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A case study of 1981 flood in the *Godavari* river

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सार — 10 से 14 अगस्त 1981 की अवधि में टेकरा से डोवलेश्वरम तक गोदावरी नदी बाढ़ से प्रभावित हुई। इस शोधपत्र में इस बाढ़ में अलग-अलग जल ग्रहण क्षेत्रों के योगदान का अध्ययन किया गया है। प्रत्येक उप-बेसिन को इकाई मानकर 3-दिन के तूफान का गहराई-क्षेत्रफल अवधि-विश्लेषण किया गया है। उससे यह अनुमान लगाया गया है कि बाढ़ में किन-किन उप-बेसिनों का योगदान था। प्रत्येक उप-बेसिन की 3-दिन के तूफान से उत्पन्न वर्षा की औसत गहराई की उसकी सामान्य औसत गहराई से तुलना करके इस पहलू को सामने लाया गया है।

ABSTRACT. The river *Godavari* was in floods during 10 to 14 August 1981 from Tekra to Dowaleshwaram. The contribution of individual sub-catchment to this flood has been studied in this paper. Taking each sub-basin as a unit, depth area duration analysis of 3-day storm has been made to assess which of the sub-basins contributed to the flood. This aspect has been brought out by comparing the actual 3-day storm average depth or rainfall with that of normal average depth of rainfall of each sub-basin.

1. Introduction

The river *Godavari* flows across the Deccan plateau rising in Nasik district of Maharashtra and falls in the Bay of Bengal after travelling about 1465 km. *Godavari* receives water from *Darna*, *Kadwa* after about a distance of 65 km from the source and from *Pravara*, *Mula* at a distance of about 220 km from the source. After travelling about 340 km further it receives water from *Purna*, *Dudna* and after another about 140 km lower down it receives water from *Manjira*. *Pranahita* river joins further downstream about 305 km (*Pranahita* is the united waters of *Penganga*, *Wardha* and *Wainganga*). About 50 km further below *Indrawati* joins it and about 100 km above Rajamundry river *Godavari* receives water from *Sabari*. About 70% of the catchment of *Godavari* drains only in the lowest one-third of its lengths. This fact is amplified in this study. *Godavari* drains only about 130 km in the heavy rainfall zone of Western Ghats but a large catchment of medium to high rainfall zone lies in the northeast of its basin which comprises of dense forest and mainly contributes to the flood in *Godavari* at its lower reaches.

Deccan plateau is under the rain shadow zone of Western Ghats during monsoon period. Consequently there is a large variability of rainfall over the Godavari basin. From the synoptic study it appears that the rainfall over Sabari, Indrawati, Wainganga, Wardha and Penganga sub-basins which form the north, northeast portions of Godavari basin receives more rainfall from disturbances forming in Bay of Bengal than compared to Arabian Sea.

2. Isohyetal analysis for D.A.D.

All available cumulative rainfall recorded during 9 to 11 August 1981 at stations in and around the Godavari basin were plotted on a map (scale 1 : 10^6) and isohyetal lines drawn for the map shown in Fig. 1. The areas between the different isohyetal lines were planimetered and the amount of rainfall in each sub-basin has been computed and from which cumulative depth of average rainfall for three days has been computed. This depth of average rainfall has been presented in Table 1. The corresponding flood hydrographs for the period 9 to 14 August for gauging stations at Tekra, Perur, Pathagudem, Dummagudem, Bhadrachalam and Dowaleshwaram are shown in Fig. 2.

Table 1 shows that *Wainganga* has the maximum average depth of rainfall of 13.3 cm during the storm period followed by *Indrawati, Wardha, Penganga* with 11.6, 10.0 and 9.0 cm respectively. An examination of isohyetal map reveals that the three-day cumulative heaviest rainfall of about 40 cm lay over Wainganga sub-basin (which represents closeness of the storm centre). The average depth of rain figures indicate that Wainganga, Wardha, Penganga and Indrawati sub-basins only contributed to the flood at downstream. The three-day D.A.D. curves of all sub-basins of Godavari basin has been presented in Fig. 3.

3. Comparison of 3-day cumulative average depth of rainfall with the normal average depth of rainfall

Available normal monthly rainfall data for all the stations in and around the Godavari basin were taken

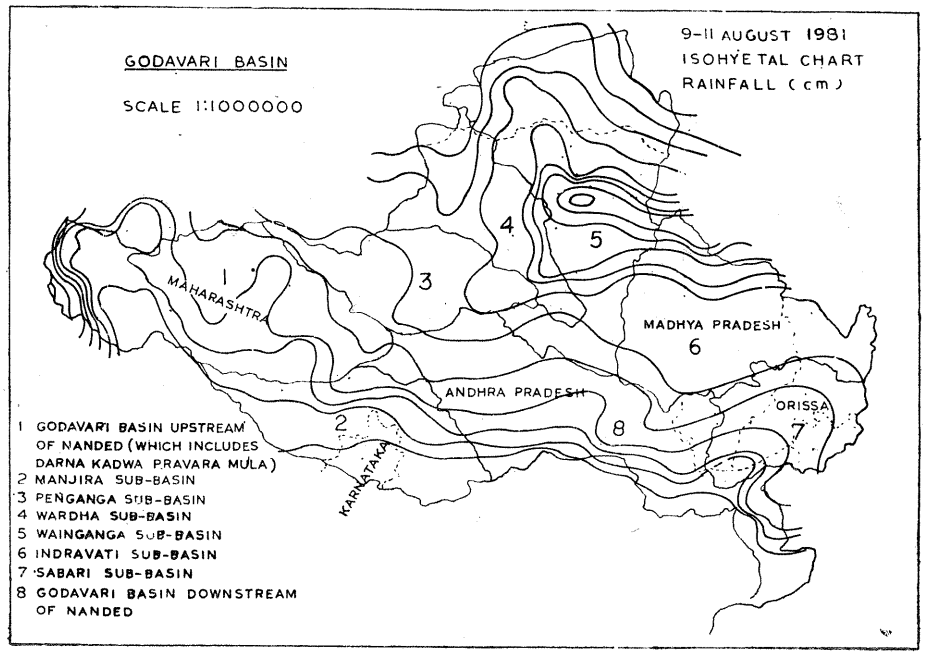


Fig. 1. Isohyetal chart of rainfall (cm) for 9-11 August 1981

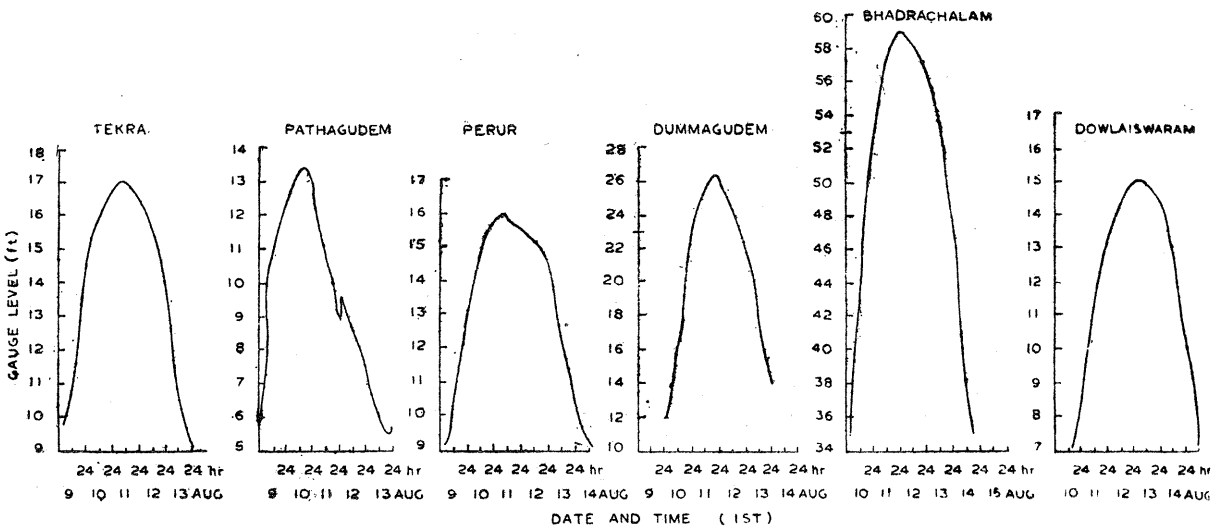


Fig. 2. Flood hydrographs of river *Godavari* at various gauging stations for the period 9-14 August 1981

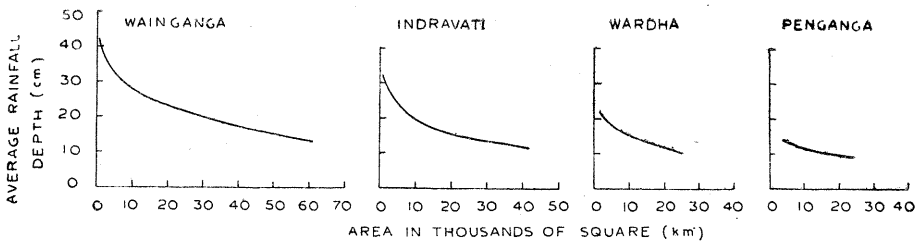


Fig. 3. DAD curves for 3-day rainstorms, 9-11 August 1981 for (a) Wainganga, (b) Indrawati, (c) Wardha and (d) Penganga sub-basins

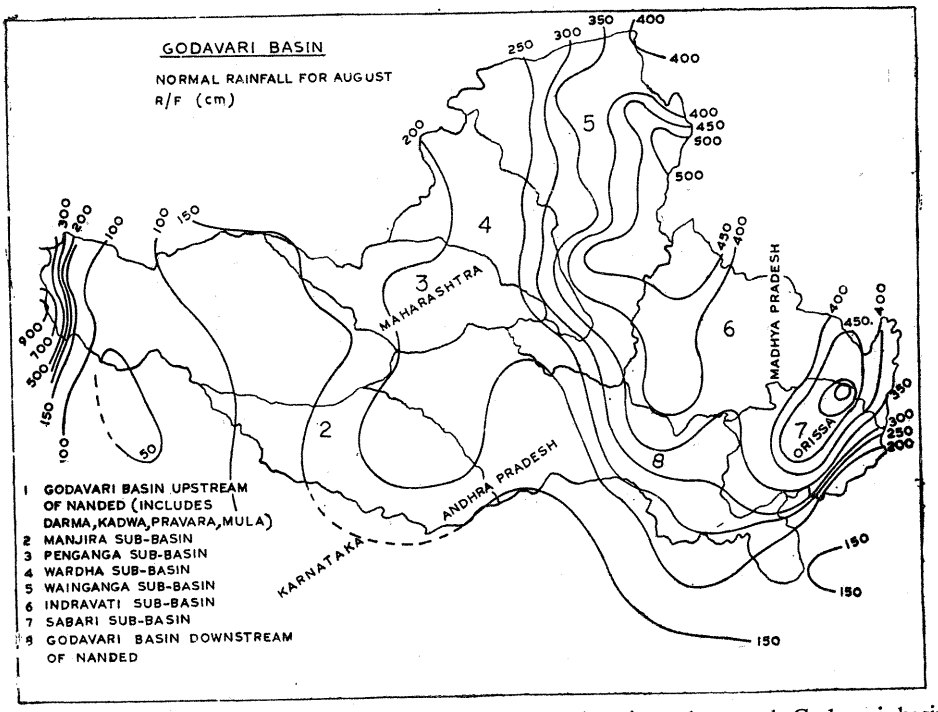


Fig. 4. Normal rainfall for August (mm) for all the stations in and around Godavari basin

TABLE 1

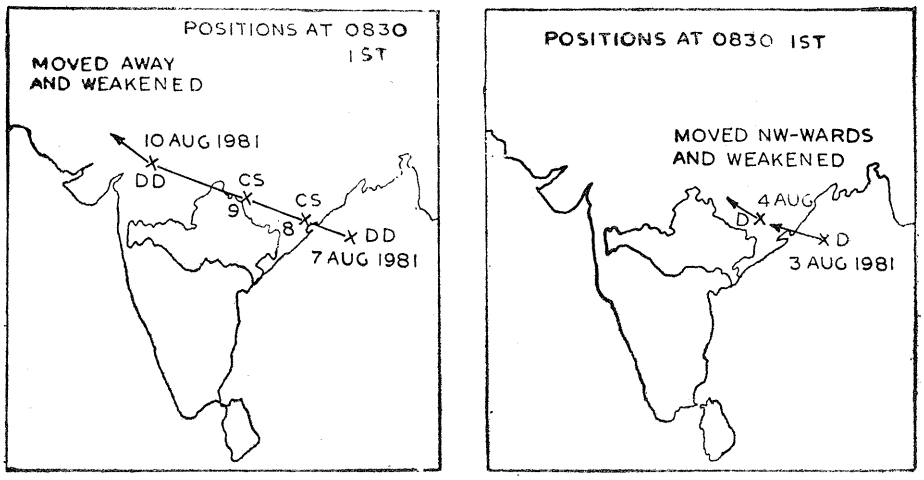
Comparison of average depth of rainfall during 3-day storm period (9 to 11 August 1981) with that of normal average depth of rainfall

Sub-basin	3-day average depth of rainfall (9-11 Aug 81) (cm)	Normal average depth of R/F (cm)			3-day storm average depth of R/F comparison with normal average depth of R/F (%)		
		Jul	Aug	Sep	Jul	Aug	Sep
Godavari basin upstream of Nanded	2.3	19.3	13.9	17.7	125.4	174.9	132.7
Godavari basin downstream of Nanded	2.8	29.5	23.9	20.3	97.3	120.2	137.0
Manjira	0.6	20.0	17.9	22.1	33.1	37.0	29.0
Penganga	9.0	28.2	20.5	18.1	329.7	455.0	497.2
Wardha	10.0	33.3	24.2	18.9	311.3	428.2	532.3
Wainganga	13.3	44.6	35.8	21.1	308.1	383.7	628.7
Indrawati	11.6	45.7	40.6	26.8	262.2	295.5	433.0
Sabari	3.5	38.9	37.8	25.7	93.3	95.9	136.4

from the *Memoirs* of the India Met. Dep. Vol. XXXI Part-III of 1961, and plotted on a map with scale 1 : 10^6 (shown in Fig. 4 for August). As above the isohyetal lines were drawn and average depth of rainfall in each sub-basin for the months July, August and September calculated. These are presented in Table 1. Comparison has been made with three-day average depth of flood period rainfall with that of July, August and September normal average depth of rainfall and percentage comparison values for each sub-basin has been calculated and presented in Table 1. These figures show that the rainfall in Indrawati, Wainganga, Wardha and Penganga sub-basins only contributed to the flood.

4. Synoptic situation

A depression formed over northwest Bay of Bengal off south Orissa and north Andhra coasts centred at 0830 IST of 3 August near 19.5 deg. N, 87.5 deg. E and it crossed coast that night. It moved in a west-northwesterly direction and weakened into a low pressure area over east Madhya Pradesh. Under the influence of this depression widespread rains occurred



D — DEPRESSION, DD — DEEP DEEPRESSION, CS - CYCLONIC STORM

Fig. 5. Storm tracks of August 1981

over northern and northeastern portion of Godavari basin and considerable inflow took place into the *Godavari* from this area. In the wake of this system another low pressure area formed over northwest Bay of Bengal on 6 August and concentrated into depression on 7 August with centre at 0830 IST close to Lat. 19.0 deg. N and Long. 88.0 deg. E. The depression intensified into cyclonic storm and moving in a westnorthwesterly direction crossed the coast near Puri on 8th morning. It moved in a westnorthwesterly direction and lay close to Raipur on 9th morning. It further moved in a westnorthwesterly direction and weakened into deep depression on the mid-night of 9th and centred close to Ujjain on 10th morning. It moved away westnorthwestwards on 11th. The tracks of these two systems are shown in Fig. 5. From the track of storms it is to be noted that the cyclonic storm, after crossing the coast, moved along the northern periphery of the Godavari basin. Under its influence heavy to very heavy rain occurred over Indrawati, Wainganga, Wardha, Penganga sub-basins during the period 9 August 1981 to 11 August 1981 and practically ceased on 12 August. These rain waters drained into the main river and caused flood.

5. August 1981 flood analysis

Due to the cumulative effect of three days rainfall on 9, 10, 11 August floods were reported in *Pranahita* at Tekra on 10th at 0000 IST crossing gauge level of 4.9 m (16.0 ft), and reached the maximum level of 5.2 m (17.1 ft) at 0900 IST on the same day. Floods were reported in *Indrawati* at Pathagudem crossing level 13.0 m at 0900 IST of 10th, which is considered as a major flood. Floods were reported in *Godavari* at Dummagudem on 11th crossing the danger level of 7.0 m (23.0 ft) at 0100 IST and reached the maximum level of 8.0 m (26.3 ft) between 1900 and 2200 IST. At Bhadrachalam danger level of 16.2 m (53.0 ft) crossed at 0300 IST of 11th and the maximum flood level of 18.0 m (59.0 ft) reached at 0000 IST of 12 August. At Dowaleshwaram danger level of 4.3 m (14.0 ft) crossed at 0900 IST of 12 August and the maximum level of 4.6 m (15.1 ft) was reached at 0600 IST of 13th.

At Tekra flood receded below 4.9 m (16.0 ft) level on 12 August afternoon, at Dummagudem it receded below 7.0 m (23.0 ft) level by 2000 IST on 12 August. At Bhadrachalam flood receded to below danger level on 13th afternoon and at Dowaleshwaram it receded to below danger level on 14th forenoon. Thus floods occurred in the *Godavari* river from 11 to 14 August, only after the systems moved away from the proximity of the basin. It is worth noting that the flood peaks occurred at Tekra, Bhadrachalam and Dowaleshwaram at a time lag of about 15 hr, 30 hr respectively and this time lag is important for flood forecasting.

6. Conclusions

From the above study it may be concluded that floods in the *Godavari* river in 1981 August were mainly due to heavy rainfalls over Indravati, Wainganga, Wardha and Penganga sub-basins under the influence of cyclonic storm which moved across the northern parts of the basin. Similar studies of other floods in the *Godavari* river may yield a method for predicting flood in the *Godavari* river.

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