

# Impact of Deforestation on Pattern of Rainfall and Number of Rainy Days of Goalpara District, Assam, India

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## Abstract

*The Goalpara district is situated in the western part of Assam. As a result of the increasing population pressure large scale deforestation has been observed in the district since 1970's (Ahmed and Das, 1998). Work was undertaken with a view to elucidate the effects of such large-scale deforestation on various parameters of the environment in this North-eastern part of India. The present work was concerned with the pattern of rainfall and number of rainy days for the five decades (1952-2000). During these five decades the rainfall and number rainy days showed a decreasing and drought days an increasing trend.*

## Introduction

Deforestation increases atmospheric CO<sub>2</sub> and other trace gases, possibly affecting climate, because the absorption of carbon is higher in forests than in the agricultural lands, which replace them (Dixon et al. 1994; Fearnside 1996; Gash & Shuttleworth 1991; Houghton 1991; Houghton & Skole 1990; Houghton et al. 1991; Keller et al. 1991; Woodwell et al. 1983). Global estimates of tropical deforestation vary widely and ranges from 50,000 to 17,000 km<sup>2</sup> y<sup>-1</sup> (Grainer 1996; Houghton 1991; Mayer's 1991, 1992). Recent FAO tropical deforestation estimates for 1990-1995 cite 1,16,756 km<sup>2</sup> y<sup>-1</sup> globally, with 47,000 km<sup>2</sup> y<sup>-1</sup> attributed to tropical South America, the majority of that in Brazil.

In this context, it may be noted that in large areas of developing countries similar trend of destruction of prime forests is

observed. It has lead to disturbances of the rainfall pattern, (Postel and Heise 1990; Lloyd 1973; Meher-Homji 1991; Ranganathan 1949), reported a decrease in the rainfall due to large-scale deforestation. Meher-Homji (1991) had brought out the link between deforestation and declining tendency of precipitation for 28 stations of western Karnataka and one at Manner, in Kerala, the trend of rainfall and number of rainy days has been assessed for 20 years by moving average. A fairly good agreement was observed between the deforested area and the number of rainy days showing a declining trend. Dr. Volker (1983) published interesting data pertaining to Ootacamund and the neighbouring areas of the Nilgiri Hills; he considered the number of rainy days increased with the increase of forest covers. It seems that between 1972-75 and 1993-94, Assam has lost 3,142 km<sup>2</sup> of dense forest (with 40% crown cover). The percent-

age of dense forest came down from 23.8% in 1972-75 to 19.8% in 1993-94 (assessment year 1997, National Remote Sensing Agency; GOI, 1997).

The Study area Goalpara is situated between latitude 25° 28' to 26° 15' N and longitude 89° 42' to 90° 15' E and lies 45 m above the sea level. The area forms roughly a square in shape. To the south of Goalpara district are the Garo Hills located in the western part of Meghalaya; an extensively dissected tract with an area of 8164 km<sup>2</sup> and average elevation of less than 600 meters. The mean monthly temperature of the coolest month January is only 11.87°C and mean monthly maximum temperature in the hottest month of June is 31.70°C. Moist and dry deciduous forests cover the plain and hilly tracts. The population has rapidly increased over the last three decades. Possible reasons for deforestation are attributed to this increased population in the district mainly due to immigration and infiltration from the present Bangladesh and Nepal. Besides, large numbers of people entered the district from other parts of India (Taher and Ahmed 2001). The economic activity of these people is mainly old-age agricultural practices. In 1807, Hamilton had reported that there was luxuriant sal (*Shorea robusta*) forest in the district of Goalpara. But since 1970's the following reserved forest have been totally destroyed by the inhabitants about 13.2% of reserved forest; 6144 ha. in Habraghat forest (present Krishnai area), 2048 ha. in Damra sal forest, 6912 ha. in Nibari (Meshelkhowa) forest, 15,910 ha. Meshpara forest (Lakhipur) and 6,553.60 ha. in Kalyanpur sal forest near Goalpara town, total 37,568 ha. (recorded forest data). At present in Goalpara the forest cover is 28,241 ha. (9.91%) of the total area of the

district (Assam Science Technology and Environment Council, March, 1990).

In view of the above evidence, the present work was undertaken to elucidate the effects of deforestation on the rainfall pattern and rainy days of the district of Goalpara, Assam.

## Materials and Methods

The data for analysis of the rainfall of the district had been collected from old government record from the Department of Public Health, Agriculture, Sericulture, Central Water Commission, Govt. of India, Goalpara and Department of Meteorology, Govt. of India, Barjhar near Guwahati, Assam.

## Results and Discussion

The analysis of average rainfall data for the period of 1952 to 2001 (Table: 1 & 2, Fig. 1). The year wise average rainfall data were analysed (1952 to 2001) and showed a number of peaks with a general trend showing a peak (maximum annual rainfall) in each decade.

- (i) For the decade of 1952 to 1961 the average annual rainfall showed a gradual rise from initial value of 101.52 mm in 1952 to a maximum of 214.67 mm in 1960, which fell to 160.06 mm in 1961.
- (ii) For the decade 1962 to 1971 the annual rainfall for the period from 1962 showed a rising trend to 1964 reaching a value of 285 mm annual rainfall. The rainfall in 1964 was highest for this decade (1962-1971), which was followed by a comparatively rapid fall until 1969, when the rainfall was 131.39 mm. There was a small rise in 1970 with 211.84 mm rainfall.

**Table 1 Total annual monthly average rainfall from 1952 to 2001 (Ref. Indian Meteorological Department, Barjhar, Guwahati, Department of Public Health, Sericulture, Agriculture and Central Water Commission (CWC), Goalpara, Assam).**

Year	Total monthly Annual rainfall (mm)	Year	Total monthly Annual rainfall (mm)	Year	Total monthly Annual rainfall (mm)
1952	101.52	1969	131.39	1986	166.95
1953	80.03	1970	211.84	1987	108.99
1954	90.50	1971	118.34	1988	237.34
1955	77.12	1972	195.58	1989	169.36
1956	98.16	1973	231.51	1990	239.57
1957	164.03	1974	325.51	1991	212.33
1958	199.07	1975	173.65	1992	182.91
1959	204.09	1976	263.93	1993	205.13
1960	214.67	1977	128.42	1994	124.29
1961	160.00	1978	160.05	1995	218.08
1962	188.30	1979	170.27	1996	138.16
1963	176.95	1980	191.45	1997	135.16
1964	285.12	1981	72.87	1998	159.41
1965	209.25	1982	182.19	1999	177.00
1966	228.38	1983	208.91	2000	165.00
1967	278.05	1984	238.93	2001	156.16
1968	200.12	1985	117.67	---	---

**Table 2 Monthwise total number of annual rainy and drought days from 1952 to 2001 (Ref. Indian Meteorological Department, Department of Public Health, Sericulture, Agriculture and Central Water Commission, Goalpara, Assam)**

Year	Total annual rainy days	Total annual drought days	Year	Total annual rainy days	Total annual drought days
1952	161	204	1977	100	265
1953	169	196	1978	105	260
1954	151	214	1979	83	282
1955	153	212	1980	88	277
1956	133	232	1981	88	277
1957	122	243	1982	111	254
1958	137	228	1983	104	261
1959	148	218	1984	108	257
1960	128	237	1985	100	265
1961	142	223	1986	90	275
1962	105	260	1987	108	275
1963	125	240	1988	107	258
1964	146	219	1989	91	274
1965	175	190	1990	121	244
1966	111	254	1991	117	248
1967	156	209	1992	89	276
1968	140	225	1993	97	268
1969	115	250	1994	84	281
1970	128	237	1995	94	271
1971	127	238	1996	88	277
1972	139	226	1997	87	278
1973	169	196	1998	74	291
1974	150	215	1999	94	271
1975	100	265	2000	82	283
1976	97	268	2001	97	268

(iii) The next decade from 1972 to 1981 showed the maximum annual rainfall in 1974 (325.30 mm) followed by rapid fall to 173.65 mm in 1975, followed by a peak in 1976 (263.93 mm). In 1977 the total annual rainfall was lower (128.42 mm), followed by a smaller peak in 1980 (191.45 mm). In the subsequent years there was a trend of lower rainfall with a minimum of 72.87 mm in 1981.

(iv) In the decade 1982 to 1991 the average rainfall data from 1982 to 1991 three prominent peaks of rising average annual rainfall were noted in 1984 (238.93 mm), 1988 (237.34 mm) and 1990 (239.57 mm). The peak in 1984 was followed by a sharp drop in 1985 (117.67 mm), a small rise to 161.00 mm in 1986, a low of 108.00 mm in 1987. The next peak in 1990 (239.57 mm) was followed by a fall in the average value of (212.33 mm) in 1991. The decade from 1992 to 2001 showed a gradual fall in values from 182.91 mm in 1992 to 205.13 mm in 1993, a rapid fall to 124.29 mm in 1994. This was again followed by a small rise of peak in 1995 (218.08 mm). The peak of 1995 was followed by a sharp drop in 1996 (138.16 mm) and in 1997 (135.16 mm), a small rise to 159.41 mm in 1998 and 177.00 mm in 1999. The next peak in 200 (165.00 mm) was followed by fall in the average value of 156.16 mm in 2001.

For the first decade the trend was a smooth rise in annual rainfall but subsequent decades showed a highly fluctuating total annual rainfall. The lowest and median value in the different decades showed highly varying values (Fig. 1). The analysis showed that

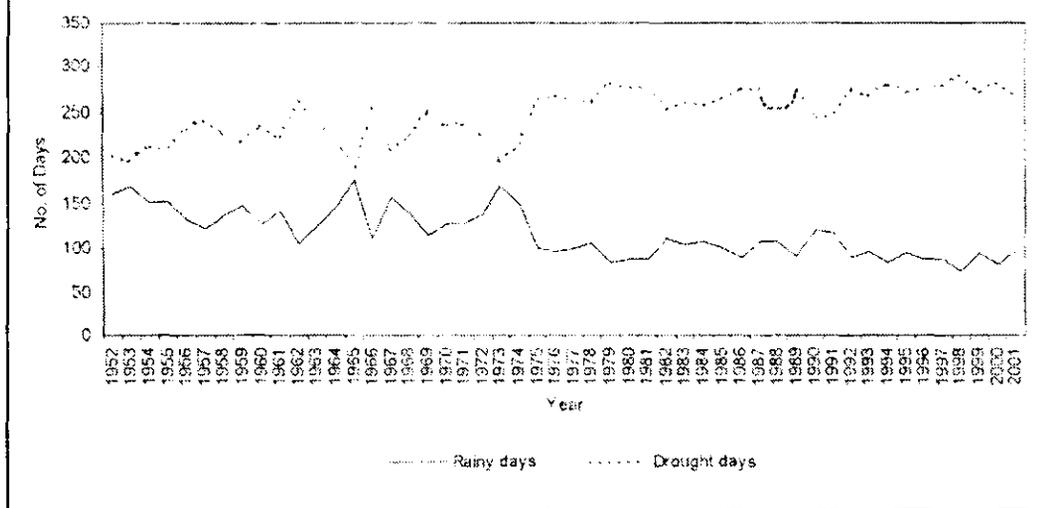
from 1972 to 1991 the rainfall was gradually decreasing.

A general conclusion might be drawn that the analysis of rainfall data though showing significant fluctuations from year to year reflect a lowering trend in the total annual rainfall, specially from 1981 to 2001. Annual rainfall data for the decades from 1952 to 2001 showed the highest peaks of 285.12 mm to 325.51 mm in the second and third decade i.e. 1964 and 1974. For the first decade the trend was a smooth increase in the average annual rainfall, the but subsequent decade showed highly varying values. This is probably due to the fact that highest deforestation occurred during the period of 1981 to 2001 in the four ranges namely Rangjuli, Krishnai, Lakhipur and Goalpara under Goalpara forest division, Assam and same trend of decline of forest in the district of Kamrup and East - West Garo Hills of Meghalaya.

The total number of rainy days and non rainy days (drought days) for the five decades (from 1952 to 2001) are shown in Table 3 & 4, Fig. 3 & 4. The total number of rainy days analysed in terms of decades showed a number of peaks with a general trend showing a peak (i.e. maximum annual rainfall and rainy days in each decade).

(I) For the decade 1952 to 1961 the total number of rainy days showed a gradually decreasing trend from the initial value of 161 days in 1952, to 122 days in 1957. There was slight rise in the number of rainy days (169) days in 1953. For the decade 1962 to 1971, the total number of rainy days from 1962 onward showed a rising trend to 1965 reaching a value of 175 total rainy days, this total value was the highest for this decade (1962 to 1971), which was followed

Fig. 1 Monthly total rainy and droughts days, 1952 to 2001 (Station Goalpara)



by a comparatively rapid fall in 1966 (111 days). The next decade from 1972 to 1981 showed that a maximum total number of rainy days of 169 in 1973, followed by rapid fall in the trend of total number of rainy days (83 days in 1979), this fall was again followed by a subsequent rising trend reaching a small peak in 1980 to 1981 (88 days). In the decade from 1982 to 1991 there were three prominent peaks in the number of total rainy days in 1982 (111 days), in 1990 (121 days) and in 1991 (117 days). The peak in 1982 was followed by a sharp drop in 1986 (90 days) a small rise to 108 days in 1987 and 107 days in 1988 but a low of 91 days in 1989. For the decade 1992 to 2001 there were three prominent peaks in the total number of rainy days in 1993 (97 days), in 1995 and 1999 (94 days) and in 2001 (97 days). The peak of 1993 was followed by a fall to 84 days in 1994; a small rise to 94 days in 1995, low in 1996 and (87 days) in 1997 was followed by a sharp drop in 1998 (74 days).

The average total number of rainy days for the five decades from 1952 to 2001 showed that: (1) The average annual rainy days showed the highest peak of 175-169 days in the second and third decades, i.e., 1965 and 1973. (2) For the first decade the average annual rainy days showed a gradual fall but the subsequent two decades showed a high fluctuation in the number of rainy days. (3) The lowest and the medium values in the different decades were highly varying. (4) Rainy days were declining from 1952 to 2001, in 1952 total rainy days were 161, but in 2001 the total rainy days were 97 days only.

The total number of non-rainy days or drought days (Fig. 2) for the five decades from 1952 to 2001 showed the same variations as in the number of rainy days, showing, instead of an overall downward trend as in the case of the number of rainy days, there was an upward trend in the case of drought days (Fig. 3).

Fig. 3 Decade wise percentage of rainy and drought days 1952 to 2001  
(Station Goalpara)

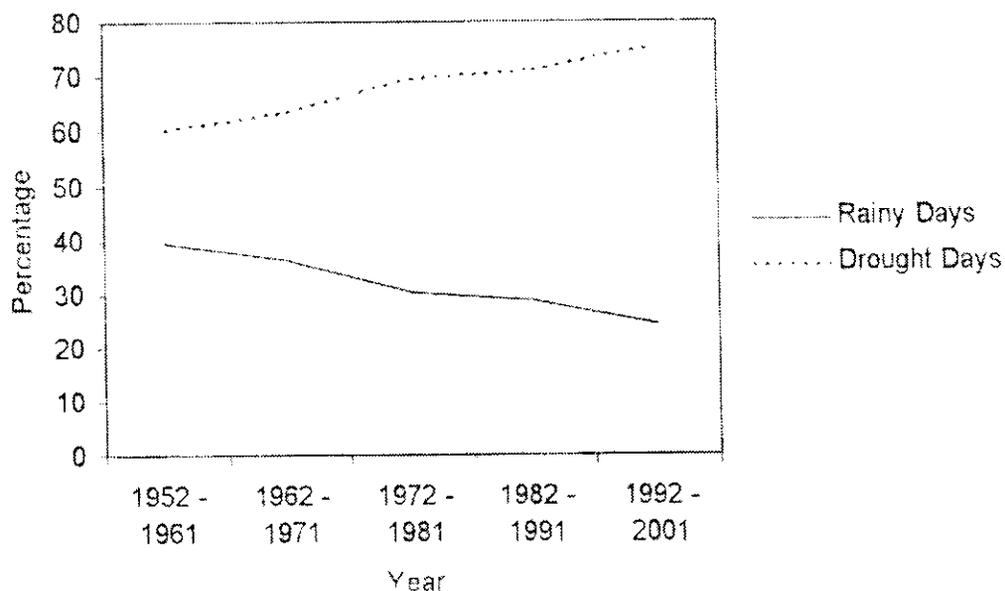


Table 3 Decade wise percentage (%) of rainy and drought days from 1952 to 2001 (Ref. Indian Meteorological Department, Department of Public Health, Sericulture, Agriculture and Central Water Commission, Goalpara, Assam)

Year	Percentage of rainy days	Percentage of drought days
1952 - 1961	39.54	60.46
1962 - 1971	36.38	63.60
1972 - 1981	30.50	69.50
1982 - 1991	28.95	71.05
1992 - 2001	24.27	75.73

In case of annual rainy days, the first decade showed a gradual fall, but subsequently two decades showed a high fluctuation of the total number of annual rainy days. The lowest and the medium value in the different decades showed highly varying values from the year 1973 onward, the general trend was a decline in the number of rainy days.

From experimental evidences (Clarke 1992) it was shown that tropical deforestation have impacts on the evaporation, an increase in surface air temperature by about 3° Celcius on reduction of cloud cover. Molchanov (1960) takes a note of the condensation of water vapour during rains, forest increased the amount of precipitation, and such increase might reach 10%. Accord-

ing to Gupta (1978) the rainfall was the main source of water supply and change in the system through deforestation and other human influences affect the annual rainfall, its seasonal distribution and intensity, thus making perceptible changes in water infiltration rates of soils.

Walsh, Hulone and Campbell (1988), showed that the rainfall decline in semi-arid Sudan since 1965 has continued and intensified in the 1980's with 1984, the driest year on record, and all annual rainfall from 1960 to 1987 were well below the long term mean. The model of hydrological impact of rainfall decline must take into account, local, physical and human conditions impact of a range of rainfall parameters and different types of human responses to drought. Sarma (1976) attributed a slight decline in the amount of rainfall to large-scale deforestation at Dibrugarh, Assam.

In Ootacamund and the neighbouring area of the Nilgiri Hills, which was devoid of trees before 1970, the number of rainy days were 374, during the 4 years period from 1970-1974, when there were no trees, this increased to 416, during the 4 years of wooded period of 1986-1990 (Dabral 1983). Further updated data suggested that the number of rainy days increase with the increase in forest cover (Ranganathan 1949). Walter (Huges, 1949) in Mauritius has shown that the decline in forest area from 25% to 5%, brought a reduction in the annual rainfall by 4% and also that it reduced the number of rainy days.

It may be noted that the decline in rainfall south of Brahmaputra namely Kamrup, Garo Hills and Goalpara is likely due to biotic disturbance of forest. The analysis of rainy days showing a significant fluctuations

from year to year indicates a decline in the overall number of rainy days for the period studied. Consequently the annual drought days were gradually increasing in the different decades from 1952 to 2001. It is observed that in neighbouring stations in William nagar (East Garo Hills) and Tura (West Garo Hills), Meghalaya, showed a fluctuating trend in rainfall pattern too.

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