	116.7	296.7	0.7	6.8	1.8	777.7	7.5	2.4	758.5	9.4	0.02	296.67	64.81	105.53	1.63	
1923	0.0	1.1	6.1	4.5	4.7	1.1	286.2	177.5	113.7	0.9	0.1	0.1	596.0	1.1	15.3	578.5	1.0	0.00	286.24	49.67	93.82	1.89	
1924	2.2	0.3	0.2	0.0	3.1	76.7	274.6	262.7	173.7	72.5	0.1	5.1	871.2	2.5	3.3	787.7	77.7	0.05	274.57	72.00	105.53	1.45	
1925	0.0	0.0	0.1	0.0	17.6	193.7	181.3	56.8	17.7	1.9	26.0	0.1	495.2	0.0	17.8	449.6	27.9	0.00	193.74	41.27	70.38	1.71	
1926	3.7	0.1	1.1	1.5	4.4	14.4	289.9	338.0	203.6	0.5	0.1	1.0	838.3	3.8	7.0	846.0	1.6	0.09	338.04	71.53	127.43	1.78	
1927	0.0	3.2	0.1	0.2	4.4	68.6	678.1	206.5	104.9	24.5	23.0	12.2	1125.8	3.2	4.8	1038.1	59.7	0.00	678.13	93.82	195.96	2.07	
1928	0.0	1.2	0.1	0.0	0.2	56.0	336.2	335.4	102.9	10.9	30.7	5.5	6.1	874.5	1.2	3.4	836.0	42.3	0.00	336.20	72.88	126.69	1.74
1929	2.5	0.2	0.3	2.3	2.6	148.8	300.2	171.4	25.9	1.3	0.2	2.6	638.2	2.7	5.2	648.3	4.0	0.19	300.21	54.85	98.28	1.79	
1930	1.5	0.1	0.5	0.1	9.6	99.0	462.0	178.4	155.3	71.9	0.2	0.1	978.8	1.6	10.2	894.8	72.2	0.08	462.02	81.86	136.40	1.67	
1931	0.0	0.2	0.2	0.1	1.5	17.2	231.7	570.8	116.2	117.2	3.2	3.3	1061.7	0.2	1.8	936.0	123.7	0.02	570.84	88.48	168.73	1.91	
1932	0.0	0.0	4.4	0.1	0.6	46.5	363.2	101.9	158.7	10.0	0.2	0.0	685.7	0.1	5.1	670.3	10.2	0.03	363.16	57.14	108.95	1.91	
1933	0.0	2.6	0.6	6.8	28.0	154.6	265.0	448.6	271.2	3.8	5.7	4.0	1190.9	2.7	35.5	1139.3	13.5	0.03	448.59	99.24	151.23	1.52	
1934	0.3	0.0	0.4	0.4	0.3	107.7	166.0	393.4	177.8	0.6	23.4	0.0	870.4	0.3	1.1	845.0	24.0	0.04	393.42	72.54	121.72	1.68	
1935	3.3	0.1	0.2	1.0	0.6	61.7	261.6	103.1	219.8	18.0	0.8	1.5	671.6	3.4	1.8	646.1	20.2	0.08	261.56	55.97	92.40	1.65	
1936	1.1	1.3	5.8	0.1	1.0	147.1	78.6	26.7	170.7	1.0	39.0	0.2	472.6	2.4	6.9	423.1	40.1	0.05	170.66	39.38	60.76	1.54	
1937	0.1	3.7	0.4	0.4	1.5	202.3	524.1	25.1	253.1	5.9	0.2	0.5	1017.1	3.7	2.3	1004.4	6.6	0.06	524.06	84.76	163.90	1.93	
1938	0.1	0.0	0.3	0.0	30.0	290.6	287.8	121.2	24.1	22.2	0.5	0.1	747.1	0.2	30.4	693.8	22.8	0.04	287.78	62.26	104.83	1.68	
1939	0.1	1.0	3.7	0.1	0.3	19.4	127.8	268.6	147.7	2.2	0.2	0.1	571.0	1.1	4.1	563.4	2.5	0.05	268.58	47.38	87.12	1.83	
1940	11.7	0.7	11.5	2.2	1.6	120.7	218.2	268.7	74.7	25.5	22.8	0.0	759.5	12.4	15.3	852.4	49.4	0.04	268.55	63.29	92.16	1.46	
1941	1.6	15.6	1.2	0.4	1.8	12.6	353.0	346.4	63.9	1.0	0.2	0.3	988.0	1.2	3.4	936.0	1.5	0.19	346.41	83.17	177.01	2.13	
1942	11.1	11.9	0.3	0.0	3.1	12.9	381.5	360.3	139.1	0.5	0.2	0.1	1008.1	23.0	3.5	980.8	0.9	0.04	381.50	84.01	142.27	1.69	
1943	1.1	0.0	0.3	0.6	7.7	116.6	431.7	88.8	141.9	11.8	0.2	0.0	800.5	1.1	8.7	778.7	12.0	0.03	431.68	66.71	126.02	1.82	
1944	15.4	0.1	9.0	1.8	1.7	114.2	518.9	594.2	75.6	16.8	0.2	0.0	1348.0	15.5	12.4	1302.9	17.1	0.05	594.21	112.33	211.11	1.88	
1945	1.5	0.0	0.3	3.8	0.9	180.7	434.0	183.4	278.1	1.5	0.2	0.0	1074.6	1.6	5.0	1096.3	1.7	0.03	434.00	89.55	143.73	1.60	
1946	0.0	2.5	0.3	1.3	2.8	244.3	289.9	448.2	117.2	2.4	29.4	13.7	1152.6	2.6	4.4	1100.1	45.5	0.03	448.21	96.05	150.40	1.73	
1947	1.0	0.1	0.4	8.0	0.2	6.3	192.7	271.3	256.2	14.0	1.0	1.0	752.1	1.1	8.6	726.4	16.0	0.07	271.26	62.68	108.50	1.57	
1948	21.4	2.6	0.5	0.4	0.2	103.6	195.7	184.1	91.3	10.6	18.6	0.0	629.0	24.0	1.1	574.7	29.2	0.03	195.67	52.42	73.35	1.40	
1949	0.0	0.1	0.3	0.0	7.9	34.2	259.1	153.7	235.7	13.7	4.3	0.0	709.1	0.2	8.3	682.7	18.0	0.02	259.08	59.09	98.99	1.66	
1950	0.0	0.0	0.3	0.0	0.9	13.9	620.3	114.2	414.1	0.9	0.2	0.1	1164.9	0.1	1.2	1162.5	1.1	0.03	620.28	97.08	203.69	2.10	
1951	0.1	0.1	0.6	0.0	5.5	66.2	229.1	130.9	18.0	3.4	3.8	0.0	457.6	0.2	6.1	444.1	7.1	0.02	229.05	38.13	71.93	1.89	
1952	0.0	0.2	0.4	0.0	0.2	81.6	647.3	167.7	24.9	0.5	0.1	0.3	923.1	0.2	0.6	921.4	0.8	0.02	647.28	76.93	186.68	2.43	
1953	24.1	0.0	0.4	0.1	0.3	130.7	130.0	390.6	77.4	3.2	0.2	0.0	777.1	24.1	0.7	748.8	3.4	0.02	390.64	64.26	116.17	1.79	
1954	0.1	5.9	6.4	0.4	0.2	71.7	244.9	137.2	384.8	24.5	0.4	0.0	1112.0	0.1	6.6	1048.6	53.0	0.01	384.84	69.69	126.37	1.82	
1955	2.3	0.7	0.5	0.0	1.3	118.4	44.2	337.9	318.9	71.2	0.4	0.0	915.7	3.0	1.8	839.3	71.8	0.03	337.89	76.31	128.25	1.68	
1956	0.4	0.3	0.8	0.1	18.9	95.3	381.4	190.7	105.2	149.2	0.4	2.4	944.9	0.7	19.7	772.6	151.9	0.06	381.38	78.74	116.85	1.48	
1957	3.4																						

Characteristics of long-term variability of precipitation in selected river catchment areas in India ..

**Table 11.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Narmada river catchment areas

YEAR	Narmada												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC						ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC
1901	38.1	18.4	12.8	7.0	4.3	68.0	306.8	455.9	1120.0	11.5	0.1	0.7	1035.5	56.5	24.0	942.7	12.3	0.09	455.94	86.29	145.21	1.08
1902	12.0	2.3	0.3	4.4	3.0	36.6	291.5	216.7	223.2	33.0	26.9	17.8	868.2	14.8	77.7	768.1	77.7	0.32	291.54	72.35	105.38	1.46
1903	6.0	1.8	0.4	1.2	4.31	64.5	312.9	318.3	286.5	74.0	0.1	0.7	1111.5	7.8	48.7	963.2	74.8	0.09	318.28	92.82	131.45	1.74
1904	1.4	27.6	26.0	0.3	10.8	106.7	228.0	166.9	208.7	23.5	0.2	6.0	805.1	28.9	37.1	707.3	31.8	0.22	227.98	67.09	86.18	1.28
1905	6.9	4.7	6.1	6.4	8.7	40.1	427.5	197.6	270.3	3.3	0.1	0.9	972.7	11.6	21.3	935.5	4.3	0.09	427.48	81.06	140.73	1.74
1906	7.1	15.7	22.1	0.3	1.9	249.8	388.5	257.4	210.7	3.9	0.3	6.4	1164.2	22.8	24.2	1106.4	10.7	0.28	388.51	97.01	138.29	1.43
1907	6.4	57.6	27	24.3	3.1	95.9	214.6	378.5	28.7	0.7	10.7	1.7	825.0	64.0	30.2	717.7	13.1	0.72	378.45	68.75	115.47	1.68
1908	9.6	8.4	15.9	2.2	1.2	143.6	410.6	378.4	87.4	8.7	0.4	5.8	1072.2	17.9	19.3	1020.1	14.9	0.41	410.61	89.35	149.18	1.67
1909	9.1	8.3	3.6	36.0	9.6	148.5	290.0	235.6	138.0	1.2	0.0	40.3	902.2	17.4	49.2	812.1	41.6	0.04	289.97	76.68	101.49	1.32
1910	6.2	6.4	0.4	1.8	2.1	213.0	244.1	333.2	251.7	61.7	50.1	1.0	1165.6	6.6	4.3	1041.9	112.8	0.42	333.22	97.14	125.20	1.29
1911	8.5	0.6	7.4	0.3	1.3	169.5	156.0	227.3	291.5	28.1	50.4	1.0	869.9	9.1	8.9	772.4	79.5	0.26	227.34	72.49	92.12	1.27
1912	5.6	36.7	0.2	2.6	2.1	46.4	353.9	345.5	1128.1	17.7	80.7	2.4	990.5	42.3	4.9	838.5	84.7	0.23	353.92	82.54	129.91	1.57
1913	1.2	30.8	11.6	0.3	24.0	204.4	361.5	307.3	88.7	2.4	0.4	15.1	1047.7	32.0	35.9	961.9	17.9	0.31	361.48	87.31	129.74	1.49
1914	0.2	4.8	36.1	11.0	14.7	147.6	402.3	246.4	205.0	8.0	6.2	3.9	1086.1	5.0	61.8	1001.3	18.1	0.21	402.31	90.51	131.37	1.45
1915	7.9	28.6	5.5	7.8	9.9	177.5	328.5	289.9	143.3	117.9	6.7	6.9	1238.5	36.6	70.3	970.2	131.4	6.67	328.54	100.70	120.24	1.19
1916	0.2	16.1	0.1	1.0	23.7	254.7	243.0	392.7	242.2	155.5	29.6	1.0	1359.8	16.3	24.8	1132.7	186.0	0.14	392.74	113.52	137.71	1.22
1917	3.9	34.6	12.5	3.1	58.1	223.3	319.4	370.3	318.6	89.4	0.0	2.7	1435.9	38.5	73.7	1231.6	92.1	0.05	370.28	119.66	145.04	1.21
1918	1.2	4.5	1.7	0.6	24.6	192.4	159.6	271.0	238.1	38.1	17.8	27.4	942.1	5.7	28.5	684.2	25.8	0.58	270.99	61.88	92.79	1.30
1919	87.9	17.3	6.7	10.1	12.7	242.4	320.9	576.7	88.3	78.4	25.8	2.7	1489.8	105.2	29.5	1228.3	106.8	2.70	576.73	122.48	175.10	1.43
1920	56.7	0.3	10.1	5.0	14.6	118.8	328.8	217.6	100.4	0.3	1.0	1.0	853.6	56.9	29.7	765.6	1.3	0.06	328.85	71.13	105.53	1.48
1921	14.3	1.7	0.1	0.3	0.1	237.2	241.4	261.2	289.8	0.4	0.1	1.0	1047.5	15.9	0.5	1029.6	1.5	0.05	289.79	87.30	126.32	1.35
1922	42.6	5.6	0.2	1.2	3.6	160.2	314.7	176.6	287.8	4.3	40.3	4.7	1041.8	48.2	5.0	936.2	49.3	0.22	314.71	86.81	117.47	1.43
1923	3.0	2.9	17.8	2.4	2.9	17.7	518.6	461.0	192.1	17.2	0.1	3.5	1239.1	5.9	23.1	1189.3	20.8	0.14	518.66	103.26	188.62	1.83
1924	24.3	2.8	3.3	1.2	1.9	46.0	390.1	363.5	221.3	86.4	10.3	18.2	1169.2	27.1	6.4	1020.9	114.9	1.16	390.06	97.43	144.59	1.48
1925	0.2	0.1	0.1	0.2	3.31	174.2	354.3	229.4	115.7	4.6	56.0	3.1	971.1	0.3	33.4	873.6	63.7	0.12	354.27	80.92	115.82	1.43
1926	29.4	2.6	26.4	26.6	15.8	24.3	330.0	491.3	300.7	57.0	0.9	2.1	1307.1	32.0	68.8	1146.3	60.0	0.87	491.33	108.92	166.44	1.53
1927	2.9	12.2	25.9	1.4	1.2	109.1	440.0	230.6	76.5	56.9	81.6	12.0	1070.2	15.1	28.5	876.2	130.5	1.19	440.03	89.19	131.29	1.47
1928	4.7	36.4	8.0	0.9	1.9	128.3	494.8	237.5	71.8	61.3	1.1	72.5	1119.3	41.1	10.8	932.4	134.9	0.86	494.83	93.27	144.26	1.55
1929	14.0	12.4	0.3	8.9	0.6	132.3	369.7	289.7	131.1	10.6	0.1	20.0	989.6	26.3	9.8	922.8	30.7	0.10	369.66	82.47	125.99	1.53
1930	0.4	1.5	1.2	17.8	4.6	146.7	538.6	214.8	181.7	23.0	5.1	4.8	1119.8	1.9	23.6	1081.7	32.7	0.38	538.57	94.99	160.30	1.69
1931	10.8	15.4	5.7	1.7	2.0	75.0	321.3	493.8	299.3	173.6	16.1	7.2	1422.0	26.2	9.4	1189.4	197.0	1.73	493.75	118.50	166.40	1.40
1932	0.1	9.9	16.3	3.8	3.9	95.4	61.1	144.4	238.1	38.1	1.7	1.0	1208.6	10.1	23.9	1134.0	41.8	0.35	61.08	102.92	182.31	1.81
1933	3.3	22.5	8.8	11.7	69.9	151.5	309.3	409.5	313.2	41.7	6.9	11.4	1419.6	25.8	90.4	1243.9	89.9	3.30	409.50	118.36	155.14	1.31
1934	4.4	0.1	4.8	2.2	0.6	170.1	31.31	407.1	413.5	16.4	27.2	6.2	1374.7	4.6	7.5	1312.8	49.7	0.14	413.48	114.55	168.00	1.47
1935	10.1	6.1	0.5	17.2	0.7	123.4	458.7	219.3	241.9	14.7	0.6	4.7	1068.2	16.2	18.4	1043.4	20.0	0.49	458.72	91.30	145.38	1.99
1936	5.5	19.6	25.5	6.1	18.9	224.2	270.4	300.2	270.2	25.6	119.5	3.4	1289.1	25.1	50.4	1065.1	148.4	3.37	300.25	107.42	122.29	1.14
1937	0.5	30.5	11.8	28.7	3.5	208.0	528.5	182.1	236.0	75.8	1.2	3.1	1309.6	31.1	44.0	1154.5	80.1	0.55	528.45	109.13	158.43	1.45
1938	20.6	6.5	4.1	1.7	27.3	366.4	412.9	268.2	111.0	107.4	0.3	0.6	1326.9	27.1	33.1	1158.5	108.3	0.25	412.89	110.58	152.27	1.38
1939	14.5	11.5	20.5	2.6	0.2	105.0	399.9	434.2	145.8	8.7	1.6	0.9	1145.5	26.0	23.3	1084.9	11.3	0.19	434.25	95.46	157.33	1.65
1940	3.1	8.7	4.0	3.1	9.2	177.4	500.5	397.0	74.9	68.4	23.3	11.8	1281.4	11.8	16.3	1149.8	103.5	3.09	500.46	106.78	168.92	1.58
1941	24.5	35.8	11.9	2.1	4.7	90.0	265.8	329.0	86.0	6.8	0.2	0.7	857.5	60.3	18.7	770.8	7.7	0.16	329.00	71.45	110.87	1.55
1942	19.1	49.2	3.1	3.5	1.0	188.3	603.5	326.4	193.1	1.0	0.1	12.3	1380.6	68.3	7.5	1291.4	13.4	0.15	603.53	115.05	186.00	1.62
1943	71.5	0.4	0.2	3.7	26.3	143.3	417.3	237.8	294.2	95.0	0.8	0.6	1261.0	71.9	30.1	1062.5	96.4	0.21	417.27	105.09	135.95	1.29
1944	22.9	40.7	51.3	4.5	1.6	109.7	619.4	578.4	186.4	69.5	2.1	3.5	1089.8	63.6	57.5	1493.8	74.9	1.61	619.37	140.82	220.88	1.57
1945	34.6	0.3	0.2	15.7	4.1	216.1	438.5	281.6	243.7	14.1	0.2	1.5	1290.6	34.9	20.0	1179.9	15.8	0.18	438.47	104.21	150.45	1.44
1946	0.1	9.5	0.3	7.6	5.8	330.9	351.3	415.1	100.6	16.5	139.3	11.9	1368.8	9.6	13.7	1197.8	167.7	0.88	415.07	115.73	157.98	1.37
1947	35.6	13.9	11.1	4.1	1.9	79.6	451.1	360.1	200.2	20.0	0.6	12.5	1226.6	49.5	17.2	1176.9	33.2	0.62	451.09	100.40	153.86	1.54
1948	39.3	9.8	2.0	3.0	1.0	201.3	426.5	361.2	240.0	17.9	82.9	0.7	1857.9	49.1	6.0	1229.1	101.5	0.73	426.53	115.47	153.56	1.33
1949	0.1	6.0	1.8	0.7	26.3	116.3	335.1	209.0	409.8	106.6	0.2	0.7	1212.7	6.1	28.8	1070.3	107.5	0.13	409.82	101.06	143.66	1.42
1950	2.2	17.2	22.7	1.6	4.2	62.6	488.5	220.5	251.9	9.2	0.3	24.2	1105.1	19.4	28.5	1025.3	33.7	0.32	488.53	92.09	152.07	1.65
1951	9.4	7.6	19.4	8.8	5.3	105.2	267.0	276.1	123.9	40.3	0.7	0.3	863.8	16.9	33.5	772.2	41.3	0.33	267.06	71.99	101.79	1.41
1952	0.7	18.2	1.9	2.6	2.4	150.6	347.4	272.3	88.3	5.4	0.1	1.4	891.3	18.9	6.9	836.6	6.9	0.12	347.38	74.28	120.41	1.62
1953	14.7	3.5	0.1	5.0	0.6	75.6	360.4	376.4	132.9	23.9	0.1	0.4	1013.5	18.2	5.7	965.2	24.3	0.08	360.36	84.46	143.01	1.69
1954	15.1	5.3	5.5	1.7	0.9	89.7	345.3	243.2	495.0	12.7	0.2	1.2	1215.9	20.4	8.1	1173.2	14.1	0.21	494.96	101.32	167.53	1.65
1955	33.4	2.1	0.8	3.3	2.2	224.4	165.3	459.9	316.4	146.6	0.1	0.3	1354.8	35.5	6.3	1166.						

Characteristics of long-term variability of precipitation in selected river catchment areas in India ..

Table 12. A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Tapti river catchment areas

YEAR	Tapti												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	36.3	0.5	10.3	4.8	7.2	117.4	224.3	227.8	42.0	63.4	0.0	0.5	734.2	36.8	22.3	611.5	63.7	0.03	227.81	61.19	84.40	1.38
1902	12.9	0.1	0.1	3.0	3.0	51.0	238.8	150.7	146.8	43.0	23.1	26.4	696.9	13.0	6.1	587.4	92.4	0.10	238.80	38.24	77.73	1.33
1903	11.0	0.0	0.1	0.3	66.1	67.1	317.0	186.3	171.1	36.7	0.0	0.5	855.9	11.0	66.5	741.5	37.0	0.03	316.97	71.33	101.69	1.43
1904	2.9	10.0	7.1	0.2	3.9	57.2	334.4	91.3	155.0	1.7	0.7	0.3	649.1	4.1	4.4	637.9	2.6	0.23	334.38	54.09	101.07	1.67
1905	0.8	3.3	0.2	0.2	1.1	236.0	266.1	255.4	100.8	2.7	1.9	12.1	873.4	5.2	3.2	846.3	16.7	0.06	266.07	72.99	110.32	1.52
1906	1.2	37.7	0.2	22.3	0.7	120.4	198.9	221.8	14.4	1.5	8.7	0.3	628.1	38.9	2.1	555.6	10.5	0.15	221.81	52.34	81.24	1.55
1907	0.7	0.1	16.5	3.2	0.6	152.1	253.9	201.1	81.1	0.9	0.3	1.5	712.1	0.8	20.4	688.2	2.7	0.12	253.90	39.34	91.77	1.55
1908	1.8	2.7	1.2	4.4	17.0	156.8	228.5	132.9	165.3	6.5	0.0	41.5	738.6	4.5	22.5	683.5	48.0	0.02	228.50	63.22	83.07	1.31
1909	0.0	0.0	0.1	0.1	0.4	231.6	213.0	237.1	165.2	59.2	38.7	0.3	949.2	0.1	4.1	846.8	98.2	0.02	237.10	79.10	101.09	1.28
1910	10.8	0.1	1.5	0.1	0.8	140.8	122.7	143.7	67.9	2.1	52.5	0.6	543.5	10.8	2.4	475.1	55.2	0.05	143.69	45.29	59.09	1.30
1911	0.1	6.3	0.1	0.5	2.8	82.9	260.9	185.4	35.3	9.6	78.1	0.9	662.8	6.4	3.4	564.4	88.7	0.07	260.90	55.24	85.37	1.55
1912	0.0	1.6	1.0	0.1	16.0	214.5	293.1	139.5	127.8	4.2	0.1	15.7	813.5	1.7	17.1	774.9	19.9	0.05	293.11	67.79	101.39	1.50
1913	0.0	5.0	5.2	3.3	18.8	250.7	262.4	151.7	284.1	8.1	18.0	10.0	1017.3	5.0	27.4	948.9	36.1	0.05	284.12	84.78	116.80	1.49
1914	9.7	14.9	46.2	13.0	3.3	178.8	209.2	103.9	143.1	108.5	7.2	15.5	853.4	24.6	62.5	635.1	131.2	3.32	209.21	71.11	74.49	1.05
1915	0.0	2.9	0.2	0.5	24.7	185.8	297.3	212.7	230.3	85.1	37.8	0.2	1047.6	3.0	25.4	896.0	123.2	0.05	297.31	87.30	105.34	1.21
1916	0.5	26.6	6.8	1.4	36.2	162.7	169.6	197.4	255.0	143.6	1.9	0.2	983.8	27.0	46.4	764.6	145.8	0.21	234.97	81.98	91.25	1.11
1917	0.4	1.8	1.7	0.1	43.4	90.9	116.5	106.5	23.7	3.3	17.8	3.3	409.4	2.2	45.2	337.5	24.5	0.07	116.47	34.12	44.71	1.31
1918	23.4	4.6	0.7	2.9	15.9	212.6	238.7	194.6	126.5	64.1	32.6	0.4	877.1	22.9	19.5	732.7	97.0	0.35	212.62	73.09	85.72	1.17
1919	75.3	0.3	0.5	0.7	7.6	95.7	169.0	101.9	67.3	1.2	0.0	0.2	519.6	75.6	8.8	433.8	1.5	0.02	168.96	43.30	57.08	1.32
1920	4.4	0.0	0.0	0.5	0.2	175.7	266.1	166.3	182.0	2.4	0.0	0.2	797.9	4.4	0.7	790.1	2.7	0.02	266.13	66.49	99.74	1.30
1921	46.3	3.8	0.0	1.5	5.6	167.4	210.6	60.8	206.2	10.6	43.2	3.8	759.8	50.1	7.1	645.0	57.6	0.04	210.64	63.32	82.39	1.30
1922	0.7	0.8	24.8	4.4	5.1	15.9	317.8	112.8	177.3	0.7	0.0	1.7	662.1	1.5	34.4	623.8	2.4	0.02	317.80	55.18	99.79	1.81
1923	10.3	0.4	1.6	3.3	3.9	73.7	190.4	224.3	177.2	102.7	0.7	16.2	804.8	10.6	8.9	665.6	119.6	0.39	224.32	67.07	85.48	1.27
1924	0.1	0.0	1.0	0.1	27.3	176.7	140.5	143.6	50.5	4.7	58.8	12.1	615.5	0.1	28.5	511.4	75.6	0.02	176.70	51.29	65.33	1.27
1925	43.9	4.0	1.6	2.4	9.2	154.2	238.2	204.0	85.3	4.6	2.4	1.5	732.5	47.9	13.2	662.9	8.4	1.49	204.01	61.04	99.95	1.64
1926	0.1	0.0	7.2	0.7	0.4	178.1	319.8	83.2	129.2	42.2	91.6	8.8	863.2	2.1	6.3	710.2	142.6	0.05	319.82	71.93	96.08	1.36
1927	0.1	35.8	5.0	0.0	1.0	130.5	245.0	155.0	150.1	71.1	3.5	4.4	843.2	35.8	6.0	680.5	120.9	0.02	244.98	70.27	81.37	1.16
1928	4.1	22.4	0.5	20.4	0.7	202.1	187.3	65.7	102.3	17.2	0.0	5.1	627.9	26.5	21.6	557.4	22.3	0.01	202.12	52.33	73.31	1.40
1929	0.1	0.2	0.1	3.5	6.4	146.2	211.6	130.0	289.2	31.3	10.9	1.4	830.8	0.2	10.0	777.0	43.6	0.06	289.23	69.24	100.15	1.45
1930	1.3	0.3	1.8	0.7	2.0	87.4	324.2	300.4	192.4	266.9	24.8	9.6	1211.6	1.6	4.5	904.3	301.2	0.25	324.19	100.97	131.28	1.30
1931	0.0	8.2	26.0	6.6	2.7	79.1	364.7	137.0	152.5	64.7	2.7	1.3	865.5	8.2	35.3	753.3	68.7	0.05	364.70	72.13	112.35	1.56
1932	1.4	4.2	1.0	2.4	57.9	162.3	178.7	265.0	316.0	42.1	3.9	22.0	1056.9	5.6	61.3	922.0	88.0	1.02	316.06	88.08	113.18	1.29
1933	4.7	0.0	0.1	1.4	0.5	126.8	226.2	286.1	176.0	3.9	54.1	0.2	891.9	4.7	1.8	627.1	38.2	0.01	226.20	74.32	106.07	1.43
1934	5.9	1.1	0.1	10.7	1.1	154.6	311.4	133.3	184.1	43.8	1.5	0.8	848.3	7.0	11.8	783.5	46.1	0.07	311.42	70.69	102.10	1.44
1935	10.5	18.5	11.0	2.9	22.2	227.7	94.4	111.5	151.7	2.4	214.5	0.2	867.6	29.0	36.2	585.3	21.7	0.23	227.74	72.30	85.58	1.18
1936	0.1	6.1	5.6	35.4	0.3	155.5	354.6	48.7	241.5	81.2	0.6	8.0	937.5	6.2	41.4	800.2	89.8	0.07	354.61	78.13	114.94	1.47
1937	4.5	0.3	5.6	1.7	39.1	321.8	310.4	154.4	140.5	79.0	0.3	0.2	1057.6	4.8	46.4	927.0	79.4	0.18	321.80	88.13	119.86	1.36
1938	2.1	0.1	12.2	4.7	0.4	77.3	231.9	288.5	62.1	11.3	14.1	1.4	706.1	2.2	17.3	659.8	26.7	0.14	231.91	58.64	98.08	1.67
1939	1.7	3.8	0.9	3.7	6.3	181.6	310.9	195.5	110.5	90.1	29.8	7.6	946.5	5.5	10.9	802.6	127.5	0.88	310.94	78.88	102.76	1.36
1940	8.9	26.2	5.2	2.1	0.7	47.4	358.4	132.3	95.3	6.7	0.0	0.2	683.5	35.1	7.9	633.5	6.9	0.05	358.45	56.96	104.11	1.83
1941	0.1	35.9	0.2	3.0	1.0	151.6	328.9	302.4	137.9	0.7	0.0	28.3	990.9	36.8	4.1	920.9	29.1	0.05	328.95	82.57	121.33	1.47
1942	16.2	0.0	0.1	0.9	36.2	142.0	246.6	87.6	191.1	145.4	0.2	0.2	866.5	16.2	39.2	667.4	145.8	0.03	246.67	73.28	88.00	1.22
1943	3.8	17.3	25.2	0.0	1.5	102.6	399.2	461.8	166.1	55.2	5.6	0.2	1238.5	21.1	26.7	1129.7	11.0	0.03	461.78	103.20	161.50	1.56
1944	14.2	0.0	0.1	3.1	1.9	101.7	297.8	225.2	255.2	12.6	2.1	0.6	884.5	14.3	5.0	849.8	65.4	0.01	297.78	73.71	109.99	1.49
1945	0.0	4.9	0.1	8.2	12.0	198.7	274.9	227.8	127.0	4.1	167.9	16.3	1041.9	4.9	20.2	826.4	168.3	0.04	274.90	86.82	105.02	1.21
1946	18.1	6.7	10.1	7.2	2.9	55.9	214.6	249.6	210.6	19.9	1.3	29.1	825.9	24.8	29.2	730.6	50.3	1.28	249.29	68.83	95.69	1.39
1947	2.5	2.1	2.1	2.0	2.1	208.5	322.1	183.7	124.2	16.4	106.4	0.2	926.3	31.6	61.2	627.1	123.0	0.19	322.01	61.36	102.66	1.26
1948	0.0	0.4	0.2	0.2	24.7	137.1	315.5	135.6	422.9	91.3	0.5	0.2	1128.6	0.4	25.1	1011.1	92.0	0.04	422.87	94.05	140.89	1.30
1949	0.1	3.7	1.9	0.8	7.4	33.2	326.3	72.4	205.9	10.0	1.2	14.0	676.9	9.9	10.1	637.8	25.2	0.15	326.33	56.41	103.32	1.83
1950	3.0	0.1	2.7	2.6	6.1	135.4	255.4	152.1	38.9	82.5	6.1	0.1	705.1	3.2	11.4	601.8	88.7	0.12	255.44	38.96	82.93	1.41
1951	0.0	4.5	0.7	1.5	3.3	106.7	212.5	101.9	51.6	9.7	0.1	1.1	493.6	4.5	5.5	472.7	11.0	0.01	212.48	41.14	67.02	1.63
1952	2.6	0.1	0.1	8.1	0.4	138.8	240.0	280.5	93.4	40.1	0.1	0.1	804.3	2.6	8.6	752.7	40.4	0.06	240.48	67.02	100.92	1.51
1953	4.9	1.3	7.8	0.9	1.3	129.4	274.2	163.8	369.1	6.3	0.2	1.7	960.8	6.2	10.0	936.5	8.2	0.18	274.20	69.07	127.27	1.59
1954	14.4	0.1	1.4	3.9	3.2	161.4	149.7	310.1	200.1	126.5	0.4	0.1	971.4	14.6	8.5	821.3	127.0	0.12	310.07	80.95	105.42	1.30
1955	4.3	0.0	0.6	2.5	84.6	138.1	301.9	143.2	182.3	65.8	51.9	2.9	998.1	4.3	87.7	785.5	120.6	0.14	301.90	83.18	95.86	1.15
1956	1.6	0.1	16.8	10.5	14.6	172.1	153.0	199.6	107.8	9.4	7.8	0.1	693.5	1.7	41.9	632.5	17.3	0.08	1			

Characteristics of long-term variability of precipitation in selected river catchment areas in India ..

**Table 13.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Damodar river catchment areas

YEAR	Damodar												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	64.2	55.2	7.2	11.2	38.9	77.0	253.7	354.9	239.9	30.2	13.5	1.0	1146.7	119.4	57.3	925.5	44.5	0.99	354.85	95.56	118.39	1.24
1902	1.0	6.6	18.3	29.2	52.6	79.5	336.3	184.8	318.9	26.1	5.1	1.5	1079.8	7.6	100.1	939.5	32.7	1.03	336.26	89.96	126.72	1.41
1903	10.1	17.9	12.6	39.6	51.7	108.8	166.2	261.5	183.2	208.3	0.1	1.0	1060.9	28.0	103.9	719.6	209.4	0.10	261.47	88.41	93.32	1.06
1904	0.6	11.7	31.0	5.7	108.5	272.2	528.3	283.1	83.1	17.2	0.2	1.2	1343.0	12.3	145.2	1166.8	18.6	0.24	528.33	111.91	166.02	1.48
1905	32.9	43.6	68.9	35.5	67.5	35.2	404.8	293.2	283.6	22.0	0.2	4.8	1292.1	76.5	171.9	1016.8	26.9	0.16	404.83	107.68	136.99	1.27
1906	37.3	100.2	31.8	1.9	34.9	152.6	276.0	279.8	136.2	95.3	1.4	1.3	1177.7	146.4	66.6	864.7	96.0	1.35	279.83	96.14	100.56	1.62
1907	1.9	63.1	96.4	18.6	17.9	306.5	230.1	408.1	249.2	2.4	0.2	15.5	1409.8	65.0	132.9	1193.8	18.1	0.16	408.08	117.49	142.71	1.21
1908	12.7	45.4	4.5	1.0	46.6	217.4	331.0	303.7	144.5	13.8	0.2	1.3	1122.0	38.1	52.1	996.6	15.2	0.15	330.95	93.50	124.18	1.33
1909	27.2	5.8	0.2	74.2	22.2	271.7	267.9	383.6	268.8	30.1	0.2	11.7	1363.6	30.3	96.6	1191.9	42.0	0.20	383.59	113.63	140.72	1.24
1910	4.8	5.9	1.1	17.7	62.0	248.0	264.6	269.9	251.4	70.0	11.4	2.2	1209.0	10.7	80.8	1033.9	83.6	1.09	269.89	100.75	118.72	1.18
1911	0.1	0.1	28.0	9.9	20.8	356.9	139.2	391.2	293.6	77.9	40.6	1.3	1339.5	0.2	58.7	1180.9	119.7	0.07	391.19	113.29	148.01	1.31
1912	1.6	10.3	13.1	16.9	38.2	125.3	311.3	311.9	78.3	33.6	59.4	1.3	1001.1	11.9	68.2	826.7	94.3	1.26	311.86	83.42	112.47	1.35
1913	0.7	104.9	35.8	2.6	98.4	366.4	257.2	379.0	161.3	65.9	17.5	15.7	1533.5	105.6	136.8	1193.8	99.0	0.71	366.40	97.31	124.50	1.11
1914	0.1	22.1	17.8	18.0	169.6	119.4	340.7	277.9	153.5	8.1	0.1	4.5	1131.8	22.2	205.5	891.4	12.7	0.10	340.67	94.32	118.44	1.26
1915	3.3	35.5	24.6	10.6	38.0	157.7	296.8	174.2	233.2	48.3	27.7	1.1	1041.0	38.8	73.1	1056.0	77.1	1.10	296.80	86.75	99.72	1.15
1916	0.1	12.2	0.0	20.0	20.9	244.3	205.9	295.7	237.5	294.3	13.5	1.1	1315.4	12.3	40.9	983.4	278.8	0.03	295.73	109.62	125.31	1.14
1917	0.4	32.7	17.2	9.5	130.6	289.2	394.2	358.2	239.6	340.7	0.1	1.2	1764.8	33.1	157.4	1232.3	342.0	0.12	394.20	147.07	155.15	1.05
1918	2.5	0.1	5.5	20.0	60.5	342.3	96.9	373.6	136.0	1.4	0.1	1.3	1042.2	2.6	86.0	950.7	2.9	0.09	373.59	86.85	134.41	1.55
1919	102.6	6.5	19.5	19.5	63.3	343.8	322.5	351.4	244.8	85.8	1.5	1.1	1262.3	109.1	102.3	1262.5	88.4	1.08	351.35	130.19	142.99	1.10
1920	0.1	16.5	63.9	18.8	41.1	115.7	376.0	226.7	172.7	4.5	0.1	1.1	1261.3	136.0	109.1	909.1	5.7	0.81	376.03	103.89	115.77	1.27
1921	32.6	8.6	0.8	20.1	11.6	183.8	289.8	338.2	182.9	28.8	0.1	1.1	1098.5	41.3	32.6	994.7	29.9	0.10	338.15	91.54	123.42	1.32
1922	9.0	7.5	0.0	18.3	20.5	362.0	370.5	388.9	255.4	68.1	4.4	3.5	1508.0	16.5	38.9	1376.7	76.0	0.03	388.90	125.67	165.36	1.35
1923	1.0	68.0	7.7	7.3	19.5	201.9	388.9	484.1	110.1	39.1	11.8	1.3	1340.7	69.0	34.4	1185.0	52.2	1.03	484.15	111.72	163.90	1.47
1924	10.4	7.0	0.6	13.7	19.9	167.9	502.2	296.7	321.5	87.5	94.2	1.0	1527.7	17.4	34.2	1288.4	182.7	0.60	502.21	126.90	160.01	1.29
1925	5.0	6.1	11.6	39.1	88.4	176.6	415.0	297.4	166.0	61.9	3.2	1.0	1271.2	11.1	139.0	1054.9	66.0	0.98	415.00	105.93	134.20	1.27
1926	31.9	0.5	72.9	10.0	36.6	59.3	514.1	351.8	310.0	29.4	1.9	27.9	1446.3	32.3	119.5	1235.2	59.3	0.47	514.10	120.52	171.30	1.42
1927	33.3	109.7	30.1	2.6	49.6	109.9	371.1	236.5	167.9	60.2	12.7	1.0	1184.5	143.0	62.3	885.3	73.9	0.98	371.05	98.71	111.70	1.13
1928	55.7	6.6	0.7	22.0	50.1	408.3	365.8	164.4	88.2	172.9	0.8	2.8	1336.3	62.3	72.8	1026.8	176.5	0.74	408.33	113.51	142.11	1.27
1929	51.0	11.5	15.1	10.8	15.9	125.1	457.9	388.9	109.5	280.4	0.1	50.9	1517.2	62.5	41.9	1081.4	331.0	0.05	457.94	126.44	159.92	1.26
1930	0.6	3.3	7.9	18.1	21.4	130.6	495.2	295.9	230.5	47.8	120.0	5.7	1386.9	3.9	47.4	1162.2	173.5	0.58	495.18	115.38	154.13	1.33
1931	4.9	113.1	15.6	6.1	27.7	88.9	344.7	275.1	192.8	82.5	25.9	1.4	1178.9	118.0	49.5	901.6	109.8	1.42	344.75	98.24	114.87	1.17
1932	0.0	27.0	0.2	12.1	45.5	92.0	312.5	266.9	197.1	45.1	52.7	2.2	1053.2	27.0	57.7	808.4	100.0	0.03	312.51	87.76	109.34	1.25
1933	53.9	44.3	2.4	42.8	83.5	238.8	314.6	374.1	172.4	61.7	0.1	3.8	1392.4	98.2	128.7	1099.9	65.6	0.09	374.06	116.04	128.48	1.11
1934	30.0	21.2	0.9	17.8	17.4	146.4	236.0	315.4	182.5	51.8	9.2	2.1	1090.6	61.3	86.0	940.2	63.1	0.86	315.41	90.89	115.77	1.27
1935	38.2	13.5	7.8	11.7	9.2	104.4	232.6	486.4	238.4	2.2	0.1	1.0	1145.4	51.8	26.6	1061.7	3.3	0.12	486.38	95.45	151.05	1.58
1936	15.1	13.6	13.6	5.1	70.7	217.8	362.6	310.4	324.3	144.6	14.5	17.8	1540.3	28.8	89.4	1245.1	177.0	5.12	362.59	128.36	145.36	1.13
1937	0.0	100.5	1.8	15.1	61.0	149.9	310.7	252.2	277.1	126.8	0.4	0.8	1296.2	100.5	77.9	989.8	127.9	0.03	310.66	106.02	116.56	1.08
1938	20.0	39.2	0.2	0.9	80.4	185.9	238.8	318.0	169.4	45.0	0.5	0.8	1099.2	59.2	81.5	912.2	46.3	0.18	317.99	91.60	109.20	1.19
1939	9.2	34.0	29.5	13.7	26.6	225.1	329.1	363.9	266.5	144.1	0.1	1.2	1427.7	43.2	69.7	1184.5	145.3	0.07	363.90	120.22	139.05	1.16
1940	0.0	30.3	86.5	14.6	43.7	107.9	256.5	418.1	107.0	48.6	0.1	24.1	1137.4	30.3	144.7	889.5	72.8	0.04	418.09	94.78	124.08	1.31
1941	37.3	0.9	1.2	7.9	62.5	280.6	284.7	329.7	206.6	195.5	15.2	0.9	1424.9	38.2	71.6	1103.6	211.5	0.88	329.67	118.74	130.25	1.10
1942	3.6	50.3	34.5	26.3	25.4	142.8	465.8	446.5	307.0	19.3	3.4	1.0	1525.8	53.9	86.1	1362.1	23.7	0.99	465.80	127.15	176.44	1.39
1943	50.2	5.8	1.1	31.4	19.2	113.7	466.5	422.1	217.9	76.3	0.0	0.8	1404.9	56.0	51.6	1220.2	77.1	0.05	466.53	117.08	165.54	1.41
1944	28.5	41.7	23.5	22.4	16.7	131.5	342.5	388.6	139.9	83.4	2.1	1.0	1221.8	70.2	62.6	1002.5	86.5	0.97	388.64	101.82	131.99	1.30
1945	35.2	32.3	0.2	25.9	40.7	147.2	238.7	254.8	257.2	130.1	1.7	1.4	1185.5	67.5	66.8	917.9	133.3	0.20	254.80	98.79	100.22	1.08
1946	0.0	17.7	27.2	74.6	75.3	254.3	316.7	309.6	219.8	141.0	20.0	0.6	1456.8	17.7	177.1	1100.5	161.5	0.01	316.69	120.40	122.42	1.01
1947	3.2	11.9	45.3	2.2	35.6	132.1	290.6	303.4	270.9	99.6	0.6	15.8	1211.1	15.1	83.1	997.0	115.9	0.56	303.45	100.93	120.14	1.19
1948	34.0	18.1	19.5	7.6	39.7	146.4	361.8	282.1	134.5	105.8	87.4	0.6	1394.2	41.2	68.8	902.5	63.7	0.78	361.75	103.89	138.47	1.16
1949	31.8	11.5	19.7	38.4	105.8	196.3	365.0	342.3	214.3	60.6	0.1	0.6	1406.3	13.3	183.9	1117.8	61.3	0.12	364.98	112.19	131.35	1.12
1950	0.2	12.2	23.0	1.1	36.4	357.5	387.8	334.0	166.4	19.9	4.7	4.2	1347.5	42.4	60.6	1245.7	28.8	0.19	387.82	117.99	156.26	1.39
1951	3.1	0.3	20.0	18.9	27.2	182.2	301.9	219.8	214.1	61.5	6.3	0.7	1055.9	3.4	66.1	918.0	68.5	0.27	301.89	87.99	109.08	1.24
1952	3.4	6.0	23.0	32.1	71.6	190.9	312.5	263.3	211.0	77.1	0.4	2.0	1193.3	9.4	126.7	977.7	79.5	0.43	312.53	99.44	113.61	1.14
1953	43.4	13.3	0.4	6.9	26.5	221.2	456.5	404.0	279.2	18.4	14.4	0.9	1485.1	56.7	33.8	1361.0	33.7	0.41	456.51	123.76	170.05	1.37
1954	14.8	5.9	3.2	30.0	37.9	168.2	236.8	228.4	238.0	33.5	0.0	6.8	996.5	20.7	44.1	891.4	40.4	0.01	238.04	83.04	105.84	1.27

Characteristics of long-term variability of precipitation in selected river catchment areas in India ..

**Table 14.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Brahmani river catchment areas

YEAR	Brahmani												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	100.8	99.5	20.6	25.4	55.7	81.3	372.4	471.0	238.5	51.6	8.1	0.6	1525.4	200.2	101.8	1163.2	60.3	0.57	471.04	127.12	152.87	1.20
1902	2.0	5.7	8.1	37.3	51.4	105.9	683.5	300.2	214.9	10.2	3.9	15.7	1438.7	7.7	96.7	1304.4	29.9	1.96	683.45	119.89	201.49	1.68
1903	44.2	31.5	7.8	24.4	66.5	158.9	345.2	341.4	200.0	249.5	1.6	0.8	1473.8	75.7	100.6	1045.5	251.9	0.76	345.15	122.81	131.60	1.07
1904	0.6	18.4	40.7	6.3	65.2	415.9	469.9	413.4	129.9	48.0	1.4	1.1	1630.9	19.0	134.2	1422.2	30.5	0.56	469.96	152.01	183.33	1.35
1905	53.8	45.3	42.0	30.9	77.7	70.9	407.3	239.2	288.7	33.5	0.7	1.9	1201.9	99.2	150.6	1006.1	36.1	0.67	407.25	107.66	130.45	1.21
1906	39.0	169.2	53.7	0.5	30.8	193.1	432.5	281.8	233.9	63.6	11.6	3.9	1533.7	228.2	85.0	1161.4	79.2	0.49	432.52	129.48	137.25	1.06
1907	0.5	37.3	83.9	47.5	22.6	300.9	299.8	637.4	157.6	1.4	0.8	48.4	1627.9	37.3	153.9	1353.7	50.6	0.47	637.43	135.66	190.59	1.40
1908	15.5	29.2	6.4	1.3	41.4	251.3	444.9	627.6	182.6	20.9	0.8	0.7	1622.5	44.8	49.0	1506.3	22.4	0.67	627.60	135.21	207.18	1.53
1909	21.5	9.5	1.8	98.9	33.3	403.0	506.7	375.4	269.3	6.5	0.8	18.2	1744.9	30.9	134.0	1554.4	25.6	0.79	506.69	145.41	188.47	1.30
1910	26.3	1.8	1.6	31.7	30.9	230.1	346.7	387.5	224.2	126.5	1.7	0.6	1429.7	28.1	64.3	1206.6	128.8	0.63	387.54	119.14	145.08	1.22
1911	0.3	0.9	28.2	6.8	29.5	398.5	196.8	460.3	253.6	90.8	25.7	0.6	1491.8	1.2	64.4	1309.1	117.0	0.32	460.26	124.32	164.82	1.33
1912	1.5	52.9	5.5	37.1	26.3	130.7	457.6	431.8	139.8	25.1	41.7	0.6	1350.5	54.4	68.8	1159.9	67.3	0.36	457.58	112.54	161.74	1.44
1913	2.4	121.0	31.6	3.4	58.0	328.0	458.6	417.9	130.5	87.7	21.7	8.9	1669.7	123.4	93.0	1334.9	118.3	0.29	458.57	130.16	167.34	1.20
1914	0.3	14.6	17.1	19.7	126.3	132.2	460.2	411.2	239.5	12.2	0.1	8.0	1441.4	15.0	163.1	1243.1	20.3	0.08	460.21	120.11	165.05	1.37
1915	8.9	23.6	29.9	16.9	65.8	126.4	287.6	251.7	231.3	93.4	50.5	0.5	1186.6	32.6	112.6	897.1	144.4	0.52	287.57	98.89	102.54	1.04
1916	0.2	9.7	0.3	21.4	25.6	375.0	221.8	379.5	169.7	211.2	21.0	0.5	1435.8	9.9	47.2	1145.9	232.7	0.22	379.46	119.65	146.80	1.23
1917	1.5	53.5	26.4	5.8	56.4	365.3	434.5	355.6	281.0	232.0	3.4	0.7	1836.3	55.0	88.7	1436.4	236.1	0.67	434.51	153.02	196.78	1.11
1918	7.9	2.4	4.8	13.7	105.0	375.9	186.0	419.6	173.5	2.3	0.1	1.1	1292.6	10.2	133.5	0.0	3.9	0.06	419.57	107.72	132.00	1.11
1919	53.7	26.3	7.3	13.9	104.7	222.8	484.2	387.5	234.4	72.5	10.1	12.7	1345.2	143.1	125.9	1315.2	100.3	1.28	484.19	145.43	181.78	1.11
1920	0.2	15.5	33.0	16.3	45.0	125.2	900.0	434.7	175.5	4.8	0.0	0.5	1792.7	15.7	114.4	1657.3	5.3	0.03	940.01	149.29	278.07	1.86
1921	30.3	6.5	0.3	8.1	5.1	283.3	385.0	407.0	221.6	32.3	0.0	0.5	1400.1	96.8	13.6	1296.9	32.8	0.03	407.02	116.67	160.57	1.38
1922	14.0	4.6	0.3	12.3	27.7	253.5	471.3	313.8	273.2	51.4	14.9	1.0	1437.9	18.5	40.3	1311.9	67.3	0.27	471.31	119.83	162.71	1.36
1923	0.4	83.7	4.7	6.8	21.1	176.5	426.5	590.3	125.9	59.9	22.6	0.6	1519.1	84.1	32.6	1319.3	83.0	0.43	590.30	126.59	189.90	1.50
1924	41.4	14.6	1.6	2.6	51.9	123.3	365.3	269.9	275.5	68.3	89.3	0.4	1304.2	96.1	56.2	1034.0	138.0	0.43	365.26	108.68	127.37	1.15
1925	2.1	0.5	3.7	36.9	87.6	377.3	507.9	361.7	193.7	95.8	4.7	5.7	1677.5	2.5	128.2	1440.5	106.2	0.49	361.73	139.79	178.99	1.28
1926	32.2	7.0	106.3	16.9	41.1	52.1	434.1	513.4	327.3	61.1	0.7	12.4	1604.8	3.9	164.3	1320.7	74.3	0.74	513.44	133.73	182.31	1.36
1927	7.0	89.6	22.0	6.4	30.9	111.8	603.8	431.6	159.9	52.7	12.7	0.5	1528.7	96.6	59.2	1307.1	65.8	0.45	603.77	127.39	192.27	1.51
1928	18.6	10.4	9.1	45.2	55.4	277.4	439.6	268.3	173.3	162.9	0.0	4.4	1464.5	29.0	109.7	1158.6	167.3	0.01	439.57	122.05	143.23	1.17
1929	39.7	16.8	4.2	9.5	32.5	123.0	738.9	448.2	167.7	157.5	0.0	48.7	1806.5	76.4	46.2	1477.7	206.2	0.00	738.87	150.54	223.66	1.49
1930	0.1	1.5	8.2	22.4	19.2	141.5	485.0	462.9	210.8	36.5	144.0	4.4	1536.5	1.6	49.7	1300.2	184.9	0.14	485.03	128.04	175.88	1.37
1931	10.8	107.6	17.4	20.0	43.7	122.6	370.6	507.4	148.8	130.8	33.6	0.6	1516.1	118.5	63.2	1149.5	185.1	0.64	507.42	126.34	157.93	1.25
1932	0.4	36.2	11.9	15.7	44.9	120.2	494.5	344.7	267.5	32.9	64.4	0.6	1403.8	36.6	72.5	1196.8	67.9	0.36	494.47	116.88	135.29	1.33
1933	37.8	103.3	7.3	13.9	104.7	222.8	484.2	387.5	234.4	72.5	10.1	12.7	1345.2	143.1	125.9	1315.2	100.3	1.28	484.19	145.43	181.78	1.11
1934	3.6	0.3	1.0	8.6	2.6	225.4	579.7	440.3	283.3	60.5	12.4	0.0	1443.7	3.9	12.2	1330.7	96.9	0.33	440.30	120.31	166.22	1.38
1935	17.9	20.0	16.7	49.3	2.9	132.5	532.4	201.4	194.5	0.1	0.0	3.0	1283.8	40.9	69.0	1130.7	3.7	0.02	532.36	105.32	163.54	1.55
1936	16.8	22.8	8.5	20.0	95.2	428.6	393.4	412.3	313.2	194.7	11.4	4.7	1903.4	39.5	105.7	1547.4	210.8	1.96	428.56	158.62	179.04	1.13
1937	0.0	97.9	15.2	43.1	66.3	238.3	487.1	291.4	296.6	104.7	0.7	0.5	1661.8	97.9	124.6	1333.4	105.9	0.03	487.07	138.49	157.75	1.14
1938	30.6	31.7	0.6	1.8	105.3	226.6	299.3	428.0	235.9	53.3	3.8	0.3	1417.0	62.2	107.7	1189.7	57.4	0.32	428.01	118.09	144.06	1.22
1939	13.0	43.1	54.8	24.9	11.0	241.9	479.8	461.2	206.2	108.9	10.2	2.2	1717.3	96.6	138.9	1389.2	181.3	0.21	479.84	143.10	173.91	1.22
1940	0.1	4.4	81.6	21.1	58.9	172.9	563.5	349.6	153.3	38.2	0.1	20.9	1504.3	44.2	161.5	1239.3	59.2	0.11	563.46	125.36	170.28	1.36
1941	42.1	5.4	5.5	10.3	50.2	298.9	463.1	361.6	175.7	135.2	59.6	0.8	1578.3	47.4	66.0	1269.4	195.5	0.76	463.11	131.53	155.83	1.18
1942	6.8	57.2	5.1	26.2	22.2	153.3	547.9	394.5	350.1	29.6	12.7	2.3	1608.0	64.1	53.6	1445.8	44.6	2.26	547.87	134.00	188.77	1.41
1943	102.3	12.6	0.7	43.6	53.7	149.8	502.3	363.5	312.7	68.9	0.8	0.4	1811.1	114.9	97.9	1528.2	70.1	0.39	502.36	150.93	199.27	1.32
1944	55.8	92.5	62.0	32.1	28.3	106.5	457.4	483.7	142.9	188.6	5.4	0.6	1655.7	148.3	122.4	1190.4	194.6	0.55	483.69	137.97	164.98	1.20
1945	48.0	12.6	0.3	23.2	33.7	168.4	419.3	336.9	344.7	127.2	2.3	1.0	1517.5	60.6	57.1	1269.4	130.4	0.29	419.27	126.46	155.19	1.23
1946	0.1	11.7	12.7	81.1	79.7	311.7	400.4	479.6	243.6	91.9	40.1	0.5	1733.1	11.8	173.6	1435.3	132.6	0.06	479.64	146.09	188.95	1.16
1947	18.4	36.2	45.4	20.0	17.0	170.4	338.2	355.5	209.0	125.6	2.2	25.0	1346.9	36.6	64.4	1073.0	132.8	2.01	355.47	112.24	128.92	1.15
1948	22.2	26.7	15.5	8.2	62.7	214.0	469.4	363.0	222.4	72.5	10.1	12.7	1345.2	143.1	125.9	1315.2	100.3	1.28	469.43	120.31	166.22	1.38
1949	5.9	11.5	7.8	50.4	94.9	192.5	408.2	489.1	251.3	97.7	0.8	2.7	1590.9	17.5	133.1	1319.1	101.2	0.80	489.12	132.57	163.95	1.24
1950	0.9	22.2	43.0	10.0	37.7	275.3	463.8	441.5	180.3	21.4	30.4	1.0	1518.5	23.1	51.8	1309.9	52.8	0.86	463.84	126.55	173.55	1.37
1951	3.9	3.3	92.2	34.5	29.7	179.3	283.0	373.1	159.2	94.5	17.2	0.8	1270.7	7.1	136.5	994.7	112.4	0.77	373.14	105.89	121.39	1.15
1952	2.8	14.2	23.7	36.1	57.9	220.8	449.5	450.1	266.4	104.4	0.5	0.6	1627.2	17.1	117.8	1386.8	105.5	0.33	450.13	135.60	170.57	1.26
1953	23.4	14.3	0.1	7.2	19.5	171.8	456.7	498.8	288.9	39.9	21.5	0.8	1543.0	37.8	26.7	1416.3	62.3	0.05	498.85	128.59	184.70	1.44
1954	4.5	7.6	6.4	12.7	17.8	162.0	274.4	279.9	254.8	26.6	1.7	9.5	1057.9	12.1	3							

**Table 15.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Krishna river catchment areas

YEAR	Krishna												ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	8.8	31.4	5.0	49.8	52.9	105.4	183.6	131.0	102.2	75.5	19.2	1.4	766.2	40.3	107.7	522.2	96.0	1.36	183.65	63.85	57.16	0.90
1902	0.9	0.1	3.2	20.0	29.0	111.1	139.7	115.9	175.3	117.2	32.9	63.1	933.4	1.0	50.2	540.0	220.2	0.09	175.28	67.78	61.38	0.91
1903	3.6	0.1	0.2	7.5	62.5	104.1	266.3	196.5	182.3	146.3	33.2	13.4	1038.7	3.7	70.2	751.3	213.6	0.10	266.34	88.58	91.03	1.06
1904	0.6	0.3	4.6	9.6	49.0	136.9	138.6	64.6	138.8	100.4	0.4	0.3	644.2	0.9	63.2	470.0	101.1	0.32	138.80	53.68	39.86	1.12
1905	0.2	3.3	6.5	12.1	46.0	101.3	121.3	138.5	56.8	85.3	5.3	0.3	597.0	3.5	64.6	438.0	90.9	0.18	158.52	49.75	55.00	1.11
1906	18.8	0.1	1.6	1.2	17.8	168.3	177.6	203.7	120.7	69.1	13.1	52.1	844.1	18.9	20.6	670.3	134.3	0.10	203.72	70.34	76.81	1.09
1907	0.6	0.5	7.5	72.4	5.8	127.2	206.1	186.5	134.4	9.1	15.5	9.0	774.5	1.1	85.7	654.3	33.5	0.50	206.13	64.54	78.20	1.21
1908	6.2	1.5	4.7	12.4	21.3	75.9	210.9	134.8	272.8	19.7	1.3	0.3	761.9	7.7	38.5	694.4	21.3	0.28	272.81	63.49	93.18	1.47
1909	2.2	0.2	4.1	19.2	51.0	141.4	209.7	156.6	141.4	35.2	8.4	2.9	772.4	2.4	74.3	649.1	46.5	0.23	209.67	64.36	75.73	1.18
1910	0.0	0.1	2.8	7.5	28.2	142.2	176.8	205.7	210.0	115.0	38.0	0.3	923.5	0.1	38.5	734.6	150.3	0.02	209.96	76.96	86.39	1.12
1911	0.3	0.1	1.4	6.8	35.6	114.0	182.9	115.3	71.6	58.0	18.1	7.2	611.2	0.4	43.8	483.7	83.2	0.07	182.89	50.93	59.37	1.17
1912	0.1	8.5	0.3	26.0	30.0	72.2	257.5	170.1	103.3	100.1	39.1	0.4	807.6	8.6	56.8	603.1	139.6	0.12	257.53	67.30	79.75	1.19
1913	0.0	0.8	0.2	11.9	61.8	129.9	207.7	74.1	96.4	86.1	1.1	2.6	672.7	0.8	74.0	508.2	89.8	0.02	207.73	56.06	66.39	1.18
1914	0.0	0.2	0.6	13.0	32.5	114.2	279.1	218.0	169.2	31.1	31.3	13.5	920.7	0.2	46.1	699.5	75.9	0.02	279.09	75.22	96.54	1.28
1915	17.3	4.5	34.1	24.0	33.3	142.9	212.2	194.1	215.3	102.1	14.0	8.8	935.5	21.8	21.4	680.0	146.3	0.45	215.27	78.62	76.88	0.98
1916	0.6	1.9	0.4	13.8	63.3	142.9	237.7	153.6	210.7	134.0	0.4	1186.4	2.4	77.5	784.9	341.6	0.38	237.74	98.68	96.87	1.06	
1917	0.2	27.7	15.7	9.5	27.1	158.2	125.9	186.3	229.5	151.7	38.5	0.3	990.5	27.9	52.3	699.9	210.5	0.19	229.52	82.54	82.44	1.00
1918	9.8	0.4	5.0	13.7	102.9	56.3	73.8	88.6	135.4	16.0	68.8	8.5	579.3	10.3	121.6	354.2	93.3	0.43	135.39	48.28	45.53	0.94
1919	7.5	0.3	2.9	14.0	50.3	150.7	145.5	91.6	225.4	69.9	75.0	5.7	838.8	7.8	67.2	613.1	150.7	0.28	225.43	69.90	72.47	1.04
1920	9.9	0.2	0.7	17.2	25.6	96.3	146.1	89.8	133.6	49.4	2.0	0.3	571.1	10.1	43.5	465.7	51.8	0.21	146.13	47.60	54.63	1.15
1921	6.2	0.1	1.1	29.1	5.4	103.2	223.4	92.5	106.6	116.2	64.9	0.7	745.4	6.2	35.6	521.6	181.8	0.07	223.37	62.11	68.73	1.11
1922	25.9	1.2	0.2	19.5	41.6	105.0	173.2	84.5	68.9	67.4	110.7	0.3	698.4	27.1	61.4	431.6	178.4	0.21	173.21	58.20	53.80	0.92
1923	0.9	11.3	25.9	13.4	27.3	49.7	275.2	96.5	167.4	20.5	2.7	1.7	694.3	12.2	66.5	590.7	24.9	0.89	275.15	57.86	84.14	1.45
1924	2.2	0.1	3.8	25.3	21.8	86.7	195.1	157.4	186.3	40.5	31.6	4.9	755.7	2.3	50.9	625.5	77.1	0.09	195.12	62.98	74.63	1.19
1925	0.0	0.1	3.1	23.5	76.4	106.5	164.9	142.3	107.7	110.7	26.4	15.9	777.5	0.1	103.0	521.5	153.0	0.03	164.91	64.79	60.02	0.93
1926	24.1	0.3	5.9	12.7	33.0	84.6	182.1	165.0	163.7	28.0	3.1	0.7	703.2	24.4	51.6	395.3	31.9	0.32	182.06	58.00	71.20	1.22
1927	0.5	1.1	2.4	5.7	26.6	143.6	221.2	95.7	190.8	38.4	89.8	0.5	813.9	1.6	34.7	699.2	128.5	0.35	221.16	67.53	79.65	1.17
1928	0.2	4.0	2.9	8.3	12.3	157.5	127.7	134.1	197.3	129.4	2.6	9.7	824.7	25.3	45.1	197.26	123.7	0.25	157.53	71.23	76.64	1.08
1929	1.1	16.6	1.4	48.8	32.5	125.5	122.1	82.4	182.9	92.3	20.5	2.7	726.8	17.7	80.7	512.9	115.5	1.07	182.87	105.57	59.81	0.99
1930	0.7	2.3	4.9	9.3	44.7	145.1	125.1	86.0	184.8	146.5	37.5	5.1	792.0	30.0	541.0	189.0	0.71	184.83	60.00	68.07	1.03	
1931	0.1	0.1	1.9	20.2	35.3	138.5	202.1	138.1	196.8	82.6	72.9	15.8	904.2	0.1	57.4	675.4	171.3	0.05	202.08	75.35	78.10	1.01
1932	0.0	7.0	1.0	18.6	48.8	76.7	226.5	210.3	148.5	144.0	82.3	0.9	964.8	7.0	68.5	662.1	227.3	0.04	226.58	80.40	83.24	1.04
1933	0.6	4.4	9.6	28.4	89.9	141.6	182.7	190.2	184.1	156.8	42.3	33.3	1064.0	5.1	127.9	696.6	232.5	0.61	190.15	86.67	77.26	0.87
1934	1.2	0.1	0.9	19.0	13.8	114.3	221.3	144.6	96.7	64.9	49.7	0.3	726.7	1.3	33.8	576.8	114.9	0.07	221.27	60.56	71.03	1.17
1935	9.4	0.2	0.6	25.2	13.3	126.6	168.9	202.6	113.0	123.5	5.7	2.9	791.9	9.6	39.1	611.1	132.1	0.24	202.58	65.99	75.26	1.14
1936	0.3	23.9	6.9	10.1	54.2	135.6	119.6	103.6	146.2	65.8	80.9	3.5	750.5	24.2	71.1	505.0	150.3	0.33	146.21	62.54	54.28	0.87
1937	0.0	15.4	9.5	77.5	16.5	89.6	203.8	69.6	146.3	106.0	0.9	5.8	744.0	15.4	103.5	509.3	115.8	0.03	203.77	62.00	66.20	1.07
1938	0.1	6.3	25.4	12.2	41.8	153.9	189.0	210.6	208.5	55.8	7.3	1.6	912.6	6.4	79.4	782.0	64.7	0.13	210.62	76.05	87.18	1.15
1939	0.1	0.1	5.8	16.6	9.2	95.4	180.0	164.2	120.8	131.2	33.9	0.7	736.0	0.1	31.7	560.4	165.7	0.06	179.98	63.17	70.02	1.11
1940	0.1	0.3	2.8	29.3	81.1	152.3	173.5	175.5	103.8	114.3	30.3	10.0	833.1	0.3	113.1	385.0	154.6	0.09	175.50	71.09	67.44	0.95
1941	18.6	4.0	12.9	8.3	22.2	109.5	142.0	100.5	192.8	69.7	2.3	14.2	643.3	22.5	33.9	392.8	84.1	0.25	192.76	71.23	76.64	1.08
1942	0.1	2.2	0.2	23.4	28.7	181.0	201.4	141.7	63.8	39.6	5.5	22.7	710.3	2.2	52.2	367.9	67.8	0.06	201.42	59.19	73.20	1.24
1943	8.1	0.5	1.8	23.9	97.7	117.3	192.7	76.7	199.6	174.1	21.2	0.3	914.0	8.7	123.4	386.3	195.6	0.34	199.58	76.17	78.39	1.03
1944	0.2	6.3	34.5	5.9	40.5	108.5	243.3	81.0	147.1	165.5	29.8	0.5	863.0	6.5	80.9	579.8	195.8	0.18	243.29	71.92	78.78	1.10
1945	0.7	0.1	0.1	21.1	25.0	95.7	235.0	139.7	104.3	66.4	8.6	0.5	697.2	0.7	46.2	574.7	75.5	0.06	235.05	58.10	73.16	1.27
1946	0.0	5.2	2.3	32.8	47.2	128.8	195.5	180.2	147.8	58.3	114.9	8.7	921.7	5.2	82.3	652.3	181.9	0.04	195.46	76.81	72.82	0.95
1947	10.9	4.3	5.8	14.8	25.0	94.6	210.5	250.6	178.3	54.5	12.5	14.6	876.6	15.3	45.7	733.9	81.7	4.34	250.56	73.05	89.52	1.23
1948	3.6	0.9	4.3	33.6	40.4	95.9	170.3	173.1	161.0	80.4	111.2	0.5	875.2	4.5	78.3	600.3	192.0	0.47	173.08	72.93	68.67	0.94
1949	0.1	0.3	2.2	10.7	67.5	101.7	165.1	146.3	234.3	103.0	8.9	0.3	840.3	0.3	80.3	647.5	112.2	0.06	234.32	70.93	80.01	1.14
1950	0.0	5.4	5.9	4.3	38.6	86.0	227.6	126.3	220.8	103.6	20.2	0.5	839.4	5.5	48.8	660.8	124.3	0.04	227.63	69.95	84.17	1.20
1951	0.1	0.1	10.7	19.4	54.6	130.9	211.3	97.7	131.7	91.5	12.3	0.7	761.0	0.2	84.8	571.7	104.3	0.08	211.29	63.41	69.02	1.09
1952	0.1	5.8	0.2	21.0	86.9	84.6	156.9	105.1	78.7	128.3	0.4	15.4	634.4	5.9	108.1	425.3	144.2	0.07	156.86	56.95	56.26	0.99
1953	0.6	0.1	0.4	35.5	57.7	179.9	223.1	137.7	181.9	216.6	0.6	0.4	940.5	0.7	41.5	689.6	217.6	0.09	223.08	78.37	93.09	1.19
1954	0.1	0.2	12.1	16.1	25.8	113.9	264.0	184.7	184.7	65.9	12.4	0.1	824.1	0.9	63.9	653.9	82.1	0.15	264.00	63.98	78.24	1.24
1955	0.2	0.1	10.1	22.9	82.5	127.3	140.8	242.1	200.8	142.3	0.6	0.3	865.0	0.4	115.5	711.1	158.1	0.13	242.11	62.09	86.36	1.05</

**Table 16.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Penner river catchment areas

YEAR	Penner												ANN	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC	MIN	MAX	MEAN	SD	CV
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	6.1	43.7	0.0	10.1	55.6	48.9	55.7	43.8	109.8	77.0	98.8	28.2	577.5	49.8	65.6	238.1	203.9	0.00	109.76	48.12	34.75	0.72
1902	5.7	0.0	0.5	19.2	39.5	70.1	42.5	94.3	151.4	200.3	42.4	24.9	690.5	5.7	59.3	338.3	297.3	0.01	230.07	57.54	62.67	1.08
1903	15.9	0.0	0.0	4.3	88.9	64.3	117.1	110.3	196.0	96.8	22.7	32.7	867.7	1.9	63.2	489.6	419.0	0.00	227.47	82.30	87.96	0.77
1904	14.2	0.0	0.0	10.9	64.6	28.7	61.0	17.4	76.2	116.5	0.6	7.5	368.4	14.2	76.3	183.3	120.6	0.00	116.47	33.20	37.59	1.13
1905	2.6	3.4	10.7	14.3	39.8	57.9	34.6	194.9	22.2	146.5	20.7	0.4	548.0	6.0	64.8	309.7	167.5	0.41	194.91	45.67	61.65	1.35
1906	49.8	1.7	1.8	1.1	10.1	78.0	116.6	127.7	130.5	106.9	15.0	128.7	788.0	51.5	130.2	452.8	280.7	1.13	130.52	64.00	56.15	0.88
1907	0.5	0.0	3.8	77.0	3.6	41.5	122.3	23.8	94.3	34.0	99.4	28.8	528.9	0.5	84.3	281.9	162.2	0.00	122.26	44.08	43.33	0.98
1908	11.8	1.3	4.9	4.3	31.2	34.5	58.6	33.6	203.9	97.1	6.5	1.3	488.9	1.31	40.4	330.6	104.8	1.25	203.90	40.75	38.81	1.44
1909	68.2	0.0	0.0	36.4	80.7	30.3	55.2	244.6	187.5	24.0	3.9	0.4	731.3	68.2	117.1	517.7	28.3	0.00	244.62	60.94	78.32	1.29
1910	0.2	0.0	0.2	10.9	33.6	45.6	171.5	164.2	173.7	169.1	104.5	0.2	873.9	0.3	44.8	555.0	273.8	0.04	173.69	72.82	77.32	1.06
1911	0.1	0.1	0.5	16.0	59.7	49.9	59.3	45.3	93.1	105.9	50.3	17.6	497.8	0.1	76.3	247.6	173.8	0.05	105.93	41.48	35.62	0.86
1912	0.2	3.9	0.4	5.7	19.5	33.0	65.8	105.2	158.8	136.1	180.9	1.5	691.1	4.1	25.6	362.8	286.6	0.22	160.93	57.39	65.21	1.13
1913	0.1	0.7	0.2	5.2	53.6	42.1	92.5	25.1	128.9	142.7	1.7	41.2	534.0	0.8	59.0	288.5	185.7	0.05	142.73	44.30	51.14	1.15
1914	0.6	0.4	0.5	22.3	51.6	47.9	69.4	104.5	141.2	53.1	41.9	4.4	537.7	1.0	74.4	363.0	59.4	0.38	141.19	44.81	44.34	0.99
1915	32.6	2.6	63.9	8.7	45.6	54.1	133.9	68.4	49.7	134.2	131.2	23.9	201.3	35.2	180.2	415.6	232.3	2.34	180.71	66.73	62.13	0.93
1916	0.1	0.5	0.0	7.7	53.6	40.4	219.3	187.0	172.0	101.8	1.2	976.4	0.5	61.2	398.5	315.7	0.03	219.32	61.57	68.63	1.09	
1917	2.6	51.6	5.2	7.8	55.8	85.5	41.8	130.0	180.4	172.2	96.1	7.0	873.8	54.2	68.3	475.6	275.2	2.64	198.35	72.82	68.80	0.94
1918	31.7	0.6	8.2	12.8	65.1	23.9	22.9	59.7	128.0	2.1	180.2	17.8	552.8	32.2	86.1	234.4	200.1	0.57	180.25	46.07	55.46	1.12
1919	14.1	0.0	22.0	23.8	49.5	66.1	118.8	20.8	255.4	62.6	137.2	16.7	870.0	14.1	95.3	465.1	216.5	0.04	255.40	65.59	73.38	1.20
1920	42.3	0.9	1.1	5.1	23.9	30.8	20.2	72.4	135.2	105.1	53.2	0.2	490.5	43.2	30.1	286.6	136.6	0.24	135.23	40.88	43.81	1.07
1921	16.0	0.0	0.0	50.4	6.6	56.2	139.8	69.3	72.6	207.9	53.1	1.5	673.4	16.0	57.0	337.8	262.6	0.03	207.90	56.12	63.15	1.13
1922	31.4	0.1	0.0	9.3	45.3	36.1	54.8	69.6	22.2	106.2	228.5	4.1	807.4	31.4	54.6	182.7	338.7	0.03	228.49	50.61	64.32	1.27
1923	6.1	9.5	18.4	17.6	25.2	37.6	55.9	19.0	150.5	68.4	6.1	5.6	421.8	15.6	61.2	263.0	62.1	5.57	150.48	35.15	41.45	1.18
1924	6.3	0.0	0.5	13.0	45.3	41.0	76.1	79.7	188.1	33.6	133.5	0.3	617.3	6.3	58.8	384.9	167.3	0.04	188.05	51.44	39.26	1.15
1925	0.0	0.0	2.1	23.0	108.1	23.8	80.9	115.2	90.3	115.3	95.3	94.1	748.1	0.1	133.2	310.1	304.7	0.04	115.33	62.34	47.99	0.77
1926	44.7	0.0	9.0	34.3	29.5	87.0	64.9	53.5	152.1	83.5	17.5	2.4	576.4	44.7	72.8	357.4	103.5	0.05	152.06	48.20	43.99	0.91
1927	0.7	1.3	0.0	1.8	25.2	61.2	99.1	73.9	180.2	53.5	151.0	0.5	648.2	1.9	27.0	414.5	204.8	0.04	180.19	54.81	62.38	1.15
1928	0.1	37.1	5.9	21.2	30.9	36.8	68.4	63.8	92.4	174.7	13.7	43.4	831.3	37.5	59.3	339.0	238.3	0.14	172.73	41.82	30.24	0.93
1929	7.8	12.3	1.6	36.5	46.8	45.6	24.4	81.3	186.3	122.4	91.1	20.8	628.9	20.1	84.9	287.6	236.3	1.61	186.32	52.41	54.95	1.05
1930	7.5	8.5	8.0	5.8	143.4	75.3	45.1	38.7	136.5	232.6	82.0	41.7	825.1	16.0	157.2	225.7	356.2	5.83	232.66	58.76	70.35	1.02
1931	0.4	0.1	1.3	6.3	40.8	87.8	68.8	24.0	138.5	97.9	70.5	27.0	963.2	0.4	48.4	319.0	195.4	0.06	138.45	46.94	45.47	0.97
1932	0.0	12.1	0.0	7.2	54.1	41.7	61.1	134.8	78.2	101.5	93.6	3.7	887.9	12.1	61.4	315.7	198.8	0.00	134.79	49.00	45.87	0.94
1933	0.0	1.2	3.0	14.9	71.6	18.6	80.5	174.9	61.4	125.8	37.1	62.5	651.7	1.3	89.6	335.5	225.4	0.03	174.88	54.31	54.15	1.00
1934	9.0	0.1	0.1	27.4	20.4	68.4	93.6	39.8	30.1	124.2	58.5	3.0	474.4	9.0	47.9	231.9	185.7	0.06	124.20	39.54	39.63	1.00
1935	4.8	1.1	1.2	32.4	25.3	73.1	82.2	228.2	83.9	150.8	11.0	5.1	699.0	5.8	58.9	467.5	166.8	1.06	228.24	58.25	70.78	1.22
1936	0.0	19.1	11.0	10.4	61.4	71.2	58.6	40.5	145.4	62.2	146.1	6.5	632.3	19.2	62.8	315.6	214.8	0.03	146.07	52.69	50.06	0.95
1937	0.1	11.9	5.3	95.3	27.2	38.7	86.6	34.2	113.9	156.9	65.2	14.0	649.3	12.0	127.8	273.4	236.1	0.08	156.93	57.10	49.61	0.92
1938	0.0	2.6	2.3	2.1	54.3	65.1	59.6	245.6	238.0	19.8	2.1	3.7	695.2	2.6	58.7	608.2	25.7	0.01	245.64	54.94	89.36	1.54
1939	7.9	0.0	15.1	53.9	12.4	65.6	44.4	91.7	138.5	147.3	122.1	1.4	700.3	8.0	81.4	340.2	270.8	0.03	147.33	58.36	54.73	0.94
1940	0.1	0.0	5.9	32.2	130.6	63.1	59.5	90.9	103.7	187.3	142.6	11.5	827.4	0.1	168.7	317.2	341.4	0.03	187.28	68.95	62.64	0.91
1941	3.5	6.1	0.0	10.7	30.9	36.8	35.5	64.2	162.4	100.9	53.8	63.2	388.2	9.5	41.5	229.0	238.2	0.02	162.40	49.02	48.09	0.93
1942	0.0	0.4	0.0	17.2	28.3	88.2	35.8	112.3	84.0	40.0	41.2	34.4	463.9	0.4	43.6	300.4	117.5	0.01	112.35	38.66	38.15	0.91
1943	9.3	0.2	0.3	23.1	183.9	29.2	65.8	38.7	125.9	247.1	73.6	4.8	822.9	9.5	207.3	280.6	325.5	0.18	247.13	68.57	79.27	1.16
1944	0.0	12.3	65.6	7.6	21.6	80.7	122.9	41.1	144.8	165.5	96.8	4.7	763.6	12.3	94.8	389.5	287.0	0.04	165.49	63.63	38.34	0.92
1945	0.0	0.0	0.0	22.5	38.5	23.6	126.1	85.9	96.2	49.3	53.9	1.0	497.2	0.1	61.0	331.9	104.2	0.02	126.14	41.43	42.46	1.02
1946	0.2	1.5	7.3	12.1	55.0	34.9	51.7	97.8	150.1	75.1	222.2	102.9	810.8	1.8	74.4	334.5	400.2	0.20	222.20	62.57	67.43	1.10
1947	15.9	1.2	0.2	7.0	14.7	67.7	107.7	146.2	160.6	91.3	11.8	9.8	634.3	17.2	21.8	482.3	112.9	0.17	160.64	58.89	59.50	1.13
1948	3.5	0.1	1.2	29.9	48.5	30.0	71.8	106.4	70.4	97.8	99.5	5.1	564.1	3.5	79.6	278.6	202.4	0.09	106.37	47.01	41.07	0.87
1949	0.0	0.0	0.3	8.0	77.1	87.7	111.9	141.1	186.8	103.7	38.8	0.3	755.7	0.0	85.3	527.5	142.8	0.01	186.83	62.97	64.46	1.02
1950	0.0	6.2	1.8	0.5	48.9	24.5	56.6	80.8	115.8	119.1	37.0	0.4	491.5	6.2	51.2	277.7	136.5	0.01	119.06	40.96	44.31	0.88
1951	0.0	0.1	16.6	29.4	77.3	61.1	86.6	37.8	73.0	71.1	30.3	0.1	483.4	0.2	123.3	238.4	101.4	0.05	86.61	40.28	32.47	0.81
1952	0.0	3.4	0.3	10.5	159.4	45.5	52.5	60.6	49.8	104.5	2.8	86.3	575.8	3.5	170.3	238.4	193.6	0.05	159.41	47.98	49.78	1.04
1953	0.3	0.2	0.1	44.6	20.2	62.9	127.8	40.8	129.8	30.4	114.0	0.2	742.6	0.5	64.9	361.2	315.9	0.07	304.29	61.88	59.42	1.45
1954	4.4	0.1	6.2	6.7	36.7	43.3	163.5	67.0	65.0	184.9	13.2	43.4	480.1	4.5	58.6	381.2	183.7	0.02	163.52	53.57	48.23	0.93
1955	3.5	0.8	6.4	15.0	116.8	36.1	86.9	150.5	133.3	94.7	45.4	16.6	706.2	4.3	136.3	408.8	136.8	0.78	150.52	59.01	54.67	0.93
1956	2.2	0.3	0.1</																			

**Table 17.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Cauvery river catchment areas

YEAR	Cauvery												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	13.9	28.3	8.5	35.2	117.2	102.7	159.4	83.8	215.7	184.9	133.4	24.4	1105.4	40.2	160.9	561.6	342.8	8.48	215.70	92.12	71.48	0.78
1902	24.4	2.8	17.4	44.0	123.2	72.6	192.2	105.7	109.0	236.4	78.2	111.2	1117.0	27.2	184.5	479.5	425.7	2.62	236.37	93.08	69.84	0.75
1903	3.1	1.8	1.2	17.1	164.4	112.7	234.0	133.5	220.1	162.3	219.1	50.2	1339.5	4.9	182.6	620.3	431.7	1.15	233.99	111.63	92.34	0.83
1904	14.8	0.3	2.4	45.1	188.0	126.5	167.6	66.5	81.6	134.8	9.5	4.5	843.7	15.2	235.5	444.2	148.8	0.34	187.99	70.31	68.92	0.98
1905	2.7	11.0	19.9	46.3	122.4	107.9	124.4	113.0	70.8	180.1	54.1	0.6	853.0	13.6	188.6	418.0	234.7	0.62	180.05	71.08	58.19	0.82
1906	21.8	8.7	7.5	7.6	98.2	80.6	187.5	280.8	82.4	181.9	74.1	62.3	1053.3	30.5	73.3	631.3	318.2	7.52	200.77	87.78	85.97	0.98
1907	6.8	0.3	28.7	81.7	76.5	114.6	180.0	167.8	126.9	105.7	93.3	36.1	1018.4	7.1	186.9	589.3	235.1	0.32	180.01	84.87	58.72	0.69
1908	8.9	16.9	17.4	48.7	126.9	85.6	157.6	85.1	103.2	162.3	8.3	4.0	824.8	25.8	193.0	431.4	174.6	3.99	162.31	68.73	59.46	0.87
1909	82.1	3.2	5.1	76.1	178.8	100.6	149.6	210.2	100.1	190.4	54.0	10.1	1160.3	85.3	260.1	560.5	254.3	3.20	210.16	96.69	72.80	0.75
1910	3.9	12.4	4.6	38.2	108.9	110.0	206.8	182.5	69.3	282.1	110.6	1.1	1150.3	16.3	151.7	588.5	393.8	1.08	222.09	95.86	93.74	0.98
1911	1.3	0.9	9.2	44.0	136.5	190.5	172.1	45.2	77.3	147.5	83.2	39.7	947.4	2.3	189.6	485.1	270.4	0.93	190.54	78.95	67.44	0.85
1912	2.8	2.6	2.2	32.8	95.9	131.8	183.1	114.5	175.4	205.1	125.4	4.7	1076.3	5.3	130.9	604.8	335.2	2.23	203.10	89.69	77.66	0.87
1913	1.2	0.7	5.4	22.2	95.3	93.3	197.8	70.5	130.6	154.5	38.1	28.1	857.8	1.9	122.8	512.3	220.7	0.70	197.83	71.48	67.35	0.94
1914	1.7	1.4	4.6	20.5	75.0	88.2	193.6	104.8	120.8	191.5	75.6	42.8	900.7	3.2	100.2	487.4	310.0	1.44	193.60	75.06	67.69	0.90
1915	15.9	3.8	38.9	44.5	75.5	200.7	164.3	93.1	168.4	175.5	131.7	20.1	1114.4	19.8	158.9	626.4	309.3	3.83	200.65	92.88	69.12	0.74
1916	0.6	0.5	1.0	26.3	138.7	141.5	234.2	193.8	126.3	220.9	115.0	18.4	1172.6	1.1	166.0	661.8	343.8	0.53	158.29	84.92	88.34	0.69
1917	4.9	44.6	24.6	22.8	79.0	135.0	74.6	159.6	244.6	149.4	114.6	4.1	1068.0	49.5	126.5	613.9	278.1	4.87	244.60	89.00	73.30	0.85
1918	20.9	0.9	27.8	31.8	108.0	62.9	58.7	96.7	66.6	81.2	232.3	26.3	814.0	21.8	167.6	284.8	339.8	0.89	232.32	87.84	61.13	0.90
1919	12.4	0.7	11.0	39.1	117.7	118.2	144.9	95.3	216.1	106.9	174.1	29.8	1066.1	13.1	167.8	574.5	310.8	0.75	117.13	88.94	70.26	0.79
1920	44.9	1.6	3.1	76.0	74.1	123.3	183.2	78.2	144.8	143.6	150.6	0.7	1024.1	46.5	153.3	529.5	294.9	0.73	183.17	85.34	63.96	0.75
1921	39.5	0.6	1.6	93.6	73.5	110.4	195.7	185.5	79.4	182.1	83.3	13.9	1079.2	60.1	168.6	671.0	279.5	0.90	190.70	89.93	68.87	0.77
1922	19.4	6.4	1.3	29.7	145.7	90.3	152.4	104.6	65.2	232.5	186.9	34.9	1069.3	25.8	176.7	412.5	454.2	1.32	232.46	89.11	76.28	0.86
1923	25.7	0.7	35.5	44.8	63.1	71.8	232.8	187.6	87.0	104.1	20.4	20.9	894.3	26.4	143.4	579.2	145.3	0.71	232.78	74.52	70.75	0.95
1924	11.1	0.3	14.0	48.9	122.2	130.3	360.3	128.8	144.0	80.0	92.0	10.2	1172.1	11.4	185.1	793.4	182.2	0.34	360.35	97.67	106.51	1.09
1925	3.5	2.1	20.9	61.4	110.2	118.9	136.5	120.3	114.6	74.7	115.8	91.0	969.7	5.6	192.4	490.3	281.5	2.06	136.51	80.81	48.26	0.60
1926	40.7	0.9	27.5	49.3	62.1	65.3	194.7	128.4	165.6	124.1	47.7	13.2	919.5	41.6	138.9	554.0	185.1	0.87	194.74	76.63	61.93	0.81
1927	3.2	5.5	6.3	27.6	100.4	134.5	179.5	112.1	159.2	44.0	101.1	8.5	882.0	8.7	134.4	385.3	153.7	3.25	179.50	73.30	65.06	0.89
1928	5.9	48.5	33.9	63.3	75.0	79.2	143.3	135.7	22.8	242.2	78.2	35.8	958.9	54.4	172.1	378.1	334.3	5.65	242.24	79.91	65.79	0.82
1929	8.9	15.9	5.3	145.8	84.0	134.6	150.2	73.7	136.3	126.9	88.1	26.1	1019.1	24.8	235.1	514.8	244.4	0.33	158.29	84.92	88.34	0.69
1930	10.8	27.5	11.5	40.8	201.6	114.1	91.5	76.6	117.1	351.1	107.2	26.1	1179.9	38.3	253.9	392.3	488.5	10.84	332.60	92.33	96.40	1.00
1931	3.6	0.2	2.4	49.5	84.2	69.4	128.9	190.8	134.4	70.3	142.8	108.9	985.2	3.8	136.2	523.2	322.0	0.15	190.56	82.10	61.55	0.75
1932	0.6	28.1	2.2	53.3	189.9	62.9	174.7	214.2	78.4	266.9	156.2	20.1	1247.5	28.7	245.4	530.2	443.2	0.58	266.93	103.95	91.73	0.88
1933	1.4	2.1	13.6	59.6	168.8	95.8	164.7	253.1	168.6	238.1	47.2	53.2	1265.9	3.5	241.9	682.1	336.5	1.39	233.08	105.50	90.03	0.85
1934	42.8	0.4	3.0	42.6	73.4	123.1	109.0	90.3	21.6	243.3	70.8	5.0	825.4	43.2	119.0	344.0	319.2	0.42	243.35	68.78	68.87	1.00
1935	14.7	2.5	4.7	75.2	51.1	94.3	138.3	164.0	96.3	179.4	64.6	27.1	912.1	17.2	130.9	492.9	271.0	2.52	179.37	76.01	60.64	0.80
1936	1.0	25.6	45.7	28.9	115.2	137.9	147.7	89.7	138.3	102.1	120.8	18.0	990.7	26.6	189.8	533.5	240.9	1.03	138.27	82.56	55.84	0.68
1937	2.9	13.2	20.9	107.4	101.8	86.3	162.6	103.3	108.5	175.2	92.2	6.9	981.1	16.0	230.1	460.7	274.3	2.87	175.17	81.76	58.68	0.72
1938	0.5	14.9	17.5	38.2	54.0	107.3	159.1	216.4	129.3	46.3	21.0	23.1	843.3	15.4	130.4	607.1	90.4	0.90	216.43	70.28	67.49	0.96
1939	13.9	1.6	21.5	94.9	73.7	91.5	128.8	147.3	116.6	280.8	145.5	1.3	1117.5	15.5	190.2	484.3	427.6	1.27	280.80	93.13	80.53	0.86
1940	0.6	0.3	6.7	83.0	173.8	143.9	146.3	118.6	102.7	143.4	236.2	33.3	1198.9	0.9	263.5	511.5	423.0	0.29	263.52	99.91	79.00	0.79
1941	9.1	2.1	0.4	64.8	102.3	120.7	139.5	157.1	150.8	111.9	97.7	71.7	1008.0	11.2	167.4	548.1	281.3	0.56	150.85	84.00	54.65	0.65
1942	0.4	0.8	1.9	71.7	104.4	114.1	159.4	140.0	96.6	151.9	40.7	61.7	943.5	1.2	126.0	510.0	254.3	0.43	159.36	76.43	58.36	0.74
1943	65.6	8.4	5.4	75.0	151.3	72.4	181.8	64.4	121.1	201.0	80.6	4.5	1121.4	74.0	231.6	438.7	276.1	1.54	200.96	93.45	83.33	0.89
1944	6.3	31.2	61.1	30.7	91.4	89.7	155.2	100.2	156.4	186.1	151.9	51.7	1111.9	37.5	183.2	501.6	389.6	6.33	186.06	92.66	58.79	0.63
1945	1.5	3.0	0.6	68.0	85.1	66.7	181.0	113.8	48.1	150.8	95.2	3.2	817.1	4.5	153.8	409.5	240.2	0.61	181.03	68.09	60.71	0.89
1946	10.3	2.0	27.7	70.4	86.0	113.9	142.3	178.7	160.4	155.5	229.2	114.4	1290.7	12.2	184.1	595.3	469.1	1.95	229.20	107.56	70.77	0.66
1947	17.8	5.4	33.7	64.4	62.0	86.5	144.0	191.9	122.9	204.5	15.5	17.6	969.1	23.2	160.0	545.4	237.6	5.39	204.50	80.51	70.21	0.67
1948	24.8	1.4	5.4	65.8	144.8	125.9	132.7	200.5	52.7	140.6	115.8	14.6	1025.0	26.2	216.0	511.8	271.0	1.43	200.46	85.42	66.20	0.77
1949	1.1	1.2	1.9	68.8	125.6	80.0	175.4	142.5	92.3	213.4	26.2	0.4	929.0	2.4	196.3	490.2	240.1	0.45	213.44	77.42	74.37	0.96
1950	0.5	42.5	8.8	6.3	63.3	73.3	181.7	159.9	111.8	145.8	86.7	6.4	887.1	43.1	78.4	526.8	238.9	0.53	181.73	73.93	64.41	0.87
1951	2.8	0.2	23.8	99.7	134.0	82.7	156.1	84.7	167.3	106.7	90.5	3.0	951.4	3.0	257.4	490.7	200.3	0.20	257.42	79.28	59.51	0.75
1952	2.7	25.0	6.3	46.2	71.9	75.5	146.2	105.8	66.1	159.9	13.6	98.8	818.1	27.6	124.4	393.6	272.4	2.67	159.89	68.17	52.54	0.74
1953	2.2	11.2	1.9	46.6	73.2	121.9	245.3	125.6	126.9	304.6	29.6	4.8	1157.3	13.4	185.4	619.7	326.7	1.92	304.66	96.44	98.45	1.02
1954	29.2	1.4	26.9	56.9	157.0	103.2	188.0	177.0	44.5	236.5	14.8	41.1	1076.7	30.7	240.8	512.8	292.4	1.44	236.48	89.73	79.78	0.

**Table 18.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2010 in the selected Mahanadi river catchment areas

YEAR	Mahanadi												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	46.2	108.8	26.1	13.9	18.5	80.1	359.0	452.4	160.4	32.5	5.3	0.5	1303.6	155.0	38.6	1051.8	36.2	0.51	452.38	108.63	147.80	1.36
1902	1.7	3.6	2.4	33.3	8.6	46.5	427.2	305.4	189.4	10.3	4.2	9.3	1041.9	5.3	44.3	968.5	23.8	1.67	427.21	86.83	142.95	1.65
1903	9.0	14.6	3.3	13.1	44.8	107.6	389.9	380.3	221.4	165.9	7.5	2.3	1339.8	23.6	61.2	1079.1	175.8	2.35	389.86	111.65	142.96	1.28
1904	0.8	12.5	28.5	3.6	38.8	395.2	330.6	404.0	119.6	78.4	0.5	0.9	1431.2	13.3	90.9	1249.3	77.7	0.46	403.99	119.27	160.36	1.34
1905	39.2	24.0	26.0	24.7	44.0	319	403.1	295.3	344.6	11.2	0.2	1.1	1284.2	63.2	94.6	1063.9	12.5	0.21	403.09	105.35	148.72	1.41
1906	25.0	84.7	39.3	0.8	6.9	195.6	444.6	281.3	219.2	43.4	6.4	20.6	1367.6	109.7	66.9	1140.7	70.3	0.96	444.65	115.64	140.25	1.21
1907	2.6	27.3	44.2	60.9	5.5	279.0	240.0	496.5	192.6	2.5	9.1	23.2	1385.4	29.9	110.6	1208.1	36.8	2.53	496.50	115.43	155.38	1.35
1908	11.6	37.3	5.2	2.4	15.5	196.0	440.6	556.7	162.9	21.3	0.3	10.2	1451.2	48.9	23.2	1396.3	22.8	0.96	556.72	120.95	189.69	1.57
1909	6.8	4.9	5.9	131.6	10.9	299.2	483.8	230.3	170.0	9.6	0.3	40.8	1394.1	11.8	148.5	1183.2	50.7	0.26	483.75	116.17	154.96	1.33
1910	7.3	1.4	2.9	28.8	12.3	237.5	336.2	453.8	234.1	107.7	10.0	0.8	1432.7	8.6	44.0	1261.5	118.6	0.82	453.75	119.39	157.19	1.32
1911	2.0	0.9	20.3	1.0	11.8	396.2	176.8	540.6	228.9	110.3	16.5	1.1	1506.6	2.9	33.2	1342.6	127.9	0.85	420.65	125.55	180.11	1.43
1912	3.8	88.0	2.2	24.0	7.1	72.3	421.2	410.6	185.8	8.3	7.8	0.8	1231.9	91.8	33.3	1089.8	17.0	0.81	541.15	102.65	156.03	1.52
1913	1.5	66.8	21.0	3.2	31.1	241.7	334.1	317.7	120.6	30.2	5.6	12.1	1205.6	68.3	55.2	1014.1	67.9	1.90	334.14	100.46	125.41	1.25
1914	0.2	7.8	17.0	46.0	79.1	161.2	485.8	340.5	230.6	9.9	0.2	3.2	1375.6	8.0	142.1	1218.2	7.3	0.23	485.80	114.63	160.17	1.40
1915	24.8	28.9	21.3	14.1	20.6	98.0	342.4	367.1	289.8	104.4	25.3	0.7	1337.4	53.7	36.0	1097.2	130.4	0.74	367.08	111.45	138.36	1.24
1916	1.2	19.8	2.9	10.0	16.6	139.8	380.0	166.8	187.6	22.5	0.3	1427.1	20.1	29.7	1219.2	169.2	1.03	380.00	118.23	148.34	1.25	
1917	1.2	66.8	29.9	11.3	39.7	315.2	374.0	413.8	265.3	223.0	1.7	1.0	1743.5	68.0	81.0	1369.3	225.2	0.74	413.80	145.29	160.93	1.11
1918	14.3	2.9	5.9	8.3	50.2	523.7	235.5	406.7	169.2	1.7	3.7	8.0	1430.3	17.3	64.4	1335.1	13.5	1.94	523.70	119.19	179.95	1.51
1919	84.6	51.6	33.3	15.2	39.1	408.0	393.0	552.3	146.1	89.4	17.3	1.4	1831.4	136.2	87.6	1499.5	108.1	1.36	552.30	152.62	188.01	1.23
1920	0.8	4.4	26.7	25.9	20.4	120.7	544.5	349.9	120.5	2.1	0.1	0.7	1216.6	5.2	72.9	1135.6	2.9	0.10	544.52	101.38	142.28	1.70
1921	39.3	0.6	2.0	4.6	0.9	293.3	283.8	387.2	241.9	11.3	0.2	0.8	1265.8	40.0	7.4	1206.2	12.2	0.15	387.22	105.48	178.69	1.41
1922	21.3	0.8	2.3	11.7	10.7	194.6	419.2	274.5	334.1	17.5	24.1	1.1	1301.7	22.1	24.6	1212.3	42.7	0.82	419.16	106.47	152.89	1.41
1923	2.9	27.6	16.0	3.7	6.3	91.1	349.7	491.5	193.7	56.1	15.0	1.9	1255.6	30.5	26.1	1126.0	73.0	1.90	491.54	104.63	160.32	1.55
1924	34.3	4.0	6.3	5.6	26.9	73.8	289.7	314.9	257.4	83.8	95.3	0.8	1192.9	36.3	38.8	935.9	179.9	0.81	314.93	99.41	118.45	1.19
1925	0.2	0.4	3.5	19.4	95.6	331.3	529.4	430.0	182.4	61.5	13.2	5.3	1672.2	0.6	118.5	1473.2	79.9	0.24	529.40	139.35	187.99	1.35
1926	36.7	9.9	92.4	49.6	42.5	44.3	311.7	397.8	324.8	70.3	0.2	3.0	1583.1	46.6	184.5	1278.5	73.5	0.22	397.79	131.92	183.97	1.39
1927	3.4	49.8	1.9	3.8	11.6	207.5	407.9	448.8	175.1	75.8	17.4	0.9	1421.0	53.3	33.4	1249.5	94.0	0.86	448.76	128.42	160.19	1.35
1928	3.5	7.8	9.7	21.2	22.6	233.4	430.0	246.9	169.9	122.5	0.0	2.6	1257.1	11.3	53.5	1097.2	125.1	0.94	419.95	104.78	136.22	1.30
1929	20.6	19.7	2.4	7.0	5.2	181.5	613.5	447.5	179.8	93.2	2.6	1.6	1437.9	30.3	19.5	1344.6	23.3	1.55	447.42	132.46	199.79	1.50
1930	0.4	2.3	8.3	36.9	7.2	185.2	449.9	269.0	216.1	26.7	93.0	4.6	1299.7	2.7	52.4	1120.2	124.4	0.38	449.89	106.20	143.30	1.25
1931	8.6	36.8	13.3	5.7	14.2	114.6	293.2	519.9	166.6	136.6	38.2	1.0	1368.5	45.4	33.2	1094.3	195.7	0.95	519.87	114.04	155.29	1.36
1932	0.3	20.2	4.7	9.9	19.4	116.8	527.1	290.2	267.7	54.7	42.0	1.0	1354.0	20.5	34.1	1201.8	97.6	0.32	527.12	112.84	165.22	1.46
1933	20.9	82.0	13.2	20.1	107.0	317.7	427.7	432.3	260.9	39.5	6.5	5.1	1727.8	103.0	140.4	1433.6	50.9	5.12	432.32	143.99	166.96	1.16
1934	1.0	0.2	3.5	6.0	1.3	255.0	362.2	431.8	330.7	55.7	8.3	1.9	1487.6	1.2	10.8	1409.7	65.9	0.17	431.81	123.96	174.12	1.60
1935	5.0	13.1	6.2	30.6	2.2	129.7	579.4	244.9	230.3	2.8	0.0	5.4	1249.8	18.2	30.0	1194.3	8.3	0.04	579.44	104.15	174.93	1.68
1936	27.2	36.1	15.4	3.3	47.1	463.8	405.8	423.7	257.5	81.8	7.4	5.1	1724.1	63.4	65.8	1500.8	94.2	3.34	463.79	147.84	184.54	1.25
1937	0.2	55.6	25.2	80.5	13.4	248.5	459.3	402.5	247.3	69.3	0.6	1.0	1603.4	55.8	119.1	1376.6	70.9	0.21	459.32	133.62	164.27	1.23
1938	12.2	22.4	5.1	3.4	60.0	252.0	346.1	300.8	272.9	113.4	8.4	0.8	1457.6	34.6	68.5	1231.8	122.7	0.84	346.13	127.41	147.01	1.19
1939	6.2	21.6	35.4	15.5	0.9	217.5	412.4	515.6	234.0	75.5	2.1	1.1	1597.7	27.8	71.7	1399.5	78.7	0.85	515.59	129.81	177.17	1.36
1940	0.3	26.0	32.5	20.3	38.0	249.4	544.9	359.1	77.4	53.9	1.0	20.9	1443.6	26.3	90.8	1250.8	75.7	0.34	544.91	120.30	166.35	1.47
1941	26.5	10.0	18.9	4.2	28.8	268.2	248.0	261.3	153.3	63.7	16.3	0.9	1082.1	36.5	51.9	912.7	81.0	0.92	268.18	90.18	108.18	1.20
1942	11.6	38.7	5.0	7.8	6.6	155.5	494.4	416.2	228.3	19.2	2.6	1.6	1437.9	30.3	19.5	1344.6	23.3	1.55	494.42	119.81	138.19	1.49
1943	108.8	2.5	4.3	23.2	29.3	195.5	424.6	403.3	383.8	34.6	1.3	0.7	1612.1	111.4	56.8	1407.2	36.7	0.75	424.63	134.34	172.26	1.28
1944	21.6	77.3	96.4	21.7	9.1	94.5	563.4	480.3	188.8	127.9	4.1	0.8	1666.0	99.0	127.2	1307.0	132.8	0.83	363.36	138.84	184.70	1.33
1945	28.3	2.6	1.5	49.3	9.5	196.0	419.0	329.0	388.7	69.5	1.2	1.4	1462.9	30.8	60.3	1302.7	61.1	1.19	419.01	119.11	162.89	1.34
1946	0.1	6.0	3.1	27.1	21.1	298.2	330.2	494.4	205.3	54.0	28.9	1.1	1489.6	6.1	51.2	1348.2	84.1	0.13	494.45	124.14	170.10	1.37
1947	24.3	33.4	14.2	3.6	4.6	138.6	456.3	478.4	214.8	72.0	0.1	13.8	1474.1	57.6	22.4	1308.1	85.9	0.11	478.36	122.84	174.41	1.42
1948	23.4	8.9	9.1	7.8	10.4	214.8	370.0	407.9	231.3	39.6	63.6	0.6	1387.4	32.2	27.3	1224.1	103.8	0.57	407.94	115.62	150.47	1.30
1949	0.6	3.5	4.3	7.8	57.6	170.9	385.6	420.8	272.8	133.9	0.1	1.6	1459.4	4.1	69.6	1250.1	135.6	0.99	420.75	121.62	157.40	1.30
1950	0.7	35.0	68.1	1.3	5.1	225.7	443.2	374.4	153.6	18.0	18.0	0.6	1343.7	35.7	74.5	1196.9	36.6	0.63	443.20	111.98	155.86	1.39
1951	4.7	2.9	104.1	53.4	30.2	131.6	307.5	414.2	130.0	97.5	5.8	0.7	1617.7	98.3	103.9	1067.7	98.3	0.67	414.18	106.98	138.58	1.39
1952	1.2	14.8	15.7	15.7	13.3	142.1	418.4	383.5	322.7	54.8	0.7	0.8	1383.8	16.0	44.8	1266.8	96.3	0.69	418.42	115.32	162.80	1.41
1953	27.6	7.2	0.6	13.6	7.4	126.6	447.4	474.4	193.2	33.1	4.3	0.4	1345.7	34.8	21.5	1241.6	47.8	0.44	474.36	112.14	173.36	1.55
1954	3.1	2.1	4.9	9.6	5.3	128.6	270.6	318.2	359.9	18.2	1.2	6.8	1127.5	5.2	19.7	1076.3	26.2	1.17	338.21	93.95	139.63	1.49
1955	2.1	6.6	18.6</																			

Characteristics of long-term variability of precipitation in selected river catchment areas in India ..

**Table 19.** A statement of total monthly precipitation [mm] and selected statistics for the long-term period 1901 – 2012 in the Godavari river area

YEAR	Godavari												MIN	MAX	MEAN	SD	CV					
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC										
1901	21.1	39.8	24.3	34.8	24.8	121.2	292.5	349.9	110.4	52.8	8.5	0.4	1080.7	60.9	84.0	874.1	61.7	0.37	349.91	90.06	114.77	1.27
1902	1.5	0.4	2.1	25.3	9.5	59.0	230.6	226.7	223.8	36.3	32.3	24.3	894.0	2.0	37.1	760.1	94.9	0.44	250.62	74.30	97.69	1.31
1903	5.0	4.5	1.4	8.6	46.8	130.9	423.6	336.2	197.9	135.5	16.0	4.0	1300.3	9.5	56.8	1078.6	153.5	1.36	423.62	106.36	142.13	1.31
1904	0.8	2.8	13.2	3.0	35.8	172.7	206.8	174.6	223.3	83.2	0.2	1.4	919.6	3.6	31.9	771.4	86.8	0.13	223.28	76.64	91.05	1.19
1905	3.9	8.7	18.3	28.7	21.1	93.6	233.9	235.4	204.6	13.3	1.0	2.0	939.1	12.6	66.1	861.5	18.9	0.46	284.60	79.39	109.41	1.39
1906	12.6	7.0	16.8	3.0	10.1	312.1	333.7	275.7	130.5	17.5	12.3	24.5	1155.9	19.6	29.9	1032.1	54.4	2.98	333.67	96.33	132.16	1.37
1907	2.1	24.7	10.4	63.5	3.8	199.3	265.9	363.4	88.9	4.3	13.4	7.1	1046.9	26.7	77.6	917.7	24.8	2.09	363.39	87.24	122.16	1.40
1908	10.2	9.8	9.0	7.8	11.1	159.5	331.6	371.1	290.8	10.2	0.5	1.7	1213.3	20.1	27.9	1153.0	12.3	0.46	371.10	101.11	146.34	1.45
1909	2.5	5.0	4.8	34.3	20.6	169.2	382.4	191.1	153.5	9.8	0.6	41.4	1035.3	7.5	79.9	896.1	51.8	0.61	382.38	86.28	117.10	1.36
1910	0.6	0.3	1.1	11.4	17.6	266.3	283.6	274.1	330.5	102.3	48.9	0.4	1337.1	0.9	30.1	1154.5	151.6	0.27	330.50	111.42	134.85	1.21
1911	7.0	0.3	5.3	5.6	13.3	205.1	222.7	294.3	180.6	40.6	35.1	3.5	1013.4	7.2	24.3	902.7	79.2	0.27	294.31	84.43	108.08	1.28
1912	1.4	41.3	1.2	17.8	18.9	56.4	373.2	335.2	141.8	20.1	23.7	0.7	1031.7	42.7	38.0	906.6	44.5	0.67	373.20	83.98	131.28	1.33
1913	0.2	19.5	4.3	11.9	28.2	179.3	334.6	225.0	129.7	37.9	0.6	15.0	1006.3	19.7	44.4	888.6	33.6	0.16	334.62	83.83	114.40	1.36
1914	0.1	7.6	10.4	38.7	28.1	277.8	337.4	268.4	296.6	10.9	8.0	10.2	1314.3	7.8	77.2	1200.2	29.1	0.13	337.40	109.52	142.61	1.30
1915	26.3	13.7	58.6	19.5	19.2	196.9	236.4	265.5	236.4	119.8	15.3	10.7	1218.9	39.9	97.3	935.1	145.9	10.67	265.48	101.52	103.17	1.02
1916	0.2	9.6	1.5	11.3	30.4	215.6	327.8	281.9	257.8	140.0	48.9	0.6	1323.6	9.8	43.2	1083.2	189.5	0.18	327.84	110.46	126.71	1.15
1917	0.4	60.4	17.2	21.7	49.7	240.0	323.5	234.5	352.9	156.6	14.7	0.6	1471.9	60.7	88.6	1150.7	171.8	0.37	352.99	122.66	132.36	1.08
1918	9.6	1.9	7.4	7.4	93.5	218.4	183.2	209.4	101.3	5.8	10.0	18.6	866.6	11.6	108.3	712.3	34.4	1.94	218.43	72.22	86.46	1.20
1919	37.1	33.9	19.7	16.2	30.3	265.9	294.2	283.0	164.7	102.7	32.1	3.9	1235.0	71.0	66.2	1401.3	52.1	3.21	274.20	103.75	108.16	1.04
1920	16.1	0.9	5.8	18.2	15.6	109.8	214.3	144.8	103.1	17.6	0.2	0.5	644.8	17.0	37.7	571.9	18.3	0.16	114.26	33.73	71.37	3.33
1921	15.3	0.3	1.2	13.5	1.8	243.8	279.7	255.7	213.9	33.8	9.9	0.5	1073.3	15.6	16.4	993.1	46.2	0.30	279.76	89.44	118.88	1.33
1922	3.2	1.8	1.1	9.8	21.5	200.5	318.7	154.5	269.3	31.5	73.2	0.5	1114.7	34.0	32.4	943.0	103.9	0.50	318.70	92.89	113.86	1.23
1923	1.2	10.3	27.8	12.3	5.1	30.8	334.8	197.8	277.9	34.1	6.9	1.9	940.9	11.3	43.2	841.3	42.9	1.23	334.79	78.41	119.80	1.33
1924	16.6	0.7	4.6	12.4	10.4	52.1	251.0	249.6	260.8	89.3	5.9	4.4	1006.7	17.3	27.5	813.5	148.3	0.70	260.79	83.89	105.81	1.26
1925	0.1	0.2	4.7	15.7	62.1	157.5	319.3	341.3	123.3	37.1	44.1	3.5	1129.0	0.3	82.4	941.5	104.7	0.12	341.26	94.09	121.23	1.29
1926	49.7	4.6	28.3	25.7	38.7	56.3	283.8	401.1	168.7	37.6	2.0	1.1	1097.6	54.3	92.7	909.9	40.7	1.10	401.08	91.47	127.25	1.40
1927	1.8	9.8	14.8	5.6	11.6	237.5	330.8	234.5	127.5	64.3	69.9	3.0	1171.0	11.5	31.9	990.3	137.2	1.77	330.87	97.38	122.71	1.26
1928	0.5	25.6	10.4	7.2	9.8	163.7	324.6	205.7	241.7	110.8	0.6	8.9	1109.6	26.1	27.4	935.7	120.3	0.52	324.60	92.47	114.25	1.24
1929	3.3	43.6	2.4	23.2	7.3	187.7	232.5	217.2	196.7	57.7	0.1	19.1	1011.1	47.0	32.9	854.2	77.0	0.14	232.55	84.26	98.13	1.16
1930	0.1	5.2	8.2	25.9	8.1	208.6	242.9	185.9	235.2	63.9	51.2	2.1	1039.3	5.3	42.2	872.6	119.2	0.13	242.86	86.61	100.08	1.16
1931	2.5	3.8	9.6	12.4	13.5	132.1	355.3	334.1	240.9	207.3	48.8	4.9	1363.5	6.5	33.6	1062.4	26.10	2.47	355.29	113.78	136.50	1.20
1932	0.2	21.0	6.9	13.5	23.3	126.2	439.2	211.6	201.2	44.7	35.5	1.7	1125.0	21.2	43.7	978.3	81.8	0.17	439.29	93.75	152.13	1.41
1933	6.4	26.0	10.3	22.9	80.6	236.8	316.7	203.8	294.0	88.1	13.3	21.6	1443.2	32.3	113.8	1193.5	123.3	6.43	216.69	120.18	131.14	1.09
1934	1.9	0.4	2.2	14.4	8.6	172.0	343.7	339.4	231.6	36.6	47.2	1.5	1218.4	2.2	32.2	1108.7	83.5	0.36	343.45	101.53	138.83	1.37
1935	9.3	3.0	1.6	27.9	4.9	148.6	408.9	199.0	247.7	45.6	1.1	2.1	1099.4	12.3	34.4	1004.3	48.4	1.07	408.94	91.62	132.29	1.44
1936	7.4	38.9	19.1	9.5	49.6	295.9	315.4	293.8	192.0	61.1	63.5	5.6	1373.6	66.3	78.2	1097.1	132.0	5.65	315.38	114.46	122.38	1.08
1937	0.2	56.0	34.1	97.0	6.1	117.8	417.5	177.7	206.0	99.2	0.4	8.0	1197.9	36.1	137.1	918.9	105.7	1.16	417.47	99.82	122.10	1.22
1938	2.5	22.1	18.9	13.4	38.9	288.2	377.5	284.6	222.0	140.1	11.7	1.0	1420.8	24.5	71.2	1172.3	152.7	0.96	377.51	118.40	138.15	1.17
1939	1.7	2.2	26.2	15.5	2.8	113.3	249.4	311.9	112.5	80.8	11.9	1.1	929.3	3.9	44.5	787.1	93.8	1.06	311.97	77.44	104.72	1.33
1940	0.3	6.6	12.3	22.2	46.6	221.0	436.5	326.6	87.7	73.9	19.4	10.9	1263.8	6.9	81.1	1071.7	104.1	0.28	436.50	103.31	144.42	1.37
1941	10.6	8.4	10.3	5.4	15.7	147.7	202.8	200.0	159.8	34.1	10.4	0.7	803.8	19.0	31.3	710.2	43.2	0.68	202.82	67.15	83.23	1.24
1942	2.1	43.5	1.0	24.1	17.1	191.4	434.3	356.4	154.1	19.4	4.8	20.6	1268.9	45.6	42.2	1136.2	44.9	0.97	434.26	103.74	149.37	1.41
1943	33.7	1.1	1.9	17.1	37.5	190.2	287.9	179.0	287.5	100.7	3.4	1.0	1140.7	34.8	56.5	944.7	104.8	0.68	287.94	95.06	112.15	1.18
1944	4.0	38.0	74.5	9.5	12.3	105.4	425.0	279.6	214.2	100.1	14.2	0.7	1277.4	42.0	96.3	1024.1	115.0	0.70	425.03	106.43	133.92	1.26
1945	12.7	0.4	0.2	36.3	10.6	163.5	381.1	296.8	268.1	56.1	5.9	2.5	1234.2	13.1	47.1	1109.5	64.5	0.25	381.11	102.85	138.09	1.34
1946	0.2	13.7	2.1	37.2	21.3	225.2	339.2	295.8	132.9	22.2	77.1	8.2	1351.5	13.9	60.6	993.2	107.5	0.15	339.24	97.93	122.27	1.23
1947	26.5	18.1	12.4	11.5	12.7	110.0	399.4	363.6	237.4	43.4	8.0	17.3	1251.5	44.6	36.6	1101.4	68.7	8.02	399.39	104.27	143.43	1.36
1948	23.3	5.8	7.8	18.4	3.6	172.0	343.7	339.4	231.6	36.6	47.2	1.5	1218.4	2.2	32.2	1108.7	83.5	0.36	343.45	101.53	138.83	1.37
1949	1.9	0.4	2.2	14.4	8.6	172.0	343.7	339.4	231.6	36.6	47.2	1.5	1218.4	2.2	32.2	1108.7	83.5	0.36	343.45	101.53	138.83	1.37
1950	0.4	23.4	19.0	2.7	15.1	104.1	334.6	167.4	187.9	28.1	15.2	4.5	924.5	25.8	36.8	814.1	47.9	0.40	334.61	77.04	109.12	1.42
1951	2.3	0.8	44.1	22.1	28.3	144.1	363.1	272.6	122.8	83.5	9.2	0.8	1093.8	3.1	94.6	902.5	93.6	0.82	363.08	91.15	117.77	1.29
1952	0.5	14.3	5.6	15.6	18.8	100.7	266.1	224.9	184.6	66.7	0.4	5.3	903.4	14.6	40.1	776.3	72.4	0.26	266.08	75.28	96.72	1.28
1953	7.9	1.4	0.3	25.5	5.4	192.8	269.9	402.7	209.7	110.6	2.3	0.4	1219.8	9.2	31.2	1075.0	104.3	0.29	402.67	101.63	135.91	1.34
1954	0.5	0.4	13.4	11.0	14.1	133.3	360.4	236.5	298.1	26.1	0.5	4.3	1118.6	0.8	38.5	1048.3	30.9	0.36	360.40	93.22	134.39	1.44
1955	7.5	0.5	3.9	15.3	27.7	210.0	248.7	395.9	268.3													

**Table 20.** A statement of periodicity values (inverses of predominating frequencies) for mean monthly precipitation sequences in the analysed long-term period 1901–2010 in the selected catchment areas in India

Analysed sequence profile	Months of the calendar year												Statistics of				
	'I'	'II'	'III'	'IV'	'V'	'VI'	'VII'	'VIII'	'IX'	'X'	'XI'	'XII'	MIN	MAX	MEAN	SD	CV
	[years]																
BRAHMAPUTRA	4.54	4.36	2.48	109.00	2.66	4.19	36.33	54.50	54.50	8.38	2.02	3.11	2.02	109.00	109.00	109.00	4.04
INDUS	3.76	13.63	7.79	5.19	7.79	3.89	2.42	2.32	4.04	13.63	2.10	4.74	2.10	21.80	2.32	2.79	3.63
GANGES	12.11	4.19	2.53	18.17	7.27	2.48	2.14	3.63	7.27	13.63	2.60	6.06	54.50	6.41	2.32	2.73	21.80
MAHI	36.33	12.11	3.89	2.73	4.36	21.80	2.42	3.11	3.63	13.63	3.03	2.10	2.79	3.52	3.52	3.52	2.22
NARMADA	12.11	36.33	6.06	2.27	3.76	27.25	2.42	2.42	5.45	13.63	10.90	2.14	3.52	54.50	2.32	109.00	5.45
TAPTI	21.80	12.11	2.10	2.48	4.74	2.66	2.42	4.74	6.41	13.63	9.91	18.17	3.52	54.50	15.57	54.50	21.80
DAMODAR	2.22	2.02	6.81	3.11	7.27	2.48	54.50	27.25	2.14	13.63	2.02	54.50	4.19	54.50	54.50	3.03	3.03
BRAHMANI	3.41	3.41	6.41	2.27	4.74	2.48	2.53	3.21	2.42	13.63	9.08	2.18	109.00	3.63	3.21	10.90	3.03
KRISHNA	4.95	3.89	2.66	2.02	2.73	2.22	5.45	7.79	2.14	9.91	15.57	3.11	6.41	15.57	15.57	15.57	3.76
PENNER	109.00	2.66	21.80	2.66	3.03	4.95	3.11	2.48	3.63	9.91	2.37	3.89	6.81	2.66	2.87	2.66	4.95
CAUVERY	109.00	2.22	2.66	54.50	3.52	2.06	4.95	2.37	2.14	54.50	15.57	4.95	2.66	2.66	7.27	2.66	3.52
MAHANADI	3.41	3.52	3.41	2.27	4.74	4.74	2.53	2.95	2.32	2.14	54.50	2.73	4.54	2.95	10.90	3.41	2.95
GODAVARI	2.27	2.06	2.66	2.53	7.27	2.66	3.11	2.14	6.41	13.63	2.37	3.76	3.89	2.73	2.14	2.66	3.76

**Table 21.** Values of parameters of the linear trend in monthly precipitation in a calendar year in the analysed long-term period 1901–2010 in the selected river catchment areas in India

	Units	Months of the calendar year												Statistics of				
		'I'	'II'	'III'	'IV'	'V'	'VI'	'VII'	'VIII'	'IX'	'X'	'XI'	'XII'	MIN	MAX	MEAN	SD	CV
BRAHMAPUTRA																		
Slope value, $\alpha$		-0.057	-0.083	-0.075	-0.221	0.166	-0.229	-0.234	-0.800	-0.120	-0.140	-0.075	-0.021	0.001	-1.242	-0.157	-0.279	-0.001
Lower limit at a 95% confidence level	[mm/year]	-0.120	-0.170	-0.252	-0.464	-0.180	-0.662	-0.758	-1.336	-0.478	-0.383	-0.167	-0.075	-0.020	-1.646	-0.252	-0.390	-0.002
Upper limit at a 95% confidence level		0.006	0.004	0.102	0.021	0.512	0.205	0.290	-0.264	0.238	0.104	0.017	0.033	0.023	-0.837	-0.063	-0.168	-0.001
INDUS																		
Slope value, $\alpha$		-0.030	0.058	-0.029	-0.010	0.013	0.086	0.084	-0.036	-0.015	0.031	0.027	-0.018	0.011	-0.019	0.013	-0.061	-0.001
Lower limit at a 95% confidence level	[mm/year]	-0.134	-0.056	-0.158	-0.095	-0.054	-0.004	-0.099	-0.218	-0.172	-0.039	-0.018	-0.100	-0.008	-0.187	-0.024	-0.060	-0.001
Upper limit at a 95% confidence level		0.074	0.171	0.099	0.075	0.080	0.176	0.268	0.146	0.142	0.102	0.072	0.063	0.031	0.150	0.051	0.030	0.000
GANGES																		
Slope value, $\alpha$		-0.005	-0.024	-0.033	-0.003	0.027	-0.005	-0.060	-0.314	0.025	0.034	-0.026	-0.018	-0.009	-0.245	-0.033	-0.079	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.087	-0.118	-0.107	-0.067	-0.067	-0.329	-0.407	-0.597	-0.306	-0.177	-0.092	-0.077	-0.024	-0.462	-0.097	-0.155	-0.001
Upper limit at a 95% confidence level		0.078	0.070	0.041	0.062	0.122	0.319	0.287	-0.031	0.356	0.245	0.041	0.042	0.007	-0.029	0.031	-0.003	0.000
MAHI																		
Slope value, $\alpha$		-0.008	-0.013	-0.014	0.017	-0.065	-0.034	0.095	0.502	0.122	0.022	0.080	0.016	0.000	-0.017	0.060	0.033	-0.001
Lower limit at a 95% confidence level	[mm/year]	-0.038	-0.032	-0.049	-0.004	-0.151	-0.417	-0.612	-0.266	-0.563	-0.194	-0.040	-0.018	-0.001	-0.706	-0.054	-0.164	-0.002
Upper limit at a 95% confidence level		0.022	0.007	0.021	0.038	0.021	0.350	0.802	1.269	0.808	0.238	0.201	0.049	0.000	0.672	0.174	0.231	0.000
NARMADA																		
Slope value, $\alpha$		-0.019	-0.022	-0.006	-0.032	-0.003	0.118	0.087	0.249	0.160	0.004	-0.017	0.004	0.003	0.306	0.044	0.071	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.115	-0.103	-0.080	-0.067	-0.084	-0.296	-0.528	-0.337	-0.450	-0.223	-0.178	-0.092	-0.003	-0.197	-0.056	-0.075	-0.001
Upper limit at a 95% confidence level		0.077	0.059	0.067	0.003	0.078	0.533	0.701	0.836	0.771	0.231	0.144	0.100	0.008	0.810	0.144	0.218	0.001
TAPTI																		
Slope value, $\alpha$		-0.045	-0.015	0.036	0.002	0.002	0.085	0.312	0.681	0.310	0.212	0.069	-0.022	0.001	0.449	0.136	0.147	-0.001
Lower limit at a 95% confidence level	[mm/year]	-0.112	-0.065	-0.023	-0.029	-0.092	-0.262	-0.099	0.227	-0.178	-0.059	-0.141	-0.098	-0.002	0.106	0.054	0.037	-0.001
Upper limit at a 95% confidence level		0.022	0.034	0.095	0.033	0.097	0.433	0.724	1.136	0.799	0.483	0.279	0.054	0.004	0.793	0.218	0.256	0.000
DOMODAR																		
Slope value, $\alpha$		-0.030	-0.128	-0.049	-0.015	0.066	-0.004	0.120	-0.141	0.575	0.021	0.003	0.043	0.003	0.260	0.038	0.052	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.139	-0.274	-0.175	-0.111	-0.120	-0.585	-0.472	-0.633	0.060	-0.401	-0.137	-0.019	-0.004	-0.238	-0.074	-0.094	-0.001
Upper limit at a 95% confidence level		0.079	0.018	0.077	0.082	0.251	0.578	0.711	0.351	1.090	0.443	0.144	0.105	0.010	0.758	0.151	0.199	0.001
BRAHMANI																		
Slope value, $\alpha$		-0.069	-0.148	-0.005	-0.006	0.091	-0.122	-0.027	-0.366	0.271	0.052	0.008	0.034	0.017	-0.448	-0.024	-0.110	-0.001
Lower limit at a 95% confidence level	[mm/year]	-0.202	-0.329	-0.140	-0.114	-0.088	-0.674	-0.631	-0.913	-0.169	-0.303	-0.132	-0.037	0.003	-0.994	-0.123	-0.256	-0.001
Upper limit at a 95% confidence level		0.063	0.032	0.130	0.102	0.270	0.430	0.578	0.181	0.712	0.407	0.149	0.105	0.032	0.098	0.075	0.036	0.000
KRISHNA																		
Slope value, $\alpha$		-0.016	-0.022	0.062	0.024	0.121	0.104	0.039	0.308	-0.006	0.241	-0.039	-0.038	-0.001	0.173	0.065	0.069	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.048	-0.057	-0.008	-0.052	-0.035	-0.089	-0.255	0.023	-0.342	-0.058	-0.231	-0.106	-0.005	-0.070	0.003	-0.004	-0.001
Upper limit at a 95% confidence level		0.017	0.014	0.133	0.101	0.277	0.297	0.333	0.592	0.331	0.540	0.154	0.029	0.003	0.416	0.126	0.143	0.001
PENNER																		
Slope value, $\alpha$		-0.095	-0.027	0.048	0.069	0.205	0.157	0.055	0.234	-0.209	0.305	-0.200	-0.001	-0.005	0.187	0.045	0.052	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.166	-0.080	-0.029	-0.034	-0.013	-0.043	-0.206	-0.129	-0.551	-0.090	-0.533	-0.151	-0.010	-0.116	-0.025	-0.035	-0.001
Upper limit at a 95% confidence level		-0.023	0.025	0.124	0.172	0.424	0.356	0.317	0.597	0.133	0.700	0.133	0.149	0.000	0.490	0.115	0.139	0.001
CAUVERY																		
Slope value, $\alpha$		-0.116	-0.016	0.084	0.149	-0.082	-0.095	-0.290	-0.087	0.018	0.190	0.067	0.013	-0.005	0.056	-0.014	0.004	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.196	-0.084	-0.027	-0.022	-0.335	-0.296	-0.571	-0.362	-0.267	-0.213	-0.272	-0.173	-0.019	-0.242	-0.081	-0.076	-0.001
Upper limit at a 95% confidence level		-0.035	0.052	0.196	0.320	0.171	0.106	-0.009	0.188	0.303	0.593	0.406	0.198	0.008	0.354	0.053	0.069	0.001
MAHANADI																		
Slope value, $\alpha$		0.006	-0.132	-0.004	-0.078	0.030	-0.206	0.163	-0.331	0.153	-0.006	0.010	0.026	0.006	-0.352	-0.031	-0.069	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.105	-0.259	-0.133	-0.194	-0.103	-0.792	-0.363	-0.829	-0.308	-0.282	-0.097	-0.045	-0.005	-0.782	-0.129	-0.193	-0.001
Upper limit at a 95% confidence level		0.118	-0.005	0.125	0.027	0.164	0.380	0.690	0.167	0.614	0.269	0.118	0.098	0.018	0.078	0.067	0.055	0.000
GODAVARI																		
Slope value, $\alpha$		0.017	-0.056	0.046	-0.049	0.028	-0.107	0.225	0.345	-0.116	0.211	0.003	-0.008	0.000	0.270	0.045	0.053	0.000
Lower limit at a 95% confidence level	[mm/year]	-0.048	-0.134	-0.042	-0.127	-0.109	-0.454	-0.175	-0.066	-0.526	-0.072	-0.143	-0.082	-0.014	-0.084	-0.038	-0.052	-0.001
Upper limit at a 95% confidence level		0.081	0.022	0.135	0.029	0.164	0.241	0.624	0.756	0.293	0.495	0.150	0.067	0.013	0.623	0.128	0.158	0.001

**VIII. Conclusion**

The strategic plans and ambitious objectives included in the water management programme for India are regrettably accompanied by numerous contrasts between extremely dramatic growth projects and poor knowledge of local environmental conditions and by attempts to import Western, supposedly universal models that ignore local and regional features and characteristics of the territory. The Ministries of Water Resources and of Agriculture and the Planning Commission are responsible for water management on a national scale; additionally, the government is authorised by the Constitution to manage river drainage basins. These statutory and organizational instruments provide great opportunities for implementation of the adopted water mission, but

further excessive exploitation of water resources with a continued low efficiency of water intake use may cause a durable and dramatic reduction in available water resources and impair their quality. The study contains an analysis of precipitation, covering multiple profiles and based on the GPCC database that provides monthly mean values for the territory of India, in 13 river catchment areas. Brahmaputra, Indus, Ganga, Mahi, Narmada, Tapti, Damodar, Brahmani, Krishna, Penner, Cauvery, Mahanadi and Godavari. The catchment areas and their closing cross-sections are defined using data made available by the GRDC agency (Table 1). The analysis includes data for the period 1901–2010 with a spatial resolution of  $0.5^{\circ} \times 0.5^{\circ}$  of geographic longitude and latitude. The data is analysed in calendar year profiles. The periodical nature of precipitation is assessed and the trends in climate changes calculated. The characteristics of trend in climate changes are described by linear equations with indicated boundary values of coefficients determined at a 5% significance level.

The long-term mean annual total of precipitation in the territory of India is estimated at 1126 mm and the mean values in the analysed period of 110 years vary from 894 mm to 1387 mm. The standard deviation of mean value of annual total precipitation reaches 10% and the coefficient of variation amounts to 0.08. The sum of mean precipitation volume in the long-term period amounts to  $3704 \text{ km}^3$ , showing a positive trend of 68 [million  $\text{m}^3/\text{year}$ ]. The trend in the mean value of precipitation in the territory of India is positive: 0.021 [mm/year].

The periodicity of precipitation in all analysed river catchment areas is characterised by minimum values of predominating repeatability periods of about 2 years while maximum values vary from 13 to 15 years in the catchment areas of Indus, Ganga, Brahmani and Krishna, amount to 22 years in the Tapti catchment area, 36 years in the Mahi and Narmada catchment areas, 55 years in the Damodar catchment area; with no indications for the Brahmaputra, Penner and Couvery rivers. The maximum value of linear precipitation trend in the analysed catchment areas is observed in the Tapti river: 0.681 [mm/year], and the lowest, negative value – in the Brahmaputra river: -0.803 [mm/year]. The trend in mean values for the analysed long-term period varies from -0.159 [mm/year] for the Brahmaputra to 0.136 [mm/year] for the Tapti river. Positive trends in mean precipitation values are observed in the Indus, Mahi, Narmada, Tapti, Damodar, Krishna, Penner and Godavari river catchment areas, negative trends in precipitation values are identified in the Brahmaputra, Ganga, Brahmani, Cauvery and Mahanadi river catchment areas.

The analyses discussed confirm spatial and temporal variability of precipitation in the key river catchment areas in India, feeding the country's surface and underground water resources. The statistics contained in this study demonstrate the regional nature of water supply, indicate the need to complete regional analyses of temporal and spatial variations in the volumes of water feeding Indian resources, and confirm that regional and local plans must be developed to adapt to climate change, based on the accepted scenarios aimed to compensate climate change effects.

## References

- [1]. A. Becker, P. Finger, A. Meyer-Christoffer, B. Rudolf, K. Schamm, U. Schneider, and M. Ziese, A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901–present, Global Precipitation Climatology Centre, Deutscher Wetterdienst, Offenbach, Germany, 2013
- [2]. Adler, R.F., G.J. Huffman, A. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, P. Arkin and E. Nelkin (2003): The Version-2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation analysis (1979- present). *J. Hydrometeorol.*, 4, 1147–1167.
- [3]. All India Area Weighted Monthly, Seasonal and Annual Rainfall in Mm 1901- 2010 from the Revised Series Computed Using all Available Raingauge Stations Data and From IMD District Rainfall Data Series while The Period 2011-2014 Are Based On The Realtime Drms Data, India Meteorological Department, Ministry of Earth Sciences, Climate Application Group, <https://data.gov.in/catalog/all-india-area-weighted-monthly-seasonal-and-annual-rainfall-mm>, <http://www.imdpune.gov.in/hydrology/>
- [4]. Ashwini A. Ranade, Nityanand Singh, H.N. Singh and N.A. Sontakke, Characteristics of Hydrological Wet Season over Different River Basins of India, Indian Institute of Tropical Meteorology, September 2007
- [5]. Ashwini Ranade, Nityanand Singh, H.N. Singh and N.A. Sontakke, On Variability Of Hydrological Wet, Season, Seasonal Rainfall And Rainwater Potential Of The River Basins Of India (1813-2006), Indian Institute Of Tropical Meteorology, Journal Of Hydrological Research And Development, Vol. 23, 2008
- [6]. P. Guhathakurta, P. A. Menon, S. K. Dikshit and S. T. Sable, Extreme Rainfall Analysis Of Andhra Pradesh Using A Probability Distribution Model : A Regional Estimate, MAUSAM, 56,4,2005, 785-794.
- [7]. P. Guhathakurta and E. Saji, Detecting changes in rainfall pattern and seasonality index vis-à-vis increasing water scarcity in Maharashtra, *J Earth Syst. Sci.* 122, 3, 2013, 639-649, ,
- [8]. P. Guhathakurta and M. Rajeevan, Trends in rainfall pattern over India, *International J. of Climatology*, 28: 1453– 1469, 2008.
- [9]. P. Guhathakurta, A. Tyagi and B. Mukhopadhyay, Climatology at any point : A neural network solution, *Mausam*, 642, 2013, 231-250,.
- [10]. P. Guhathakurta, Drought in districts of India during the recent all India normal monsoon years and its probability of occurrence, *MAUSAM*, 54, 2, 2003, 542-545.
- [11]. P. Guhathakurta, Highest recorded point rainfall over India, *Weather*, December 2007, Vol. 62, No. 12.
- [12]. P. Guhathakurta, O P Sreejith and P. A. Menon, Impact of climate changes on extreme rainfall events and flood risk in India, *J. Earth System Science.* 120, No. 3, 359-373,
- [13]. P. Guhathakurta, Rainfall network of India and the recent rainfall normals, *Indian J of Power and River Valley development*, 56, 11&12, 2006, 254-259.

- [14]. Rakesh Kumar, R. D. Singh and K. D. Sharma , Water resources of India, National Institute of Hydrology, Roorkee 247 667, India, Current Science, vol. 89, no. 5, 10 September 2005
- [15]. Rudolf, B., and U. Schneider (2005), Calculation of gridded precipitation data for the global land-surface using in-situ gauge observations. Proceedings of the 2nd Workshop of the International Precipitation Working Group IPWG, Monterey, October 2004, 231-247.
- [16]. Twaróg B., Zmiana charakterystyki opadów atmosferycznych w ostatnich latach i jej wpływ na wymiarowanie urządzeń odwadniających. Dostępność i jakość danych do projektowania pozyskiwanych z IMGW, II Ogólnopolskie Forum Specjalistyczne „Odwodnienie dróg, kolei i mostów w aspektach bezpieczeństwa ruchu i ochrony środowiska, Odwodnienie 2014, Kraków, 4 – 5 czerwca 2014 r.
- [17]. Twaróg B., Characteristics of long-term variability of precipitation in the territory of Poland based on GPCC data for the years 1901, IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN: 2319-2402,p- ISSN: 2319-2399. Volume 10, Issue 10 Ver. I (Oct. 2016), PP 50-64, 2016
- [18]. U. Schneider, M. Ziese, A. Becker, A. Meyer-Christoffer, P. Finger, Global Precipitation Analysis Products of the GPCC, Global Precipitation Climatology Centre (GPCC) Deutscher Wetterdienst, Offenbach a. M., Germany, May 2015