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A CASE STUDY OF UNPRECEDENTED FLOODS IN THE GODAVARI RIVER DURING AUGUST 1986

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ABSTRACT

Unprecedented historical floods were recorded in the lower reaches of the Godavari River during 13-20 August 1986. According to available records since 1881, the highest gauge level was recorded at Dowlaiswaram on 16th August 1986, while an all time high gauge level was recorded at Bhadrachalam on the same day. In this paper an attempt has been made to bring out the synoptic situations and the rainfall contribution of each sub-basin to the floods. The average depths of cumulative rainfall of storm period is derived by Depth Area Duration analysis, treating sub-basin as a unit. A comparison has also been made between the storm period average depths with that of August normal rainfall depths. The historical floods in the lower reaches of the Godavari River during August 1986 were the direct result of heavy falls associated with the Deep Depression of Bay of Bengal Origin. This system moved initially over the eastern parts of the basin which subsequently skirted along the north-eastern parts of the basin. Associated heavy rainfall zones were located over central and eastern parts of basin, which contributed to the floods in the lower reaches.

INTRODUCTION

The Godavari is the second biggest river in India. Godavari rise in the Nasik district of Maharashtra and flows across the Deccan Plateau, about 1465 km, and falls into the Bay of Bengal. According to central Flood Forecasting Division (CFFD) Hyderabad and Flood Meteorological Office Hyderabad the Godavari basin has been divided into eight sub-basins as under (1) Godavari basin upstream of Nanded (which comprises of tributaries Darma, Kadwa, Pravara, Mula, Purna and Dudna), (2) Manjira, (3) Penganga (4) Wardha, (5) Wainganga, (6) Indravati, (7) Sabari and (8) Godavari basin downstream of Nanded.

During southwest monsoon period the Deccan plateau is under the rainshadow zone of Western Ghats. About 80% of the annual rainfall is received during monsoon period (June to September). However the rainfall variability over Godavari

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basin is very large during monsoon period. The normal rainfall over the individual sub-basins vary widely, Godavari basin upstream of Nanded receives about 860 mm while Indravati (-) monsoon receives 1580 mm. During monsoon period the eastern half of the basin receives about 750 to 1500 mm while the rest of the area, excepting a narrow Ghats strip, rainfall is between 450 to 750 mm. Consequently eastern half of the basin is more prone to floods as compared to the west. The coefficient of variation is about 20 to 30% over the major portion of the basin. During July the coefficient of variation ranges between 40 to 50% over major part of the basin. The variability is more during August as compared to July.

Floods in the Godavari river are the direct result of heavy rains over the basin. The heavy falls are mostly associated with the depressions/cyclonic storms of Bay of Bengal Origin. The unprecedented floods in the Godavari basin during 13-20 August 1986 were associated with the Bay depression. According to available records since 1881, the highest gauge level recorded at Dowlaiswaram was 6.55 M (21.5 ft) on 16th August 1986, while the previous highest record was 5.95 M (19.5 ft) recorded on 15th August 1953. The flood level at Bhadrachalam touched an all time high record of 24.4 M(75.6 ft) on 16th August 1986.

According to local news papers and Government of Andhra Pradesh, the floods during August 1986 affected 18 districts of Andhra Pradesh. It took a toll of 161 human lives and over 4000 head of cattle. It damaged about 12.5 lakh acres of cropped area, affected 2321 villages and fully damaged about 1.05 lakh houses. There was a 200 feet breach in the flood embankment of Vasistha river, a tributary of Godavari, at Gopalapuram in East Godavari district. On the night of 18th August 1986 Dowlaiswaram anicut was breached at Cotton Guest House and inundated about a dozen villages. At Palocole the railway track was under six feet of water while Dowlaiswaram approach road was under ten feet of water. Polavaram and Kunavaram towns were completely submerged under flood waters. The flood waters touched the rails of the old bridge and new rail-cum road bridge on Godavari river near Rajahmundry. About 5.5 lakh people were evacuated to safer places.

2. SYNOPTIC SITUATIONS

A low pressure area was formed over East Madhya Pradesh on 5th August 1986. Associated upper air cyclonic circulation was extending upto 5.8 km (500 mb) a.s.l. Moving in a westerly direction it concentrated into deep depression on 8th morning and centred close to Surat in Gujarat i.e. northwest of the

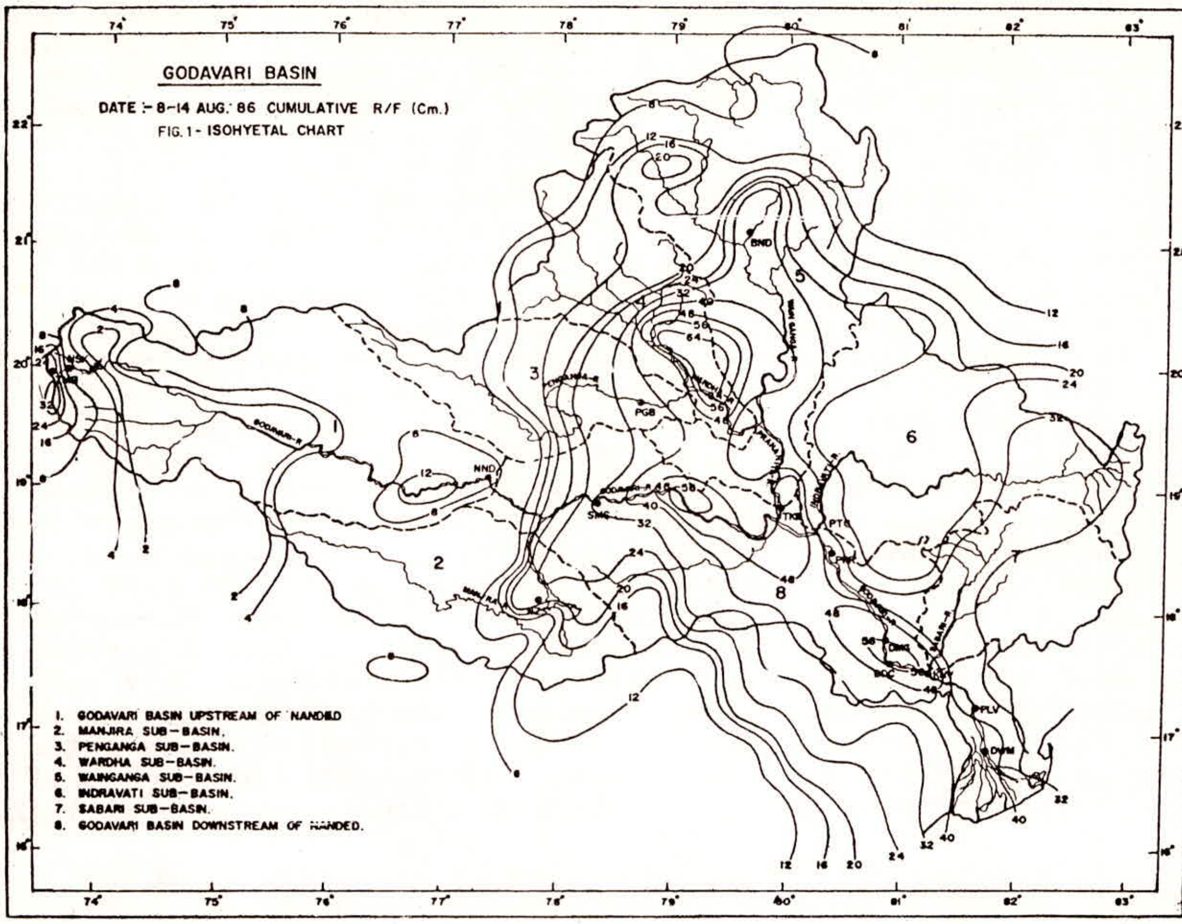
Godavari basin. It moved in a west-north-westerly direction and emerged into Arabian Sea on 9th evening. On 10th morning it was centred near lat. 23.0°N and long. 66.5°E. It weakend into low pressure area on 11th morning. This system contributed little to the flood, however it sufficiently moistened the basin.

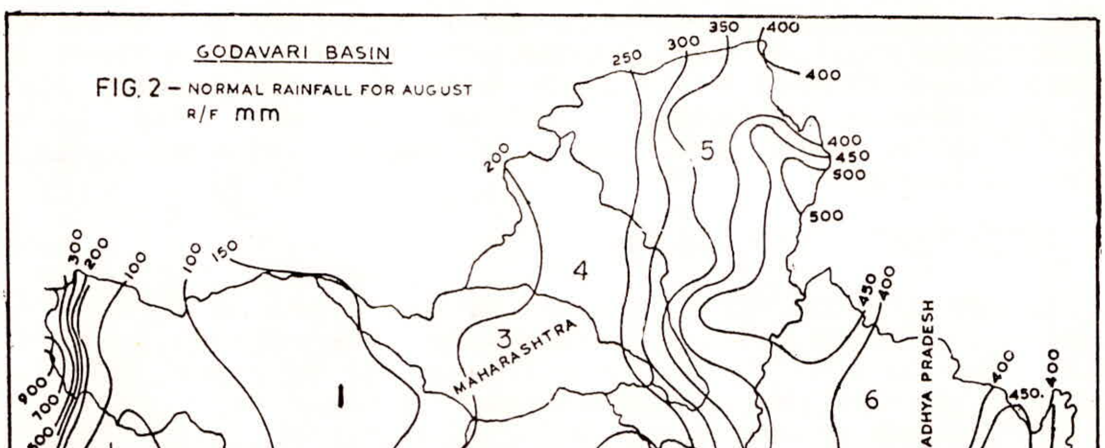
The flood causing system was developed as a low pressure area over North_West Bay on 9th August 1986. Associated upper air cyclonic circulation was extending upto 7.6 km (400 mb) a.s.l., which was tilting southwest wards above 5.8 km a.s.l. This system became well marked on 10th morning and concentrated into depression on the same evening, with central region near lat. 18.0°N and long. 88.0°E. It moved in a westerly direction and intensified into deep depression and centred near lat. 18.0°N and long. 86.5°E on 11th morning. Moving in a west-north-westerly direction it crossed north Andhra coast near Kalingapatnam on 12th night. It centred over eastern part of the basin near Karaput on 13th morning. Moving in a north-westerly direction it moved over the extreme eastern part of the basin weakened into depression and centred near Raipur on 14th morning. It further weakened and laid as a well marked low over northwest Madhya Pradesh on 15th morning. This resulted into improvement of weather over the basin. Associated with this system the upper air cyclonic circulation was extending upto 7.6 km a.s.l. till 14th. Subsequently the depth of circulation reduced and merged with the monsoon trough on 15th.

In addition to the above system an east-west oriented trough in the lower and mid-troposphere was observed runing across the basin on 8th, 9th and 10th. Subsequently this trough was observed only in the mid-troposphere till 12th and became unimportant on 13th. Under the influence of these two systems heavy to very heavy falls were reported at many places over the eastern and central parts of the basin. The flood period 8 to 14 August 1986 isohyetal map of Godavari Basin is presented in Fig.1.

3. ASSESSMENT OF FLOODS

Floods are the direct result of all types of surface run off of water which are associated with Meteorological conditions. The fury of floods vary from river to river, month to month and year to year. Floods are of two types: Short Duration (about a week days) and long duration. Virtually all floods in the Godavari river of short duration. Assessment of rainfall floods of short duration has great significance in disaster mitigation. Short duration flood prediction mainly depends on the observations of river stage and rainfall. Most river forecast procedures are designed to take into account the observed meteorological conditions and quantitative precipitation forecasts to serve as input data.


GODAVARI BASIN
DATE :- 8-14 AUG.' 86 CUMULATIVE R/F (Cm.)
FIG. 1 - ISOHYETAL CHART
1. GODAVARI BASIN UPSTREAM OF NANDED
2. MANJIRA SUB-BASIN.
3. PENGANGA SUB-BASIN.
4. WARDHA SUB-BASIN.
5. WAINGANGA SUB-BASIN.
6. INDRAVATI SUB-BASIN.
7. SABARI SUB-BASIN.
8. GODAVARI BASIN DOWNSTREAM OF NANDED.


GODAVARI BASIN
FIG. 2 - NORMAL RAINFALL FOR AUGUST
R/F mm
MAHARASHTRA
MADHYA PRADESH
ANDHRA PRADESH
KARNATAKA
ORISSA
1 GODAVARI BASIN UPSTREAM OF NANDED (INCLUDES DARMA, KADWA, PRAVARA, MULA)
2 MANJIRA SUB-BASIN
3 PENGANGA SUB-BASIN
4 WARDHA SUB-BASIN
5 WAINGANGA SUB-BASIN
6 INDRAVATI SUB-BASIN
7 SABARI SUB-BASIN
8 GODAVARI BASIN DOWNSTREAM OF NANDED

Floods may be assessed by gauge heights, peak discharge and volume of flow. Of these gauge heights at fixed locations along the river are more realistic as other parameters are derived from it.

The flood potential is assessed mainly by river stage and actual rainfall depth over individual sub-basins and its cumulative effect at downstream. It may be noted here that floods result from substantial volume of rain spread over a few sub-basins or over entire basin. Thus, any appraisal of storm rainfall for the purpose of estimating flood magnitude, rainfall volumes must be expressed as average depths over specified areas falling in a specified periods of time. This is best achieved by depth area duration (DAD) analysis.

In the present study the cumulative effect of rainfall was assessed by average depths of rain over each sub-basin which were derived by isohyetal method. For this purpose storm period cumulative point rainfall in respect of all available stations (about 130) in and around Godavari basin for the period 8-14 August 1986 were studied. For clarity the cumulative rainfall amounts for the period 8-11 August, 8-12 August, 8-13 August and 8-14 August 1986 were subjected to isohyetal analysis. The normal August rainfall isohyetal analysis is presented in Fig.2. The normal average rainfall depths for monsoon months June, July, August and September calculated by the author in case study of 1981 floods in the Godavari river are presented in table-1. For this purpose the normal monthly rainfall for all stations in and around the Godavari basin were taken from the Memoirs of IMD XXX I Part III of 1961 and subjected to isohyetal analysis. Since monthly coefficient of variation of rainfall is very large, sub-basin as a unit has been taken,using the same isohyetal analysis. This facilitated in assessing individual sub-basin rainfall contribution for floods. The average depths of rainfall for 8-14 August 1986 together with normal average rainfall depths for August for each individual sub-basin and basin as a whole are presented in table 1. The values of similar studies made by the author for 9-11 August 1981, are also presented in table-1. Table-2 contains the percentages of the flood period average depths of rainfall as compared with the normal August rainfall depths.

From normal rainfall statistics (table-1) of Godavari basin it can be inferred that July and August months are potentially favourable for floods. It may be mentioned here that the occurrence of a flood does not depend on the normal rainfall but depends on the cumulative rainfall depth, during heavy falls in these months. The flood period isohyetal analysis showed that the main centre of storm rainfall was located near Warora (in Wardha Sub-basin) and a secondary centre was located near Bhadrachalam (in Godavari basin downstream of Nanded. The storm period cumulative rainfall depths in these

TABLE 1

NORMAL AVERAGE DEPTH OF RAIN-FALL AND ACTUAL FLOOD PERIOD RAINFALL DEPTHS IN VARIOUS SUB-BASINS OF THE GODAVARI RIVER BASIN

Sr.No.	Name of sub-basin	Normal average depth of rain-fall(cm).				Flood period average depth of rainfall(cm)	
		June	July	August	September	9-11 August 1981	8-14 August 1986
1.	Godavari basin upstream of Nanded	14.3	19.3	13.9	17.1	2.3	5.47
2.	Manjira	12.5	20.0	17.9	22.1	0.6	10.07
3.	Penganga	17.5	28.2	20.5	18.1	9.0	16.65
4.	Wardha	16.9	33.3	24.2	18.9	10.0	22.77
5.	Wainganga	18.9	44.6	35.8	21.1	13.3	23.71
6.	Indravati	22.1	45.7	40.6	26.8	11.6	26.35
7.	Sabari	20.3	38.9	37.8	25.7	3.5	31.74
8.	Godavari basin downstream of Nanded	16.3	29.5	23.9	20.3	2.8	35.45
9.	Godavari Dasin (as a whole)	17.25	32.67	26.74	21.00	6.77	22.00

TABLE 2

COMPARISON OF FLOOD PERIOD AVERAGE RAINFALL DEPTH WITH THAT OF AUGUST NORMAL AVERAGE DEPTH (%) IN VARIOUS SUB_BASINS OF GODAVARI RIVER BASIN

Sr.No.	Name of Sub-basin	9-11 August 1981	8-14 August 1986
1.	Godavari basin upstream of Nanded	174	174
2.	Manjira	37	249
3.	Penganga	455	360
4.	Wardha	428	508
5.	Wainganga	384	293
6.	Indravati	295	287
7.	Sabari	96	372
8.	Godavari basin downstream of Nanded	120	657
9.	Godavari basin (as a whole)	262	366

sub-basins were little more than the August normal rainfall depths.

4. SOME FEATURES OF FLOODS

There were heavy to very heavy falls in various sub-basins during 8-14 August 1986, while floods were reported during 13-20 August 1986. River stage at various gauging sites along the Godavari river are presented in table-3. The peak flood level of 19.3 M was recorded at Perur on the morning of 15th August 1986, which is the highest ever recorded after the gauge site started functioning. Bhadrachalam gauge site recorded the all time high peak flood level of 23.0 M (75.6 ft) on 16th August 1986. As per the available records since 1881, Dowlaiswaram gauging site recorded the highest peak flood level of 6.55 M (21.5 ft) on 16th August 1986, while the previous highest record was 5.95 M (19.5 ft) recorded on 15th August 1953.

5. CONCLUSION

The present study suggests that the occurrence of floods in the Godavari river are favourable during the months of July, August. Floods are mainly caused by heavy falls in a few sub-basins. The August 1986 floods in the Godavari river were due to heavy to very heavy falls, which were associated with the initial movement of deep depression over the eastern part of the basin and its subsequent movement bordering outside the northeastern part of the basin. The quantitative assessment of the unprecedented floods during August 1986 (Table-1) reveals that the storm period cumulative rainfalls in Wardha sub-basin and Godavari basin downstream of Nanded were little more than the August normal rainfall depths in their respective sub-basins. It is worth noting that the storm rainfall centres were located in these sub-basins but the synoptic storm centre never moved over these sub-basins. In addition to the above the cumulative rainfall depths in Penganga, Wainganga, Indravati Sabari sub-basins were little more than or equal to two-thirds of August normal rainfall depths in their respective sub-basins. The flood period rain fall of various sub-basins indicate that Wardha, Wainganga, Indravati, Sabari Sub-basins and Godavari basin downstream of Nanded mainly contributed to the floods.

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TABLE 3

FLOOD FEATURES AT VARIOUS GAUGING SITES OF GODAVARI RIVER DURING AUGUST '86

DL : Danger Level L : Level

Sr.	Name of gauging site.	Initially level attained	Date & time (IST)	Peak level attained	Date & Time(IST)	Level receded to below danger level. Date & Time (IST)
1.	Tekra	DL 13.0 M	12.8.86 2100 hrs	19.6 M Historical	15.8.86/0300 hrs.	18.8.86/ 1500 hrs.
2.	Perur	DL 13.0 M	12.8.86 2400 Hrs	19.3	15.8.86/0300 hrs.	18.8.86/ 2400 hrs.
3.	Bhadrachalam	DL 16.2 M (53 ft)	13.8.86 0300 Hrs	23.0 M (75.6 ft) all time high record.	16.8.86	19.8.86/ 1200 Hrs.
4.	Kunavaram	DL 13.41M (44 ft)	12.8.86 1500 Hrs	24.4 M (80.0 ft)	16.8.86/2100 hrs.	After 20th
5.	Dowlaiswaram	DL 4.3 M (14.4 ft)	13.8.86 0900 Hrs	6.55 M (21.5 ft) All time high record.	16.8.86	20.8.86/ 0300 hrs.

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