

APPRAISAL REPORT-2018
FLOOD FORECASTING
NARMADA BASIN (UPPER NARMADA)



GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
NARMADA BASIN ORGANISATION
NARMADA DIVISION, BHOPAL

February-2019

प्रस्तावना

भारत में प्रतिवर्ष मानसून की अवधि के दौरान आमतौर पर सभी प्रमुख नदियों में बाढ़ आ जाती हैं, जिसके कारण जान माल आदि का नुकसान होता है। हालाँकि बाढ़ जैसी प्राकृतिक आपदाओं की घटना को रोका नहीं जा सकता, लेकिन उचित समय पर दिए गए बाढ़ के सही पूर्वानुमान से होने वाले नुकसान को कम किया जा सकता है। बाढ़ के पूर्वानुमान की सूचना से सम्बंधित विभागों के द्वारा आवश्यक कार्यवाही से बाढ़ से होने वाली जानमाल की हानि को कम किया जा सकता है।

बाढ़ से होने वाली क्षति को कम करने तथा जलाशय और विभिन्न प्रयोजनों के लिए उपलब्ध जल संसाधनों के समय प्रबंधन हेतु बाढ़ पूर्वानुमान प्रमुख गैर संरचनात्मक उपायों में से एक है। केंद्रीय जल आयोग द्वारा जल स्तर/अंतर प्रवाह पूर्वानुमान के लिए सभी प्रमुख अंतर्राज्यीय नदी, कछारों में बाढ़ पूर्वानुमान के स्थलों का संजाल विकसित किया गया है।

नर्मदा मंडल, केन्द्रीय जल आयोग, भोपाल की स्थापना सन 1976 में नर्मदा, तापी और उनकी सहायक नदियों पर गेज निस्सारण तथा मौसम संबंधी आंकड़ों के मापन हेतु 80 प्रमुख स्थल, योजना के अंतर्गत हुई थी। मानसून वर्ष 2000 से ऊपरी नर्मदा यानी डिंडोरी से होशंगाबाद के बाढ़ पूर्वानुमान का कार्य नर्मदा मंडल, भोपाल जबकि निचली नर्मदा यानी होशंगाबाद से भरुच के बाढ़ पूर्वानुमान का कार्य तापी मंडल, सूरत द्वारा किया जा रहा है।

इस प्रतिवेदन में मानसून 2018 के दौरान मंडल कार्यालय द्वारा जारी किये गए बाढ़ पूर्वानुमान, वर्षा के आकड़े एवं उनका पिछले दस वर्षों के आकड़ों के साथ तुलनात्मक मूल्यांकन प्रस्तुत किया गया है। मानसून 2018 के दौरान मंडला जिले के लिए 07 बाढ़ पूर्वानुमान जारी किये गए। लगभग सभी स्थलों पर सामान्य से कम वर्षा दर्ज की गई। नर्मदा मंडल बाढ़ पूर्वानुमान के प्रदर्शन और उपयोगिता में सुधार करने के लिए सतत प्रयासरत है।

मैं, मुख्य अभियंता, नर्मदा बेसिन संगठन, केन्द्रीय जल आयोग, भोपाल और अधीक्षण अभियंता (सं), नर्मदा बेसिन संगठन का समय-समय पर उचित मार्गदर्शन के लिए आभारी हूँ। मैं, मंडल और उपमंडलों में कार्यरत सभी अधिकारियों एवं कर्मचारियों का भी आभारी हूँ जिनकी सतत एवं उत्कृष्ट सेवाओं द्वारा बाढ़ पूर्वानुमान के कार्य को सफलतापूर्वक संपन्न किया गया है।

भोपाल
फरवरी 2019



(संजय कुमार मालवीय)
अधिशायी अभियंता
नर्मदा मंडल, भोपाल

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Abbreviation and Symbols Used

CWC	: Central Water Commission
IMD	: India Meteorological Department
WRD of GoMP	: Water Resources Department of Government of Madhya Pradesh
NCA	: Narmada Control Authority
MCM	: Million cubic metres
Cumec	: Cubic metre per second
ha	: Hectare
ha ²	: Square hectare
ha ³	: Cubic hectare (Million cubic metres)
M.S.L.	: Mean sea level
F	: Float Observation
FF	: Flood forecasting
G	: Gauge
GTS	: Great Trigonometrical Survey
hrs	: Hours
IWYB	: Integrated Water Year Book
Hm ³	: Hectometre cube = Million cubic metre
mm	: millimetre
m	: Metre
m ³ /s	: Cubic metre per second
°	: Degree (00°)
'	: Minute (00')
''	: Second (00'')
80 key	: 80 key Hydrological Station Scheme
67 key	: 67 key Hydrological Station Scheme

Chapter- 1

INTRODUCTION

During monsoon, every year all major rivers in India get flooded. These floods cause severe loss of property, human lives, cattle etc. and also these floods render thousands of acres of cultivated land useless for further cultivation due to sand deposit and silting. No one can stop the natural phenomenon like floods in the rivers but issuing correct and timely warnings of the incoming floods to the Central /State Authorities can minimize flood damages. Such warnings with adequate warning time are helpful in reducing the damages to property, loss of human lives, cattle lives etc. to a considerable extent. Flood forecasting thus plays a vital role in reducing damages and also in proper regulation of reservoirs and as such in overall management of the available water resources for various purposes.

The work of developing scientific technique of flood forecasting and issue flood warnings in different river basins was entrusted to Central Water Commission. Initially, a small Cell was created in late fifties to issue flood warnings in the Yamuna catchment and this Cell has now been expanded into Central Flood Forecasting Organization of the Central Water Commission to cover almost all the important inter-state rivers.

1.1 FLOOD FORECASTING SETUP

Narmada Division, Bhopal was established in February-1976, previously known as Bhopal Gauging Division, Bhopal under 80 Key-station scheme for gauge and Discharge observation on various G&D sites on Narmada and Tapi river and their tributaries. The flood forecasting work of Narmada was entrusted with Tapi Division, Surat along with G&D observations up to 1999-2000. From 2000-2001 the flood forecasting works of Narmada Basin is reallocated as follows.

Sr. No.	City	Flood Forecast Division
1	Mandla	Narmada Division, Bhopal
2	Hoshangabad	Narmada Division, Bhopal
3	Garudeshwar	Tapi Division, Surat
4	Bharuch	Tapi Division, Surat

Narmada Division has one Control Room at Bhopal for issuing Flood-Forecast to the State Authorities concerned for Mandla and Hoshangabad cities.

Under the Hydrological Observations (H.O.) setup Gauge, Discharge and Water Quality are being observed at 16 stations of CWC. Out of above, silt observation is also being made at 9 stations of CWC. Under Flood Forecasting set up, Gauge-Rainfall at 4 sites, Gauge-Discharge-Rainfall at 5 sites and Rainfall at 2 sites are being observed and transmitted through wireless on real time basis. The data of these 11 sites of Gauge/Gauge Discharge/Rainfall sites is being utilized for formulation of flood forecasts.

At present one Sub-Division namely Middle Narmada Sub-Division-I, Hoshangabad under Narmada Division Bhopal is carrying out the Flood-Forecasting activities.

The location of Division office, Sub Division and field Stations are indicated in Annexure -1 and details of Communication Network and River Gauge Network & Annexure 3 respectively are shown in Annexure -2. Plate-1 shows the map of Narmada basin. Plate -2 shows the location of all the Gauge/ Gauge-Discharge, Wireless and Rainfall stations under F.F Net work in Narmada basin. Plate -3 shows the Communication Diagram of wireless network of Narmada Division. Line diagram of Narmada basin is shown in Plate -4.

Flood level forecast, even if 100% accurate is of no use until it is disseminated in time to the users/ beneficiaries. Hence dissemination of forecasts should be quick without loss of time. Dissemination is, therefore, done on top priority by wireless/ telephone or by sending Fax or by sending special messenger to the State Authorities as per the guidelines given in flood memorandum of state Government or by the State District Collectors.

Based on our forecasts received on real time, the user agencies take immediate action for regulation of reservoirs or for precautionary measures against the onslaught of coming floods and as such flood damages are minimized. In addition to dissemination of forecast to the user agencies, message is conveyed to newspapers also, if required. Based on our forecasts State Government arranges to broadcast the flood messages over Radio and T.V. so as to inform the public well in advance.

METHODOLOGY

The methodology used for issuing forecast is as per the C.W.C. manual on flood forecast for level forecasts. Mainly graphical technique is used for most of the sites. In graphical techniques various co-relation diagrams depicting the effect of basin parameters are prepared and tested for accuracy. This Division is having a number of co-relation diagrams, stage discharge curve/ tables, travel time curves for both the forecasting sites based on 10 to 15 years data.

1.2.1 MANDLA FORECASTING SITE

(A) G& D CURVES

Average Gauge Discharge curves for Dindori, Manot, Mohgaon and Mandla have been developed by incorporating the data for 5 to 10 years.

(B) CORRELATION CURVES

Different type of correlation with different parameters between different sites from Dindori to Mandla has been developed i.e.

- (i) Dindori to Manot on Narmada
- (ii) Mohgaon to Mandla on Burhner & Narmada
- (iii) Manot to Mandla on Narmada

(C) TRAVEL TIME STUDIES

Considering the related floods carried out peak-to-peak travel time between various fixed points on Narmada River. It had been seen that points were widely scattered in most of the cases. However, most suitable time lag curve was drawn and average travel time had been calculated and is being used in flood forecasting for Mandla.

(D) PROCEDURE ADOPTED FOR ISSUING THE FLOOD LEVEL FORECAST FOR MANDLA

Whenever appreciable rain occurs in the upper catchment of Narmada and Banjar river, the water level of Dindori on Narmada and Mukki on Banjar starts rising and if it is felt that water level at Mandla is expected to reach warning level 437.200 m, the Flood-forecast is issued.

In such situation Water levels of these two sites are observed, initial forecast for Mandla is formulated and issued about 8 to 12 hrs in advance by using the correlations of Dindori to Manot and then final forecast of Mandla is issued using stage discharge curves of Manot, Mohgaon & Mandla sites. Subsequent revised forecast or a fresh forecast, about 3 to 4 hrs in advance, based on peak levels at Manot and Mohgaon, effect of local rain falls and contribution from Banjar river, is also formulated and issued, if required.

1.2.2 HOSHANGABAD G-D SITE

(A) G-D CURVES

Average gauge discharge curves for Barmanghat and Hoshangabad have been established by incorporating the data of last 10 to 15 years.

(B) CORRELATION CURVES

Different types of correlation with different parameter between sites from Barmanghat to Hoshangabad have been developed i.e.

1. Barmanghat to Sandia
2. Sandia to Hoshangabad
3. Tawa to Hoshangabad

(C) TRAVEL TIME STUDIES

Peak to peak travel time between various fixed points on the Narmada River had been carried out by considering the related floods. It had been seen that the points were widely scattered in most of the cases. However, the time lag curves had been drawn but when tested their results were not found satisfactory and hence average travel time had been calculated and used in flood forecasting for each site.

(D) PROCEDURE ADOPTED FOR ISSUING THE FLOOD LEVEL FORECAST FOR HOSHANGABAD

Whenever water level at Hoshangabad is expected to reach warning level 292.830 m due to heavy rainfall in upstream catchment, or heavy releases from Bargi or Tawa reservoirs, Flood forecast is issued.

Flood level forecast based on Bargi release with the use of co-relations of Barmanghat to Hoshangabad, Gauge Discharge curves of Barmanghat and Hoshangabad sites, is formulated and issued about 30 to 40 hrs in advance.

Subsequent revised forecast or fresh forecast for about 20 to 40 hrs in advance based on Barmanghat peak with the use of different curves and available rain fall data / weather forecast, level forecast is formulated and issued. Advance information (if any) of Tawa release is also considered while issuing this forecast.

The forecasts issued as stated above are sometimes revised (if necessary) due to appreciable contribution of Tawa river (release from Tawa Dam) and heavy rainfall information on the interim catchment between Barmanghat to Hoshangabad (if received on real time) only 6 to 8 hrs in advance.

Sometimes main river Narmada is flooded due to heavy rains in Tawa dam catchment, forcing heavy releases from Tawa. In such cases, forecast (if found necessary) for about 6 to 8 hrs in advance is formulated and issued taking in to consideration the affect of local rain, if any.

1.3 Uploading of Flood Forecasts data on e- SWIS Platform via internet

CWC (HQ), Delhi has taken an initiative in getting all the flood forecasts related data uploaded on e-SWIS platform via internet for General public use. This data was also successfully uploaded during Monsoon period.

Chapter- 2

BASIN PHYSIOGRAPHY, RIVER SYSTEM AND BASIN RAIN FALL

2.1 NARMADA BASIN

Narmada Basin extends over an area of about 98796 sq km and lies between East Longitude 81° 45' to 72° 32' and North latitude 23° 45' to 21° 20' lying in Northern extremity of Deccan plateau. The Basin covers the large area in the states of Madhya Pradesh and Gujarat and comparatively smaller area in Maharashtra & Chhattisgarh. The State wise distribution of drainage area is as under:

Table 2.1 State wise Distribution of Drainage Area

S.I. No	Name of States	Drainage area in Sq km	Percentage area
1	Madhya Pradesh	85,149	86.2
2	Chhattisgarh	710	0.7
3	Maharashtra	1,538	1.5
4	Gujarat	11,399	11.6
	Total	98,796	100.0

The Narmada Basin is bounded on the North by the Vindhya range, on the East by Maikal range, on the South by the Satpura and on the West by Arabian Sea. The Basin has an elongated or fern leaf shape with maximum length of 953 km from the East to West and maximum width of 234 km North to South. The basin has five well-defined Physiographic regions as under

Table 2.2 Physiographic Regions

Sl. no.	Region	Length (km)	Fall (m)	Average Bed slope	Name of District. Covered fully or partially
1.	Upper Hills	378	690	1 in 548	1. Shahdol 2. Mandla 3. Kavardha 4. Balaghat 5. Seoni 6. Dindori

Sl. no.	Region	Length (km)	Fall (m)	Average Bed slope	Name of District. Covered fully or partially
2.	Upper Plains	462	190	1 in 2430	1. Jabalpur 2. Narsingpur 3. Sagar 4. Chindwara 5. Hoshangabad 6. Betul 7. Raisen 8. Sehore 9. Damoh
3.	Middle Plain	206	72	1 in 2860	1. Khandwa 2. Khargaon 3. Dewas 4. Indore 5. Dhar 6. Harda
4.	Lower Hills	105	86	1 in 1221	1. Khargaon 2. Barwani 3. Narmada 4. Baroda 5. Dhulia 6. Nandurbar
5.	Gujarat	161	19	1 in 6315	1. Bharuch 2. Baroda 3. Surat 4. Pachmahal
	Total	1312	1057		

The hilly regions are well forested. The upper Middle and lower plains are broad and fertile areas well suited for cultivation.

In general the soil are red, yellow, shallow black and skeletal in upper Narmada, medium black in middle Narmada and medium and deep Black in lower reaches of the basin. A plate of soil formation of Narmada basin as shown in data book.

2.1.1 RIVER SYSTEM

River Narmada is the fifth largest river of India. It originates at Amarkantak (M.P.) in Maikal Hills of Vindhya range at an elevation of 1057m. It flows from East to West between Vindhyan and Satpura ranges in long and narrow catchment. It falls in to Gulf of Cambay down-stream of Bharuch (Gujarat) and has a total length of 1312 kms. For the first 1079 Km, it runs in Madhya Pradesh and then forms the common boundary for Madhya Pradesh and Maharashtra for 35 Km. and Maharashtra and Gujarat for 39 Km. In Gujarat state it stretches for 159 km.

There are 41 important tributaries of Narmada River. Major tributaries joining from left are Burhner, the Banjar, the Sher, the Shakkar, the Dudhi, the Tawa, the Ganjal, the Chhota Tawa, the Kundi, the Goi and the Karjan.

Major tributaries joining from right are Gour, the Hiran, the Barna, the Tenduni, the Kolar, the Chankeshwar, the Kanar, the Man, the Uri and the Orsang.

The Narmada basin has been divided in to 4 (four) sub-basins. Salient features of the sub basins are furnished in the Annexure -4.

1.2.2 RAIN FALL

The South West Monsoon sets in by the middle of June and withdraws by middle of October. As per IMD the normal Monsoon rainfall (June–Oct) of Mandla & Hoshangabad stations are 1596.0 mm and 1650.0 mm respectively. Station wise (Dindori to Hoshangabad) comparison between normal rainfall and actual rainfall occurred (Monsoon-2018) is shown in the form of bar chart in Plate -5.

Chapter- 3

METEOROLOGICAL DATA

3.1 ROLE OF METEOROLOGICAL DATA

In flood forecasting both, weather forecast and actual rainfalls received in the basin play vital role in the formulation of correct forecast. Although weather forecast does not indicate the magnitude of flood, yet it is useful to anticipate the probability of floods in their respective areas. Actual rainfall received in the basin helps in assessing the correct magnitude of floods. Hence, an adequate network of rain gauge with arrangements to transmit rainfall data on real time and the arrangements for obtaining weather forecasts like QPF/ Inference etc. are the basic need of flood forecasting network.

3.2 ARRANGEMENT FOR RECEIVING WEATHER FORECAST

Flood Met Office, Ahmadabad is helping this office in the field of weather forecast. F.M.O., Ahmadabad and Tapi Division are connected by Telephone/ Fax for communication of weather warning, storm movements QPF/ WAR daily rainfall etc. Tapi Division is connected to Narmada Division, through wireless network also.

Heavy rainfall warnings are also received through e-mail from I.M.D. Bombay/ Nagpur/ Bhopal/ Ahmadabad. As such this office is getting following weather information from I.M.D.

1. Heavy rainfall warnings
2. Regional weather summary
3. Weight age average rainfall of sub basins
4. Q.P.F for next 12/24/48 hrs
5. Inference information about the movement of depression/storm formed in Bay of Bengal/ Arabian Sea.
6. Satellite images and weather reports available in Website of Indian Meteorological Department also helped a lot in monitoring the movement of storm/ depression zone over the basin during the flood.

3.3 RAIN GAUGE NET WORK IN NARMADA BASIN

At present up to Hoshangabad 4 nos. SRRG and ORG had been installed in Narmada basin by I.M.D. and 1no. SRRG and 12nos.ORG by the CWC. The Location of all these rain gauge stations is shown in the Index map of Basin (Plate -2).

Daily rainfall data recorded at all the wireless stations are transmitted to controlling Sub Division/ Division on real time twice a day or even at shorter intervals like hourly/ 3 hourly, if required. Arrangements for rainfall by Telegram to our nearest wireless stations are also made by I.M.D. for some key Rain gauge stations. The flood forecast is formulated more accurately and well in advance for both forecasting sites by giving the weight age to heavy rainfall warnings, QPF, movement of depression and rainfall data received on real time.

Chapter- 4

BRIEF DESCRIPTION OF HYDROLOGICAL & METEOROLOGICAL EVENTS RESPONSIBLE FOR FLOODS DURING 2018

In the Narmada Basin monsoon started in mid June and showered up to the 2nd week of October. In all catchments the monsoon rainfall was below normal rainfall. The major rainfall spells in the basin were as follows:

Mandla

Spell	Duration
I Spell	20.07.2018 to 23.07.2018
II Spell	24.07.2018 to 28.07.2018
III Spell	07.09.2018 to 14.09.2018

Hoshangabad: The maximum level Peak 288.400 Mtr. Dated 01.09.2018 at Hoshangabad remained below warning level 292.83 mt. throughout the monsoon season. There was no forecast issued during this monsoon as there was no significant flood.

Mandla: During the sixth spell which occurred between 20.7.2018 to 28.07.2018 heavy rains took place in upstream of FF Station Mandla. The maximum water level at Mandla was 437.370 Mtr. Dated 23.07.2018 (Warning level 437.2 m). A total 07 Nos. forecasts were issued for Mandla Station.

Chapter- 5

FORECAST FORMULATION

This year on an average rainfall was below normal in Narmada Basin. However, the rainfall was not uniform over the basin.

5.1 STATIONS FROM ORIGIN TO MANDLA

Out line of the catchment area

Stations	Catchment area
At Dindori	2292 Sq km
At Manot	4667 Sq km
At Mohgaon	4090 Sq km
At Mukki	968 Sq km
At Mandla	13000 Sq km

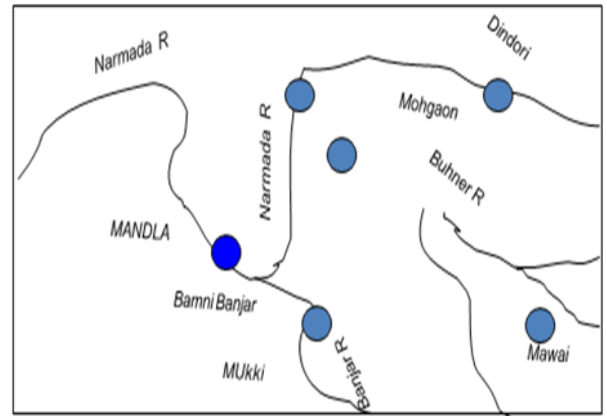


Table 5.1 Real Time Data Availability from origin to Mandla

Stations	Data
Dindori	Hourly gauge, discharge and daily rainfall
Manot	Hourly Gauge, Discharge, daily rainfall and three hourly rainfalls (if required)
Mohgaon	Hourly gauge, discharge daily rainfall and 3 hourly rainfalls
Mukki	Hourly gauge, daily/3 hourly rainfall.
Mawai	Daily / 3 hourly rainfalls.
Mandla	Hourly gauge, daily discharge and daily/3 hourly.

As per existing arrangement, forecast for Mandla site is being issued based on discharge method. First preliminary forecast for Mandla site can be issued about 10 to 12 hours in advance based on the data of Dindori on Narmada, Mukki on Banjar and rainfall data of Mawai in Burhner Catchment. As Mukki is not a Discharge site and Mawai is only rainfall reporting station, contribution from Banjar and Burhner cannot be assessed accurately so preliminary forecasts cannot be issued. Only final forecasts based on the data of Manot and Mohgaon and judgment about the contribution from Banjar catchment are issued about 4 to 5 hours in advance for Mandla.

5.2 STATIONS FROM BARGI TO HOSHANGABAD

Outline of the Catchment area

Stations	Catchment area
At Barmanghat	26453 Sq km
At Tawa Dam	6060 Sq km
At Hoshangabad	44548 Sq km
At Sandia	33954 Sq.Km

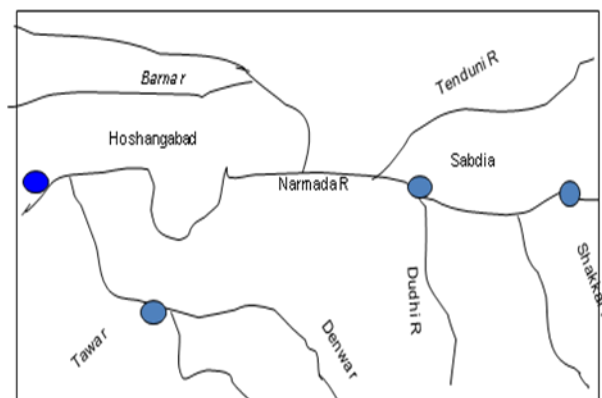


Table 5.2 Real Time Data Availability from Bargi to Hoshangabad

Stations	Data
Bargi	Hourly Gauge daily and three hourly rainfall
Barman	Hourly gauge, daily discharge and three hourly rainfall
Sandia	Hourly gauge, daily discharge and three hourly rainfall
Tawa dam	Hourly gauge daily and three hourly rainfall, releases from Dam
Hoshangabad.	Hourly gauge, daily discharge and three hourly rainfall

Forecast for Hoshangabad is issued based on stage at Barmanghat and releases from Tawa Dam. Forecast is further revised based on stage and discharge at Sandia G&D Site & corresponding releases from Tawa, if necessary.

The Catchment area between Barmanghat to Hoshangabad excluding Tawa catchment (12035 km²) is very large and lies in the heavy rainfall zone. Gauge to gauge correlation is giving desired results thus discharge method and judgment are used for forecasting of Hoshangabad. At present there is no arrangement to get any information on real time for the above said catchment, d/s of Sandia although some temporary arrangement had been made to receive release information from Barna Dam, but the information is generally not received in time and hence affect the forecast performance of Hoshangabad site. There is no wireless station at site Sandia. Permanent telephone has been installed at site Sandia. This facility is very helpful for assessing correct forecast of Hoshangabad.

In the existing practice basic flood forecast is to be formulated at Hoshangabad Sub Division and analysed and approved by Divisional office.

Chapter-6

FORECAST PERFORMANCE DURING THE SEASON 2018

In Year 2018, actual rainfall was below normal rainfall in Narmada basin and the rainfall was uniform over the basin. During this year 07 Nos. forecasts were issued for Mandla town and no forecasts was issued for Hoshangabad town.

6.1 MANDLA - River Narmada

Total forecast issued during Monsoon 2018	07
Revised	Nil
Forecast with in limits (± 15 cm)	06
Beyond limits	01

6.2 HOSHANGABAD - River Narmada

Total forecast issued during Monsoon 2018	Nil
Revised	Nil
Forecast with in (± 15 cm) permissible limit	Nil
Beyond the permissible Limits	Nil

Chapter-7

COMPARISION OF PERFOMANCE WITH PREVIOUS PERFORMANCE

The flood forecasting work for Mandla & Hoshangabad was allocated to this Division in the year 2000.

This year monsoon remained active throughout the season. However, the rainfall was not uniformly distribution over the basin, 7 Nos. forecasts were issued for Mandla town and No forecast was issued for Hoshangabad town.

Average forecast performance including 2018 remained stable for both the sites as compared to the 10 years average performance from 2008 to 2018 as indicated in Annexure -8.

Chapter-8

PROBLEMS FACED AND DIFFICULTIES NOTICED IN THE NET WORK DURING THE MONSOON 2018

The catchments area between Dindori to Mandla and Barmanghat to Hoshangabad are very large and also rain fed. Gauge to Gauge co-relation for this reach is not giving desired results and thus discharge method is being used for flood forecasting of Mandla and Hoshangabad. Due to above problem, performance for these sites are affected. Communication system at Barna Dam for release may be made to improve the performance of forecast for Hoshangabad. For this purpose one gauge site opened at Barna dam under DWRIS plan Scheme in this year. The performance of Network was excellent and Telephones at vital sites has provided valuable information during this Monsoon and every official in FF work has performed his duties excellently with full sincerity.

Though Narmada Division is entrusted with the various types of works like flood forecasting, conducting hydrological observations, carrying out various deposit works undertaken by Narmada Basin Organisation etc and has a wide jurisdiction in state of Madhya Pradesh yet the staff strength provided is inadequate, even the sanctioned posts are not filled.

1 Key posts like post of P.A. Met in Division office is required for flood forecasting. Posting of E.A.D. / P.A. Met is very essential for proper assessment of floods during Monsoon and for up gradation/ updating of Flood forecast formulations during Non monsoon season.

2 In order to make the staff involved in flood forecast work well conversant with Meteorological aspects and its applications in flood forecasting, it is suggested that the staff should imparted training at regular intervals in meteorology and other aspects of flood forecast.

3. During the beginning of this Monsoon the Junior Engineer (Communication) posted at the Division Office, Bhopal has retired. Therefore, suitable skilled staff is urgently required for round the clock monitoring the Flood Forecasting activity and also for on line data entry through <http://180.92.171.80/eSWDES/eswdes>

4. A TV set (LCD/LED) had installed in the office of Executive Engineer and Hoshangabad FF Control room for live news coverage of FF related events to take necessary steps for smooth functioning of FF related work .

Chapter-9

SPECIFIC MODERNISATION EFFORTS

Presently, conventional methods of flood level forecast are being used for both the sites for flood forecast. Most of the work is being done manually and performance is satisfactory. A mathematical model for flood forecasting by using software like MIKE-11 etc. Shall be attempted and be revalidated by actual hydrological condition during floods at site.

Satellite images and weather reports available at website of Indian Meteorological Department also helped a lot in monitoring the movement of storm/ depression zone over basin during monsoon.

Efforts for providing and using communication facilities like Telephone/ mobile phone to all sites are on.

Internet facility at Sub division level particularly at Hoshangabad has been installed to download Weather reports and Satellite images available at different Web sites proved more helpful to formulate accurate forecast. The Facility at Mandla site is also required for better communication to be set up.

The Flood Forecast are being uploaded on <http://180.92.171.80/eSWDES/eswdes> for general public use.

Chapter-10

APPRECIATION OF FORECAST

Narmada Division has started the work of issuing flood level forecasts for two stations in Narmada Basin since 2000. The performance of the Division during last ten years is very fruitful and encouraging as indicated in Annexure -9. During Monsoon 2018, total 7 Nos forecasts were issued for Mandla with 85 % accuracy (forecast lying within +/- 15cm. of the actual level reached).

However for Hoshangabad No forecast was issued in this Monsoon Season 2018.

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CONCLUSIONS

Flood forecasting plays a vital role in minimizing flood damages. Existing methods are giving fairly good results. The coordination between Bargi and Tawa Project Authorities to release water can be even more helpful in appreciably reducing severity of flood at Hoshangabad.

This year Monsoon was normal & uniform in the Monsoon season in Narmada basin. Rains were not evenly distributed all over the catchment. During monsoon period 07 Nos. forecasts for Mandla town and Hoshangabad No forecast was issued .

Although traditional wireless network performs well except some minor failures, alternative arrangements like mobile or fixed line phone may be made available to sites as standby arrangement, in case of failure of conventional/ traditional wireless network.

Junior Engineer (Comm.) and P.A.Met at Bhopal Division may be posted to avoid any chance of error in Flood Forecast and to upgrade Flood Forecast formulation.

In order to modernize the flood forecasting system at least two/ three officials from Division should be imparted proper training in Basin/ Flood simulation using computers.

The Mobile Phone facility to all sites and the Sub Division & Divisional office involved in FF activity should be made available for timely dissemination of flood warnings in case of emergent situation arising due to failure of wireless communication & normal telephone services.

Annexure 1 LOCATION OF DIVISION OFFICE, SUB DIVISION OFFICES AND FIELD STATIONS IN NARMADA BASIN.

S.No.	Code No	Name of Station	Zero of Gauge	Location		River/tributary	District/ State
				Lat	Long		
1	2	3	4	5	6	7	8
I	Head Quarters of Division office						
1	Narmada Division, CWC, Bhopal			23°14'16"	77°25'36"		Bhopal / M.P.
II	Head Quarters of Sub Div. offices						
1	Upper Narmada Sub Division, CWC, Jabalpur			23° 09'25"	79° 52'31"		Jabalpur/ M.P
2	Middle Narmada Sub Divn. No.1, Hoshangabad			22°45'20"	77°43'25"		Hoshangabad
III	Field Stations						
	010215001	Dindori	660.000	22°56'52"	81°04'34"	Narmada	Dindori/ M.P.
	010215002	Manot	442.000	22°44'09"	80°30'44"	Narmada	Mandla/ M.P.
	010215003	Mawai	-	22°30'00"	81°04'15"		Mandla/ M.P.
	010215004	Mohgaon	447.000	22° 45'57"	80° 37'22"	Burhner	Mandla/ M.P.
	010215005	Mukki	89.000	22° 8'59"	80° 39'54"	Banjar	Balaghat/ M.P
	010215007	Mandla	432.130	22° 35'57"	80° 21'50"	Narmada	Mandla/ M.P.
	-	Bargi Dam	--	22°56'25"	79°55'23"	Narmada	Jabalpur/M.P
	010215011	Barmanghat	306.000	23° 01'51"	79° 00'56"	Narmada	Narsingpur/ M.P.
	010215016	Pachmarhi	-	22° 27'45"	78° 25'29"	-	Hoshangabad/M.P
	010215017	Tawa Nagar	308.762	22° 33'48"	77° 58'34"	Tawa	Hoshangabad/M.P
	010215019	Hoshangabad	282.000	22° 45'22"	77° 43'58"	Narmada	Hoshangabad/M.P

Annexure 2 COMMUNICATION NET WORK

Sl. No.	River/ Station	No and Type of Wireless Set	No and type of Standby Set	Date of Functioning
1.	Narmada / Dindori	LHP228,15Watts	Nil	19.08.1987
2.	Burhner/ Mohgaon	KENWOOD T.K.90, 100W/VHF-MOTOROLA	Nil	17.06.1987
3.	Burhner/Mawai	LHP 228,15 Watts	Nil	09.10.1988
4.	Narmada/ Manot	VHF-MOTOROLA	Nil	17.06.1987
5.	Banjar / Mukki	ECIL-C-5211,15 Watts	Nil	18.08.1987
6.	Narmada/Mandla	Barrett 530 100 Watts	Nil	June-1974
7.	Narmada / Bargi Dam	BARRETT-530 100Watt	LHP 228, 15 Watts	April 2001
8.	Narmada/Barmanghat	BARRETT-530	Nil	28.08.1973
9.	Tawa/Tawa	KENWOOD T.K- 90, 100 W	Nil	June-1974
10.	Denwa/ Pachmarhi	Barrett 530, 100 Watts.	Nil	14.06.1984
11.	Narmada / Hoshangabad	Barrett 530 100 Watts		Aug-1969
12.	Mortakka	ECIL C-5211, 15 Watts	Nil	Aug 1969
13.	Bhopal control Room	Barrett 530 100 watts		28.12.1989

Annexure 3 RIVER GAUGING NETWORK IN NARMADA BASIN UP TO HOSHANGABAD

Sl.No.	River/ site	Length of River to site in km	Catchment Area up to site in Sqkm	Bank of Station Gauge	Type of Observation/ Site	Commencement year
1.	Narmada at Dindori	97	2292	Left	WGDR	1987
2.	Banjar at Mukki	64	968	Right	WGR	1988
3.	Narmada at Manot	265	4667	Right	WGDRSWQ	1976
4	Burhner at Mohgaon	160	4090	Right	WGDRSWQ	1977
5.	Narmada at Mandla	295	13000	Right	WGRFF	1974
6.	Narmada at Bargi Dam	350	14561	Left	WGR	2001
7.	Narmada at Barmanghat	526	26453	Right	WGDRSWQ	1970
8.	Tawa at Tawa D/S	126	6060	Left	WGR	1974
9	Narmada at Hoshangabad	676	44548	Left	WGDRSWQFF	1970

Annexure 4 SALIENT FEATURES OF NARMADA BASIN

Sl. No.	Name of Sub Basin/ Sub Division	Bank	Length in km	Catchment in Sq km	% area with reference to total area
1	Upper Narmada up to Mandla	Main	295	13000	13.2
2	Middle Narmada Mandla to Hoshangabad	Main	381	25210	25.5
3.	Tawa	Left	172	6338	6.4
4.	Lower Narmada from Hoshangabad to confluence to sea near Bharuch	Main	636	54248	54.9

Annexure 5 DAILY RAINFALL ASSOCIATED WITH FLOOD SPELL, 2018

Forecast for Mandla

S.No.	Name of site	First Spell				Second Spell					Third Spell				
		20 Jul 18	21 Jul 18	22 Jul 18	23 Jul 18	24 Jul 18	25 Jul 18	26 Jul 18	27 Jul 18	28 Jul 18	04 Sept 18	05 Sept 18	06 Sept 18	07 Sept 18	08 Sept 18
1	Dindori	3.80	0.00	11.40	28.00	7.80	8.80	23.60	18.60	3.00	0.00	5.80	33.20	76.20	34.00
2	Mohgaon	7.80	0.00	47.60	78.00	18.00	14.20	30.00	29.80	1.40	0.00	1.80	5.00	31.00	33.40
3	Manot	33.00	0.00	46.20	35.40	22.60	5.00	17.40	11.60	0.00	0.00	1.40	3.80	23.80	30.40
4	Mukki	5.60	0.60	22.40	94.60	30.40	1.00	25.80	9.00	3.40	10.80	0.60	34.00	6.40	9.60
5	Mawai	75.60	36.40	16.80	70.20	9.00	1.80	35.80	38.00	2.40	0.00	0.40	41.80	30.20	5.60
6	Mandla	4.00	0.00	10.80	94.40	30.80	1.00	5.80	17.40	4.00	0.00	0.00	12.60	10.20	27.80
7	Bargi Nagar	0.00	0.00	20.80	27.20	3.00	0.00	22.40	3.00	0.00	0.00	0.00	11.60	2.80	9.80
8	Barman	1.00	0.00	9.80	26.40	15.40	0.00	49.40	7.60	0.00	1.20	12.60	18.80	13.40	32.60
9	Tawa Dam	0.00	0.00	1.40	13.20	16.60	0.00	8.80	0.60	0.00	0.00	3.00	1.80	1.80	5.60
10	Pachmarhi	27.80	0.00	3.80	19.00	0.00	0.00	7.00	31.00	48.80	3.60	8.00	20.80	63.00	28.60
11	Hoshangabad	43.80	1.60	1.80	15.80	49.80	2.60	29.40	0.00	0.40	0.00	49.60	0.40	1.20	10.40

Note:-Other spell not associated with flood forecas

Annexure 6 FORECAST PERFORMANCE DURING 2018

SL.No	Forecasting Station	Total No. Forecast Issued	Variation in Forecast with Actual	
			Within +/- 0.15m	Beyond Limit +/- 0.15m
1	Mandla	07	06	01
2	Hoshangabad	Nil	Nil	Nil

Annexure 7 FORECAST PERFORMANCE FOR LAST TEN YEARS (NARMADA BASIN)

Narmada at Mandla (Flood level) Commencement year 1989			
Year	Total Forecast	Within +/- 15 cm	%
2009	0	0	-
2010	0	0	-
2011	7	7	100
2012	0	0	-
2013	0	0	-
2014	13	13	100
2015	02	02	100
2016	09	09	100
2017	0	0	-
2018	07	06	85

<i>Narmada at Hoshangabad (Flood level) Commencement year 1973</i>			
Year	Total Forecast	Within +/- 15 cm	%
2009	11	10	90.9
2010	0	0	-
2011	0	0	-
2012	15	15	100
2013	47	46	97.9
2014	0	0	-
2015	0	0	-
2016	05	05	100
2017	0	0	-
2018	0	0	-

Annexure 8 COMPARISION OF FORECAST PERFORMANCE OF 2018 WITH LAST 10 YEARS UP TO 2018

River	Station	Percentage Accuracy from 2009 to 2018	Percentage Accuracy 2018
Narmada	Mandla	97 %	85 %
Narmada	Hoshangabad	97.2 %	Nil

Annexure 9 OVER ALL PERFORMANCE FOR THE LAST10 YEARS

Year	Total forecast issued	Forecast within admissible limit	Overall performance of the Division in %	Forecasting Division
2009	11	10	90.9	Narmada Division, CWC, Bhopal
2010	0	0	0	-do-
2011	7	7	100	-do-
2012	15	15	100	-do-
2013	47	46	97.9	-do-
2014	13	13	100	-do-
2015	02	02	100	-do-
2016	14	14	100	-do-
2017	0	0	0	-do-
2018	07	06	85	-do-

**Annexure 10 DURATION AND PEAK OF FLOOD WAVES OF NARMADA BASIN
DURING MONSOON 2018**

Sl.No	Forecast	Flood wave
1.	MANDLA	1
	I) Peak(m)	437.370 Meter 21.00 hrs dated 23.07.2018
	II) Duration	03 hrs.
	a) Above warning Level 437.2 m .	03 hrs
	Total hours	03 hrs
	b) Above danger Level 437.8 m	Nil
	Total hours	Nil
	c) Forecast issued	07
	d) Forecast with in limit	06
2.	HOSHAGABAD	
	I) Peak(m)	Nil
	II) Duration	Nil
	a) Above warning Level 292.83 mt	Nil
	b) Above danger Level 293.83	Nil
	c) Forecast issued	00
	d) Forecast with in limit	00

Annexure 11 Flood/ Heavy Rain Fall Damage-2018

SL. No.	Name of District	Area affected/Village	Population affected (in lakh)	Damage to crops		Damage to Houses/Huts		Cattle lost		Human lives lost	Damage to public utilizes in Rs Crores	Total Damage to crops, House & public utilizes etc Col. 5(b)+6(b)+7(b)-9	Remarks
				Area in M.Ha	Value in Rs. crore	Nos	Value in Rs. crore	Nos	Value in Rs. crore		Value in Rs. crore	Value in Rs.crore	
1	2	3	4	5(a)	5(b)	6(a)	6(b)	7(a)	7(b)	8	9	10	11
1	Mandla*												-
2	Hoshangabad	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	

***Note: The flood damage report for Mandla has not been received from Revenue Department, Govt. of M.P.**

Annexure 12 List of User Agencies

Sl No	Name of Agency
1.	State Data Centre Bhopal (Flood Cell)
2.	Relief Commissioner, Mantralay, Bhopal
3.	Deputy Commissioner (Relief), Mantralay, Bhopal
4.	Chief Secretary, Govt. of MP, Mantralay, Bhopal
5.	Deputy Commissioner, SDMA, Bhopal
6.	Collector, Mandla
7.	SP, Mandla
8.	Distt. Commandant, Home Guard, Mandla
9.	EE, Irrigation Division, Mandla
10.	CMO, Flood Control Room, Mandla
11.	Officer In-charge, Flood Control Room, Mandla
12.	Flood Relief Officer, Narsinghpur
13.	Collector, Hoshangabad
14.	SP, Hoshangabad
15.	SE, Tawa Circle, Hoshangabad
16.	In-charge, Flood Control Room, NVDA, Bhopal
17.	In-charge, Flood Control Room, Hoshangabad
18.	Director FFM, CWC, New Delhi
19.	Chief Engineer, Rani Avanti Bai Dam (Bargi), NVDA, Jabalpur
20.	Rani Avanti Bai Dam (Bargi), Jabalpur
21.	Member, NVDA , Bhopal
22.	Member (Engineering), NVDA, Bhopal
23.	Joint Secretary, NDMA, New Delhi
24.	Executive Engineer, NVDA, Barwani
25.	EE, NVDA for Collector Barwani
26.	EE(M&E), NVDA, Indore
27.	EE, Design, NVDA, Bhopal
28.	EE, M&D, Bargi, Jabalpur

Annexure 13 Weather Reports received from IMD during the flood days

Statement showing heavy rainfall warnings and QPF received from IMD during floods waves 2018

Sl.No .	E-mail received from	Time and Date	Heavy rainfall warning	QPF Range mm
1.	FMO, AHMEDABAD	09.15 Hrs /07.09.2018	Heavy rain would occur likely at few places in upper Narmada Basin	26-50
2.	FMO, AHMEDABAD	09.10 Hrs /08.09.2018	Day-1 Heavy rain likely at few places in Narmada Hoshangabad to Sardar Sarovar upper and middle Narmada basin.	11-25

Narmada Division, Bhopal



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Plate 2 Wireless and S.R.R.G Stations in Narmada Basin

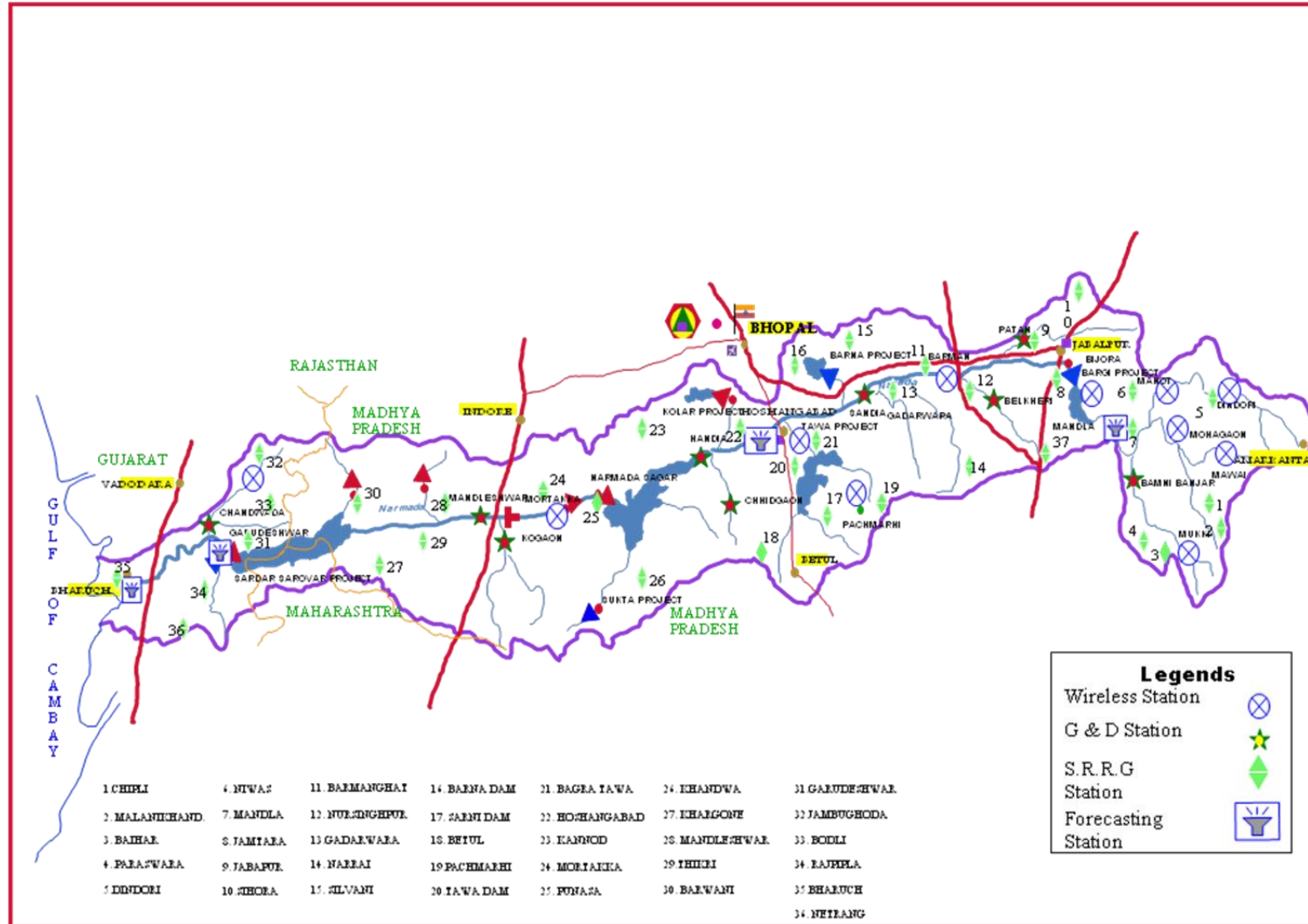


Plate 3 COMMUNICATION NET WORK OF NARMADA DIVISION

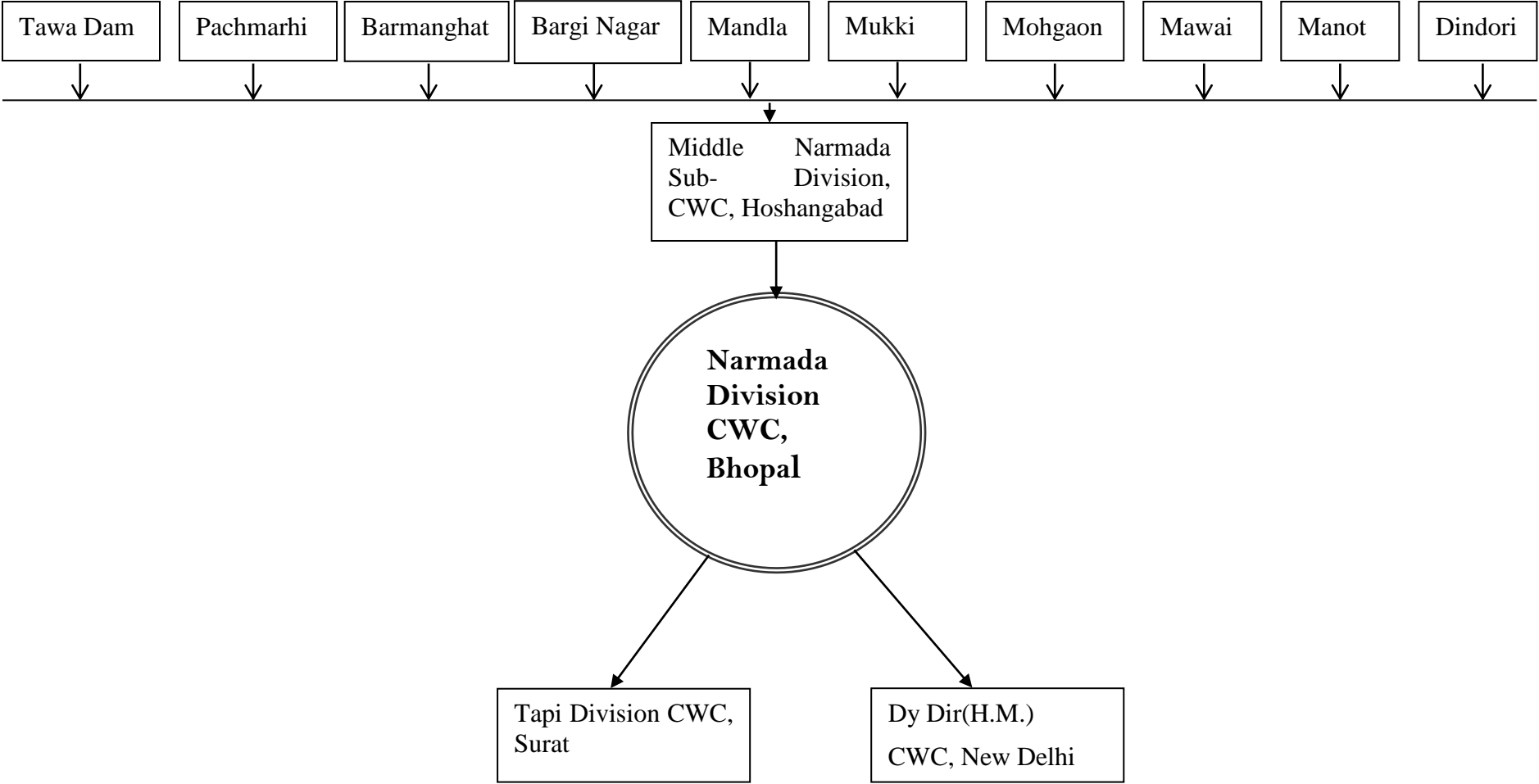


Plate 4 Line Diagram of Narmada Basin

Plate No : 4

LINE DIAGRAM OF NARMADA BASIN

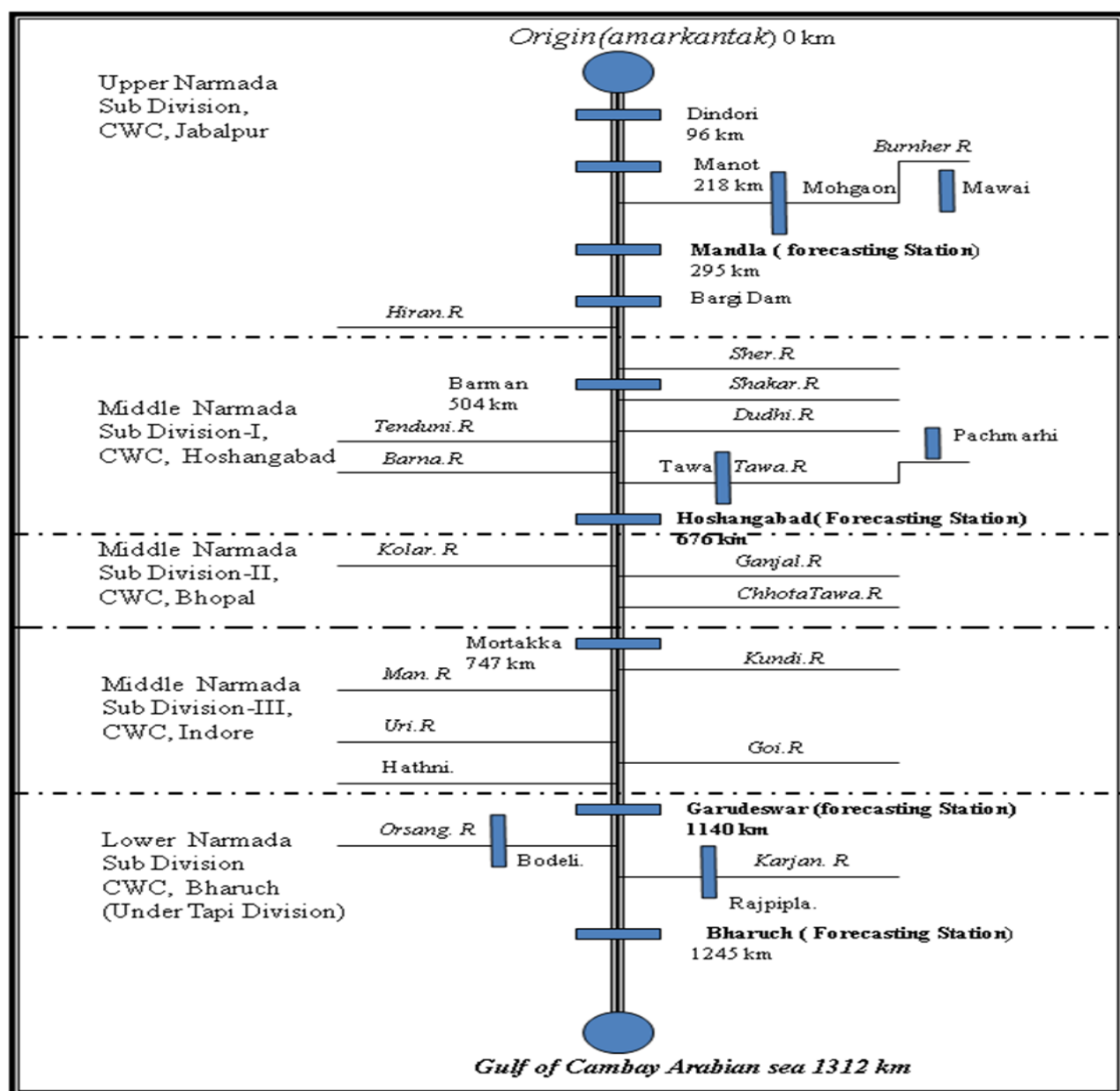


Plate 5 Comparison of site wise Normal Monsoon and Actual Monsoon 2018 Rainfall

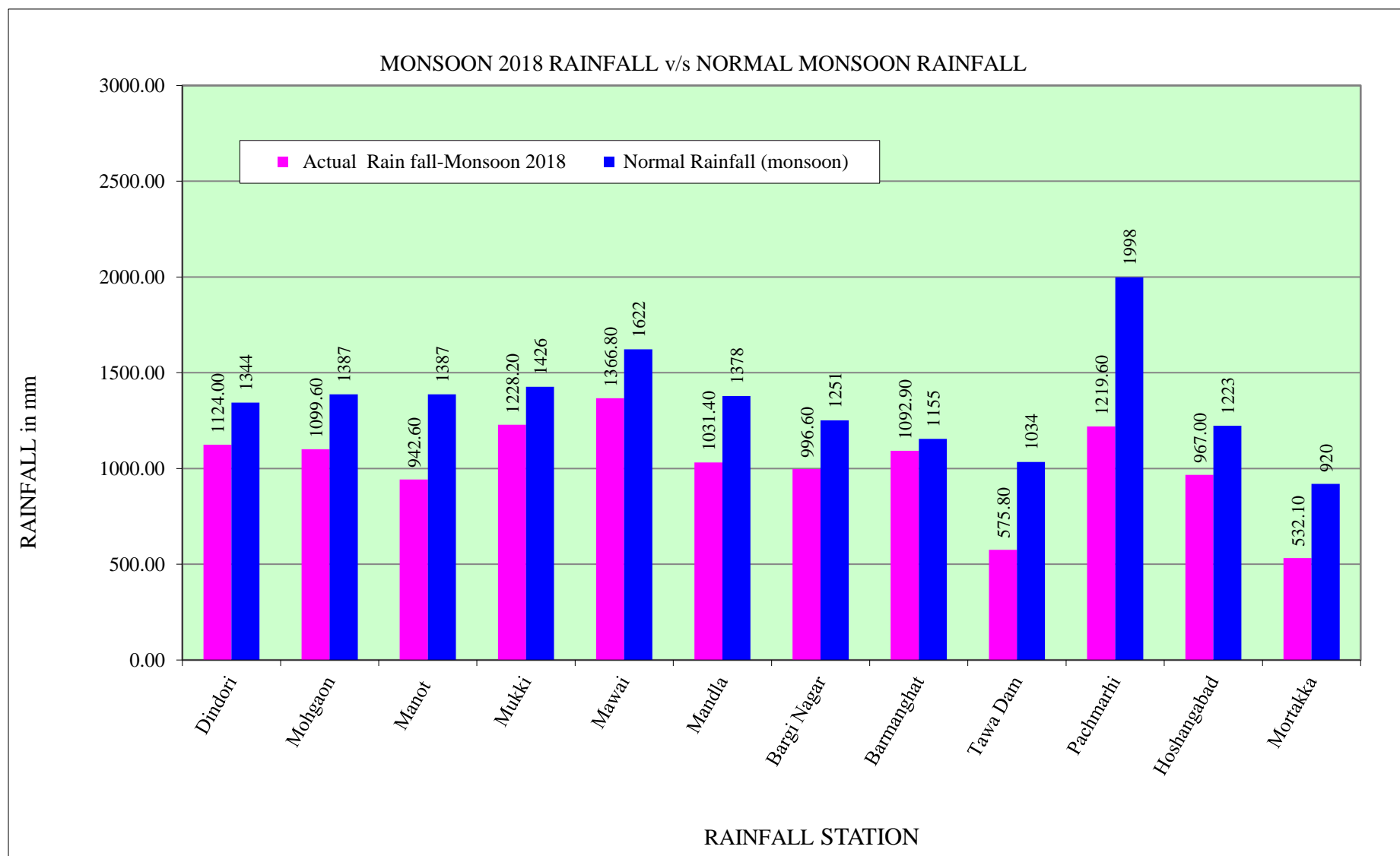


Plate 6 Bar Chart showing the Flood Forecast performance for last 10 years of Mandla

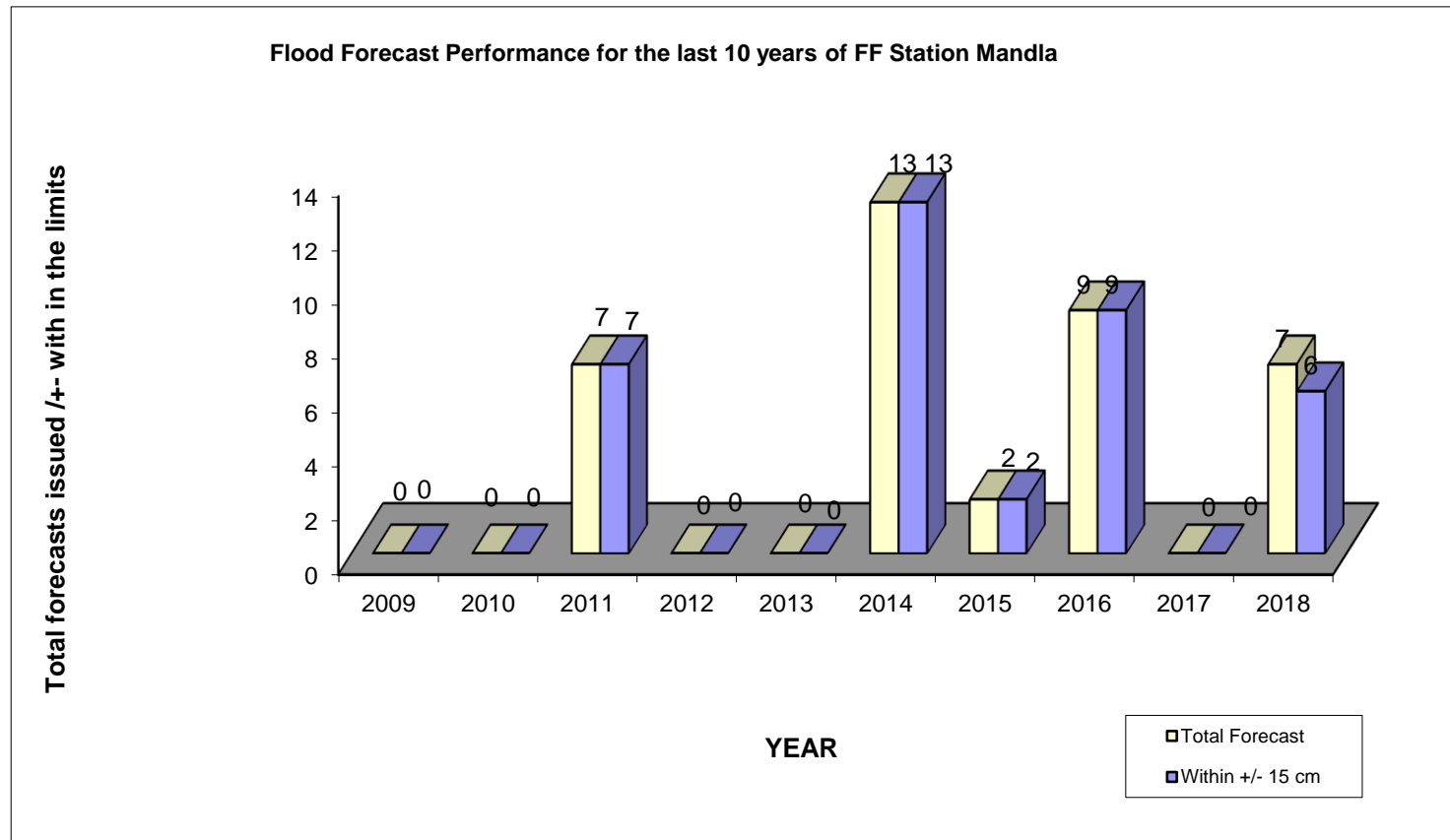


Plate 7 Bar Chart showing the Flood Forecast performance for last 10 years of Hoshangabad

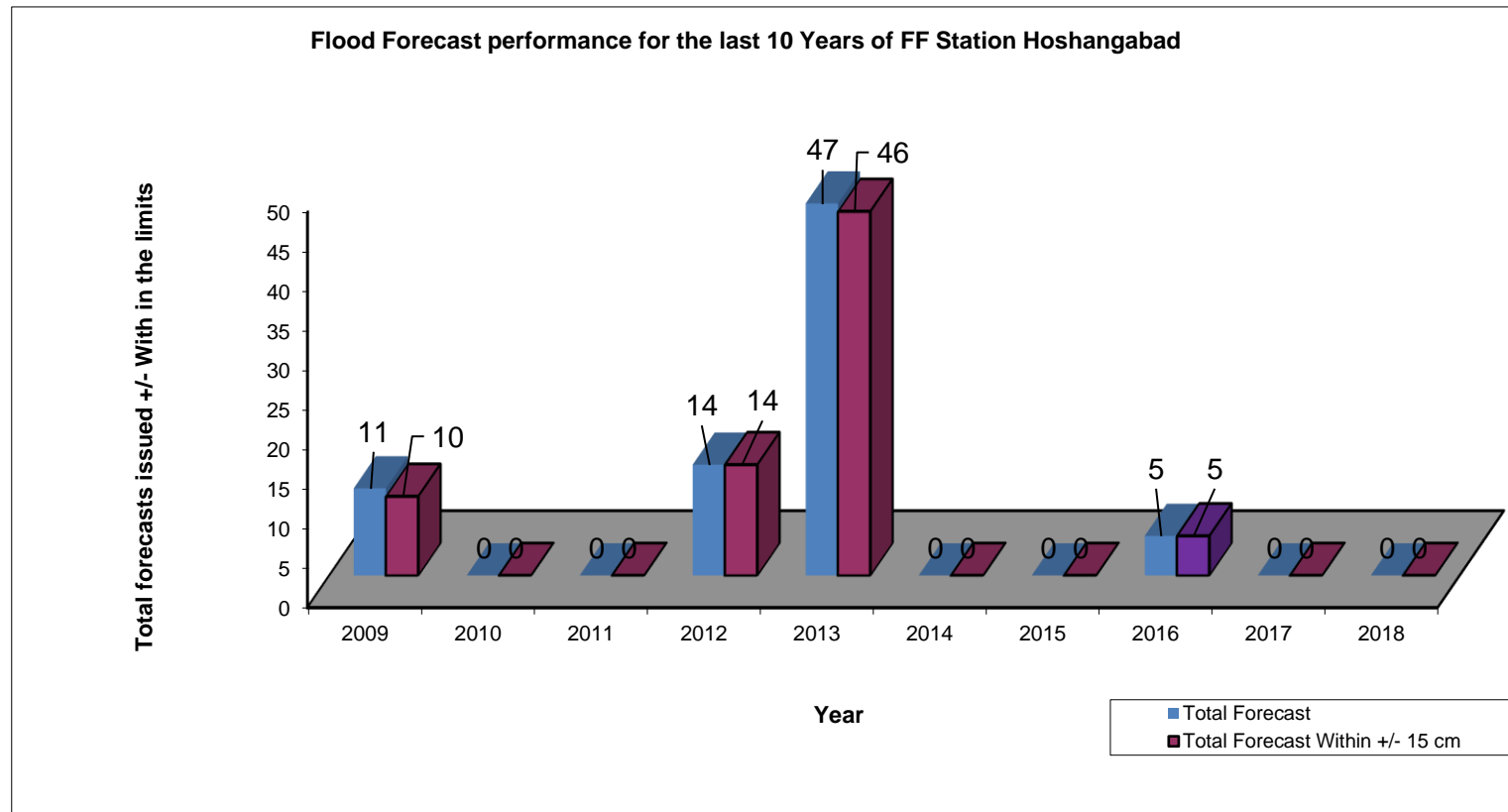


Plate 8 Forecast Diagram for Mandla

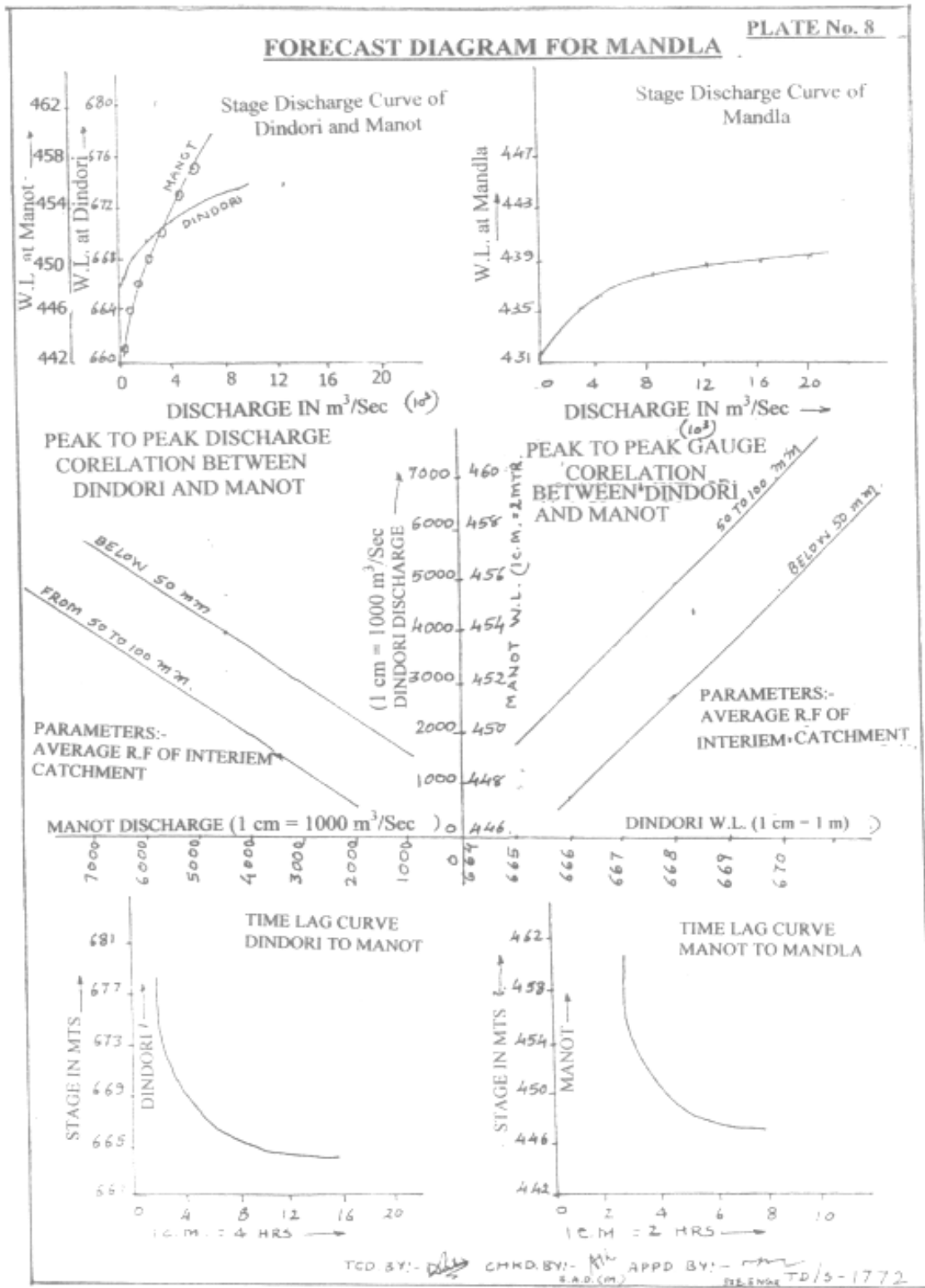


Plate 9 Forecast Diagram for Hoshangabad

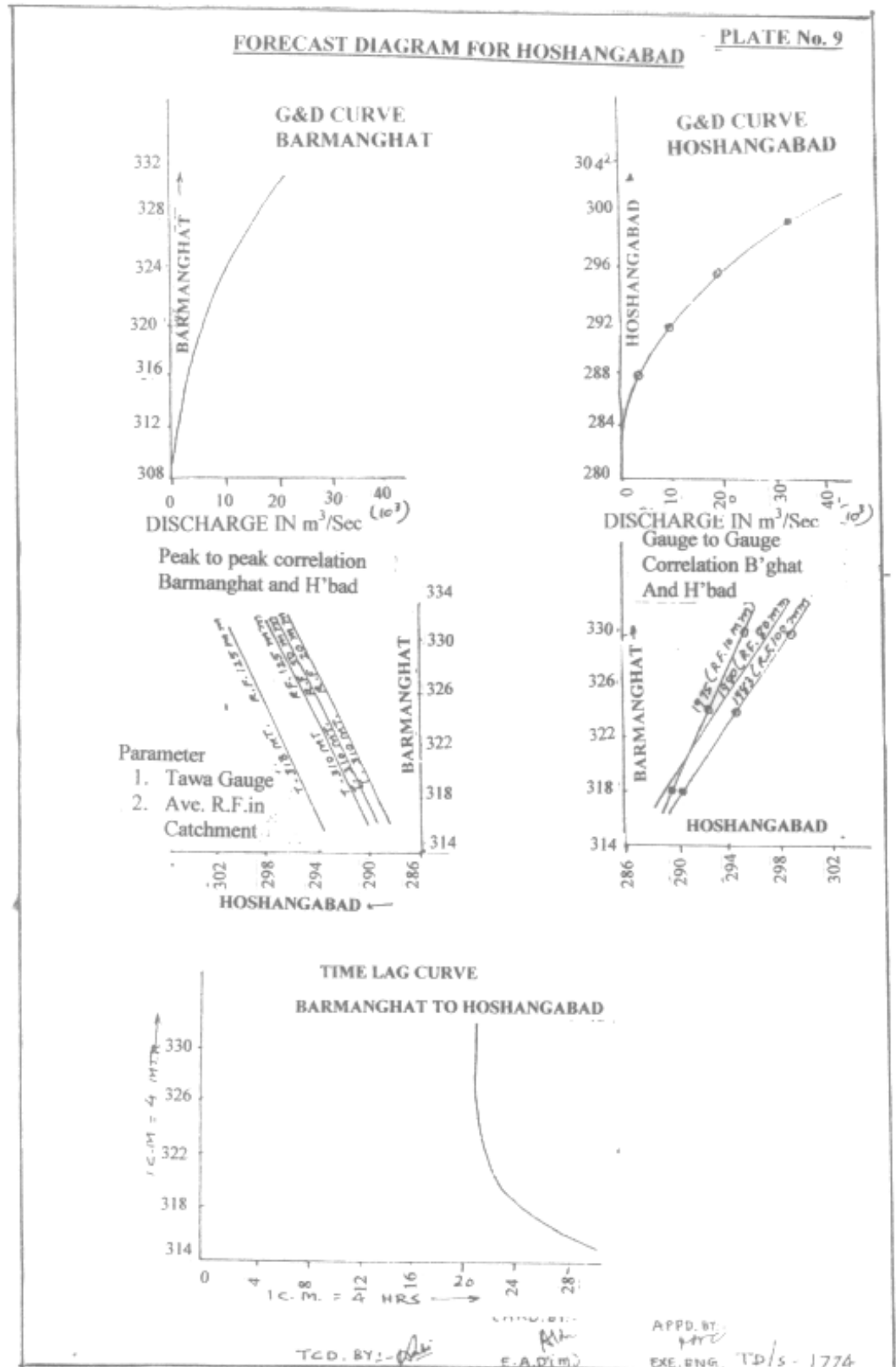


Plate 10 Line Diagram from Dindori to Mandla

LINE DIAGRAM FROM DINDORI TO MANDLA

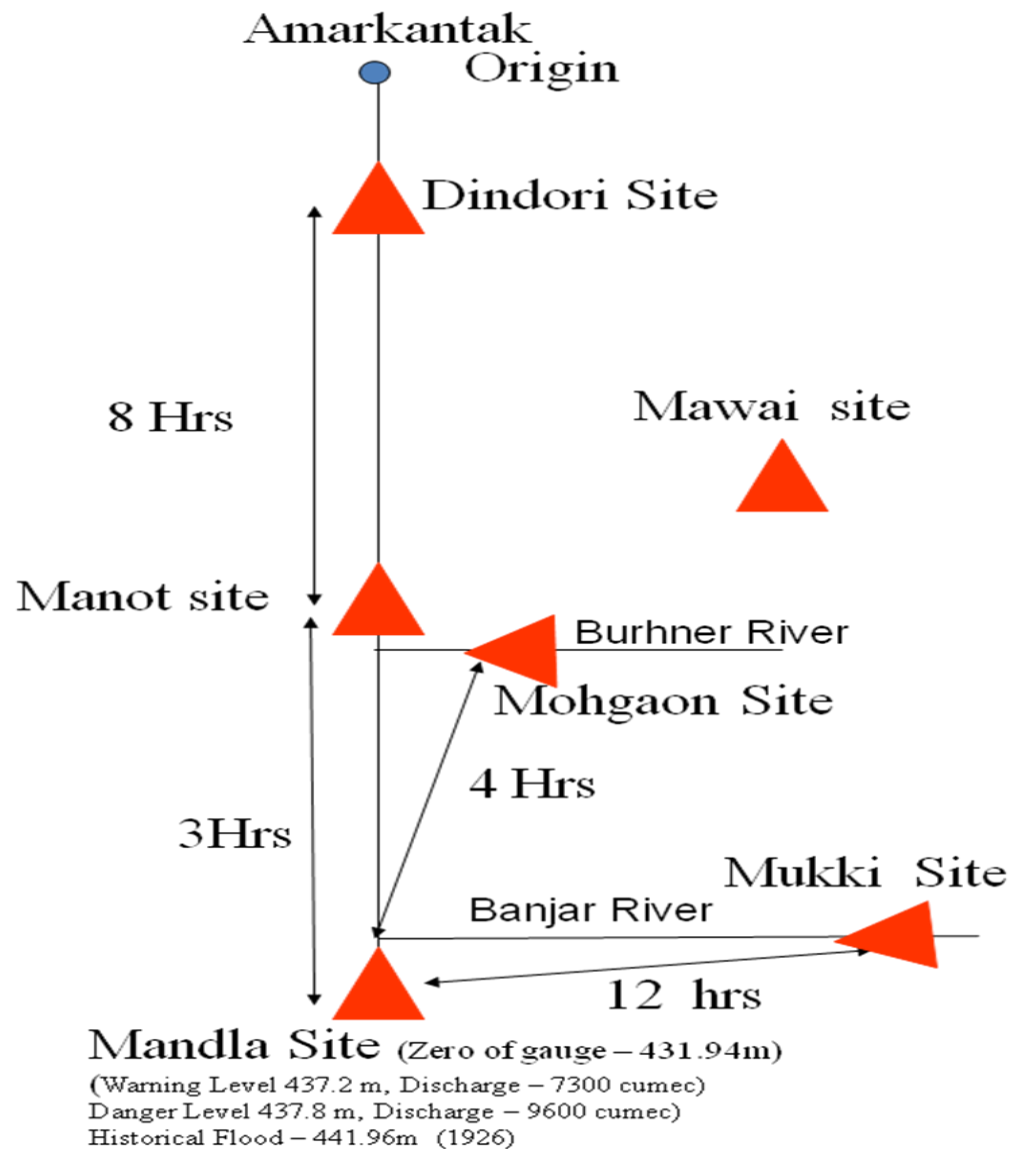


Plate 11 Line Diagram from Bargi to Hoshangabad

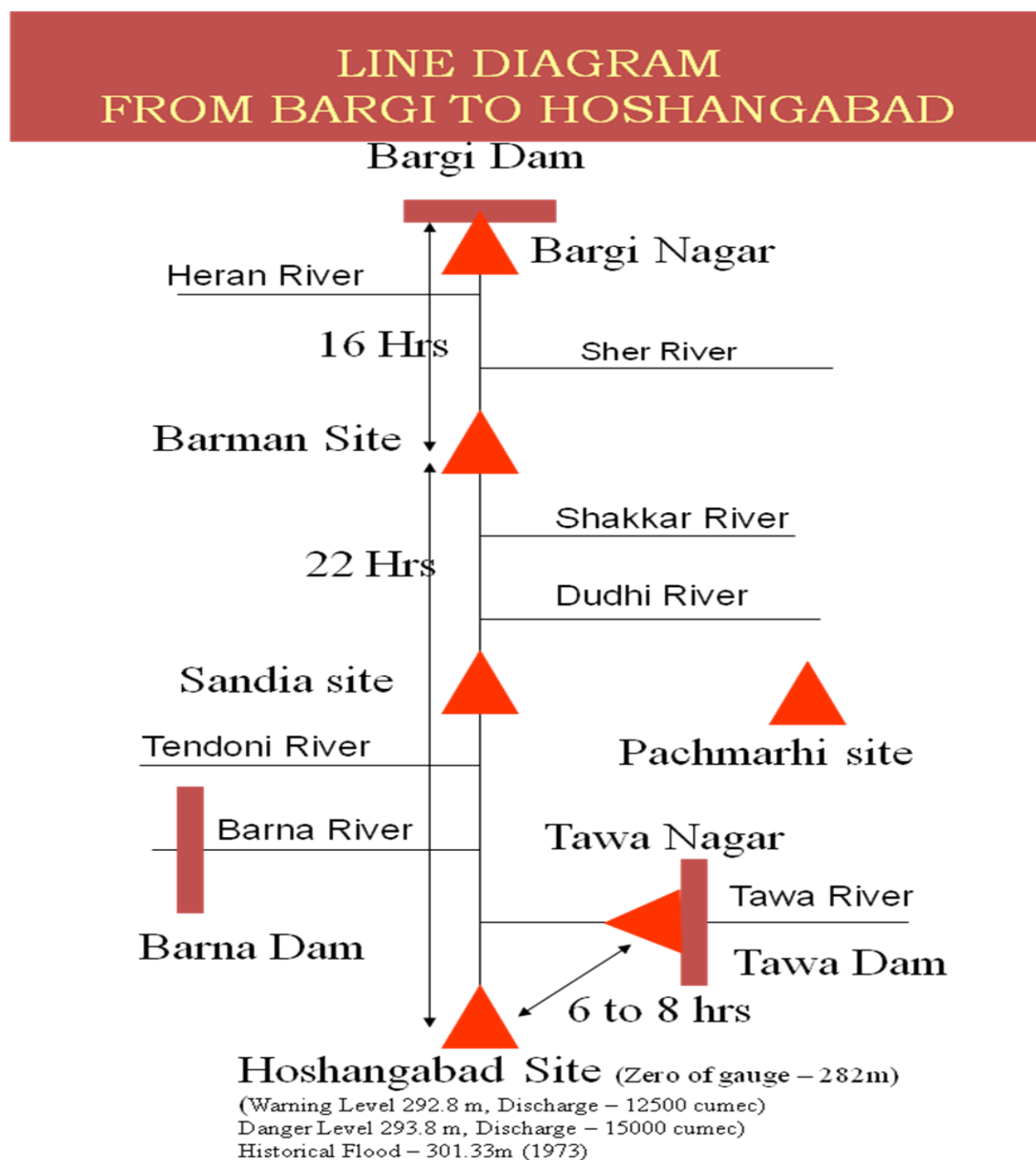


Plate-12 Narmada Basin – Soil Classification Narmada Basin – Soil Classification

