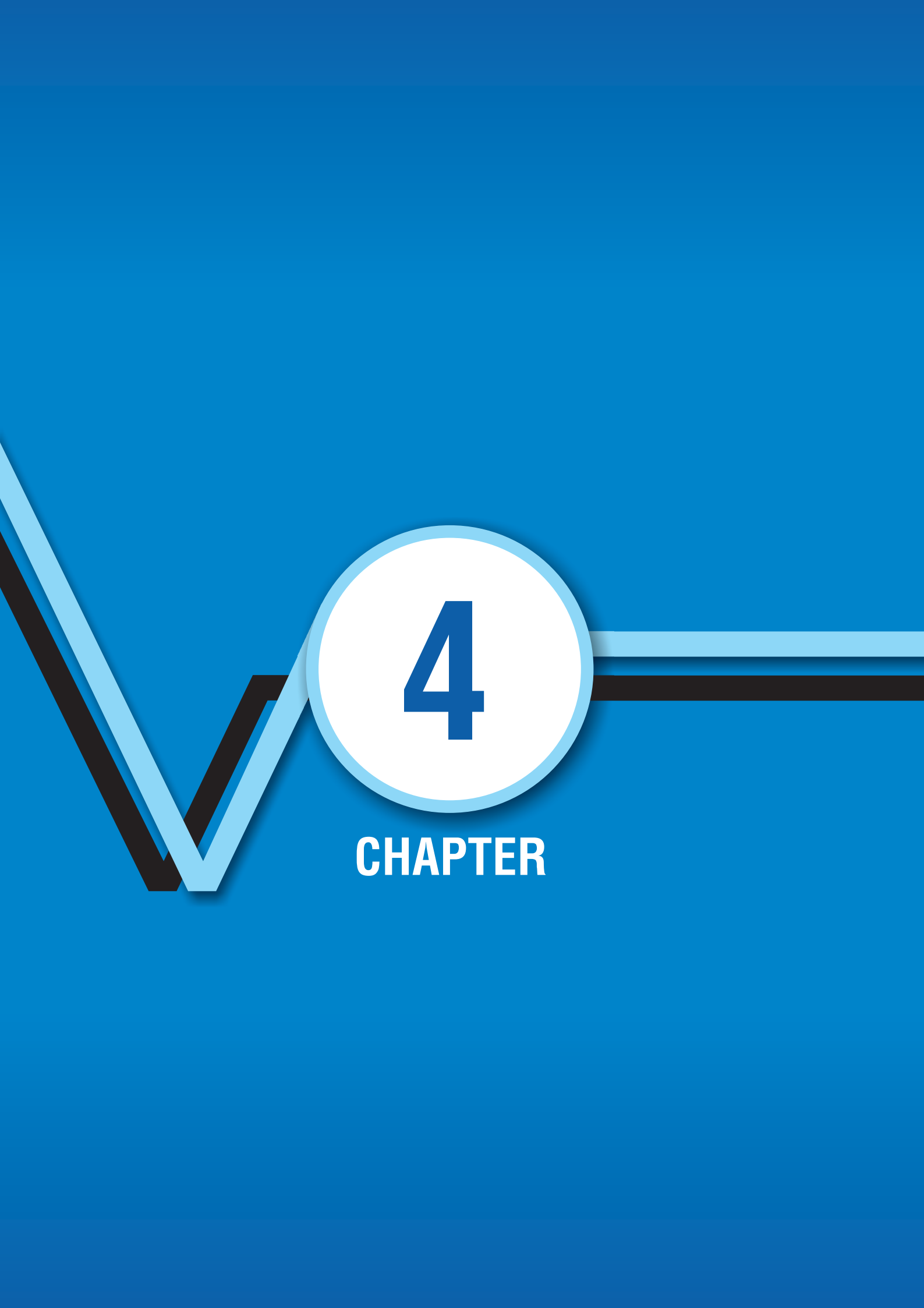
4
CHAPTER

4 Chapter

Flood Forecasting

4.1 Introduction

Flood Forecasting is a non-structural measure[32] and has been recognised as an effective tool for flood management by providing advance warning to the flood prone areas. The formulation of a forecast requires effective means of real time data communication network between the forecasting station and the base station. Flood Forecasting comprises of Level Forecasting and Inflow Forecasting. The Level Forecasts help the user agencies in deciding mitigating measures like evacuation of people and shifting people and their movable property to safer locations. The Inflow Forecasting is used by various dam authorities in optimum operation of reservoirs for safe passage of flood downstream as well as to ensure adequate storage in the reservoirs for meeting demand during non-monsoon period.

Flood forecasting and flood warning in India commenced in a small way in the year 1958 with the establishment of a unit in CWC, New Delhi, for flood forecasting for the river Yamuna at Delhi. Since then, CWC established 175 Flood Forecasting Stations (FFS) comprising of 147 level flood forecasting and 28 inflow forecasting stations upto 2006-07, and the number remained stagnant till 2014-15. Presently (2016-17), CWC's flood forecasting network covers 184 FFS in 19 States, UT of Dadra and Nagar Haveli and NCT Delhi. CWC has not established any FFS in 15 States/UTs i.e. Andaman and Nicobar Islands, Chandigarh, Daman and Diu, Goa, Himachal Pradesh, Kerala, Lakshadweep, Manipur, Meghalaya, Mizoram, Nagaland, Puducherry, Punjab, Rajasthan and Sikkim.

4.2 Modernization of Flood Forecasting Stations

CWC undertook the work of modernization of flood forecasting network during the IX Plan on pilot basis. The modernization works envisaged establishment of telemetry equipment in the FFS to enable collection and transmission of automatic real time data, automatic formulation of flood forecast and expeditious

[32] Different structural as well as non-structural methods of flood protection have been adopted in different States. Structural measures include storage reservoirs, flood embankments, drainage channels, anti-erosion works, channel improvement works, detention basins, etc. and non-structural measures include flood forecasting, flood plain zoning, flood proofing, disaster preparedness, etc.

dissemination thereof in order to increase the lead time for enabling concerned agencies to undertake mitigation measures for reducing the risk of disasters from flood. The basin-wise establishment of telemetry stations in the country since IX plan is given in Table 4.1.

Table 4.1: Details of Plan-wise and basin-wise installation of Telemetry stations

Five Year Plan	Name of Basins	No. of telemetry stations installed
IX	Chambal (20 nos.), Mahanadi (35 nos.)	55
X	Godavari (63 nos.), Krishna (41 nos.), Brahmaputra (21 Nos.) Damodar (20 nos.), Yamuna (15 nos.), Mahanadi (8 nos.)	168
XI	Narmada & Tapi (76 nos.), Indus (4 nos.), Ganga (63 nos.), Yamuna (25 nos.), Mahanadi (36 nos), Brahmaputra (14 nos.) and Godavari (4 nos.).	222
XII	56 telemetry stations installed upto July 2016. Basin wise details are not available	56

During XI Plan, a Central Sector Scheme, namely, Flood Forecasting was prepared by amalgamating two ongoing schemes of X Plan namely;

a. Establishment and Modernisation of Flood Forecasting Network in India including inflow forecast, and
b. Strengthening and Modernisation of Flood Forecasting and Hydrological Observation Network in the Brahmaputra and Barak Basin.

The flood forecasting scheme for XII Plan was approved in December 2015 with a provision of ₹ 281 crore.

The physical and financial targets and achievements of Flood Forecasting Scheme during XI and XII Plan are given in Table 4.2.

Table 4.2: Plan-wise physical and financial targets and achievements

Period	Physical		Financial (₹ in crore)	
	Target	**Achievement**	**Target**	**Achievement**
XI FYP	Installation of 222 telemetry stations.	Installed after delay of 26 months	130	103
	Modernisation of 219 stations with telemetry stations.	56 stations modernised (August 2016).	281	114.09 (March 2016)
	Creation of 36 level forecasting stations, 64 inflow forecasting stations and 310 base stations.	Work in progress (August 2016).		

XII FYP	Work of inundation modelling using available DEMs (about 30 M ha flood prone area whose high resolution DEMs were available with NRSC[33])	Work in progress (August 2016).		
	Preparation of new Probable Maximum Precipitation (PMP) Atlas and updation of old Atlas.	Work in progress (August 2016).		
	Setting-up of six additional modelling stations.	Work in progress (August 2016).		

As would be seen from the table above, the work of modernisation of only 56 telemetry stations had been completed as of August 2016.

4.3 Delay in installation of telemetry stations during XI plan

The work of supply, installation, testing, commissioning and maintenance of 222 telemetry stations, one Earth Receiving Station (ERS) and 10 Modelling stations including hardware, software and peripheral for eight years of real time data acquisition was awarded (March 2010) to Essel Shyam Technologies Limited, Noida (contractor) for ₹ 30.07 crore. The work was to be completed by April 2011.

However, the work of installation of all 222 telemetry stations was completed by June 2013 after delay of 26 months. We observed that in only seven telemetry stations the delay was attributed on part of the contractor and a penalty of ₹ 8,998 was levied. Delay in installation of the remaining stations was due to non-availability of sites/approved design and drawings and delay in handing over of sites to the contractor, indicating deficient planning and preparation.

Ministry stated (February 2017) that the delay in execution was primarily due to high water level in river causing delay in civil works on the site for installation of Bubbler Termination Point as well as the high water level in dams which were beyond the control of CWC as well as vendor. Land acquisition was another reason for delay in installation of sites.

The fact remained that MoWR, RD&GR could not achieve the commissioning of telemetry stations targeted during the XI Plan, which spilled into the XII plan period.

[33] National Remote Sensing Centre, Hyderabad, a unit of the Department of Space.

4.4 Non-functional telemetry stations

Scrutiny of records at MoWR, RD&GR revealed that out of 375 telemetry stations for which information was made available by the Ministry, 222 telemetry stations were non-operational. As a result, the real time data was not available for the corresponding period as indicated in **Annexure IV**.

The telemetry stations were non-functional due to reasons such as theft of telemetry equipment, dismantling due to inadequate security arrangements and non-installation of Radar Sensors/Bubbler. We also found cases in which telemetry stations were washed away, parts of stations were stolen, parts not working, parts damaged, receipt of erratic/non reliable data, solar panel and battery stolen and non-functional modelling centres, etc.

We observed that flood forecasting data was used in formulation of flood forecast only after comparing the telemetry data with manually observed data; and in the case of mismatch between the two sets of data, manual data was adopted. Thus, CWC did not depend on telemetry data even after investing in modernisation of telemetry station network for nearly 20 years. This defeated the purpose of establishment of telemetry equipment for meeting the requirement of real time data collection, its transmission and flood forecast formulation.

The work of 'Supply, Installation, Testing, Commissioning and Maintenance of the Telemetry Stations' was entrusted to an agency (Essel Shyam Technological Limited, Noida) by the Upper Yamuna Division of CWC. We noticed that the concerned divisions repeatedly requested (January 2014/May 2016) the agency to undertake proper maintenance of the non-working stations, however, no action was taken.

Ministry stated (February 2017) that all efforts were being made to make other telemetry stations functional at the earliest.

4.5 Non-implementation of Flood Forecasting Scheme/operations

We observed that flood forecasting was not done in some States due to lack of sanction for the scheme, absence of request from State Government, etc. as discussed below.

i) No flood forecasting scheme was sanctioned in the State of Tamil Nadu during XI Plan under Central Sector scheme. In XII Plan, action plan for installation of 41 telemetry stations in Tamil Nadu was prepared (July 2016) but tenders remained to be finalised (July 2016). Modernised flood forecasting infrastructure using real time data acquisition system and forecasting models for all river basins were not developed in Tamil Nadu. Floods forecasting were based on the meteorological forecast and special warning issued by IMD**.**

Ministry stated (February 2017) that under XII Plan, 13 forecast stations (four Level and nine Inflow) have been planned in the State of Tamil Nadu, of which five have been operationalised during 2016.

ii) Flood forecasting operations were not conducted in Himachal Pradesh. The Regional Committee for scientific assessment of flood prone area asked (September 2014) CWC Shimla to take up the matter with Government of Himachal Pradesh to collect/share related information and real time data available with project authorities to develop a robust flood forecasting system. We observed that no further progress was made since.

iii) There were 32 FFS in Bihar under CWC. However, Inflow forecast of reservoirs or barrage was not done as the request in this regard from State authorities was not made.

iv) The Karimganj FFS at River Kushaira, Assam was modernised under XII FYP so as to get real time data through telemetry system. Though a telemetry machine was installed (January 2015), data regarding water level and rainfall was not collected from the telemetry machine, as the FFS had not received any instructions in this regard. Non-utilisation of the telemetry machine for flood forecasting defeated the purpose for which it was installed.

v) CWC proposed to install 14 and 15 telemetry stations in Damodar and Lower Brahamputra Divisions respectively during 2012-17. However, as of June 2016, no progress was made in this regard.

4.6 Insufficient number of Flood Forecasting Stations

In Jammu & Kashmir and West Bengal, we noticed that the number of FFS/Rain Gauge Stations was not adequate to meet the requirements of the States. The observations are as follows:

(i) There are four rivers in Jammu & Kashmir i.e. Indus, Tawi, Chenab and Jhelum, which are prone to flood every year. However, only one FFS was established (2015) at Rammunshi Bagh for flood forecasting on river Jhelum, following the devastating floods during September 2014 in Kashmir Valley.

Working Group on Flood Management strongly recommended (2014-15) undertaking a comprehensive study of the entire flood related scenario in the area within six months and directed the CWC to initiate urgent steps to set up a centralized forecasting station in the State. CWC proposed installation of 19 additional modernised stations comprising five new level

forecasting-stations and 14 base stations on river Jhelum, Chenab and Indus during XII five year-plan.

However, even after nearly two years, only seven sites were established (level forecast station). No automatic telemetry equipment was installed, due to which data was being collected manually.

Ministry stated (February 2017) that the process of installing of telemetry system was taken up during 2016 as the Standing Finance Committee (SFC) memo was approved only in December 2015. The fact remained that sufficient number of FFS could not be installed in the flood prone State of Jammu & Kashmir.

(ii) There are 27 Rain Gauge Stations in Lower Brahmaputra Division in West Bengal. Scrutiny of records revealed that since construction of these stations, a number of flood protection works like barrages, embankments, spurs, culverts, etc. were constructed. These hydrological structures disturb the flow of the river causing time lag between base stations and forecast stations. Besides, most of the small tributaries of the major rivers remained un-gauged. In view of the difficulties in assessment of river flow during heavy downpours, the Division felt (since 2008) the deficiency of Rain Gauge Stations and requirement for more Rain Gauge Stations. However, CWC was yet to approve any new forecasting stations. Thus, flood forecasting was not effectively carried out in this division.

4.7 Wrong alignment of manual water level gauge and telemetry bubbler

At Naharkatia FFS, Assam we observed that the main channel of the river was flowing about 100 m away from the position at which the manual water level gauge and telemetry bubbler were installed. As a result, the actual water level and discharge of water as recorded in FFS and then transmitted was not accurate. The Department stated (June 2016) that the river course had changed a long time back and shifting of gauges at the main river course was not possible due to limitations of the telemetry system.

Ministry stated (February 2017) that concerned officers were instructed to maintain the proper approach to the Gauges.

The fact remained that the water level gauge and telemetry bubbler no longer served their purpose and remained idle.

4.8 Lack of flood forecasting due to non-maintenance of water level

Orissa State Water Policy, 2007 states that in highly flood prone areas, flood control would be given overriding consideration in the reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits. The Flood

Management Manual states that Officer in charge of Dam has to maintain the reservoir level according to the Rule Curve[34] which is determined on the basis of prior experience. To maintain the water at safe level, adequate number of sluice gates should be opened to discharge the water.

India Meteorological Department (IMD) made repeated forecasts of heavy rains in the State of Chhattisgarh and a part of Odisha located in the upstream of Mahanadi river for Hirakud Dam and also in downstream areas of Hirakud dam during the period from 24 August 2011 to 09 September 2011. For the above period, CWC also informed about heavy quantum of inflow of water to the Hirakud reservoir.

Despite above warnings, Dam Authorities maintained the water level above the lower limit of Rule Curve i.e. 590 feet (ft) for the above period. It was noticed that adequate number of sluice gates were also not opened during the period prior to the forecast.

There are a total of 98 sluice gates in this Dam. On 01 September 2011 the level was 624.50 ft and seven sluice gates and three crest gates were opened. On 04 September 2011 the level was 624.97 ft and 13 sluice gates and five crest gates were opened, on 09 September 2011 the level was 628.50 ft and 55 sluice gates and four crest gates were opened. This caused flood in the downstream areas of Hirakud dam. The loss of life and property assessed during three days in September 2011 in 13 districts was assessed to the extent of over ₹ 2,000 crore.

Similarly, the Dam authorities did not maintain the Rule Curve level of 590 ft in the Hirakud Reservoir during August 2014 and raised the reservoir level up to 628 ft Due to heavy rain in both upstream and downstream area of Mahanadi during first week of August 2014, 50 gates of the dam were opened which caused heavy discharge of water resulting in flooding in the lower basin of Mahanadi.

Dam authorities, Burla stated (June 2016) that keeping in view the rainfall and runoff pattern of the year 2011, it was decided to keep the reservoir level at 600 ft to meet the water requirement for irrigation and power. The Dam Division further stated that the Rule Curve was a guideline to follow as a filling schedule during normal operation but it did not restrict the operator to use the reservoir space for flood moderation.

Ministry stated (February 2017) that CWC issues inflow forecasts to project authorities on daily basis and the project authorities take their considered

[34] Rule curve is the target level planned to be achieved in a reservoir, under different conditions of probabilities of inflows and/or demands, during various time period in a year.

decisions on releases from reservoir based on the rule curve and situation downstream; CWC's inflow forecast plays only an advisory role.

The reply may be viewed in the light of the fact that the provisions of the State Water Policy, Flood Management Manual as well as forecasts of IMD and CWC were not heeded to by the Hirakud Dam authorities adherence to which would have helped in mitigating the severity of the flooding in the lower basin of Mahanadi.

4.9 Lack of flood forecasting due to incorrect fixation of warning and danger levels

No flood forecast was issued by the Himalayan Ganga Division, CWC, Dehradun (HGD), Uttarakhand for the river Alaknanda at Srinagar during June 2013 despite heavy losses to public property due to floods. The justification given was that warning and danger levels were at 539 metres (m) and 540 m respectively and the maximum water level touched 537.90 m only during the time, thus not reaching the warning level.The State Government revised (October 2013) the warning and danger levels at 535 m and 536 m respectively after the flood was over.

Ministry stated (February 2017) that the Government of Uttarakhand reviewed the Warning and Danger Level in consultation with the CWC and they were revised and flood forecasts were being issued from 2014 flood season onwards with newly fixed levels.

4.10 Conclusion

Against a target for the XII Plan for installation of 219 telemetry stations, 310 base stations and 100 flood forecasting stations, only 56 telemetry stations had been installed as of August 2016. Most of the telemetry stations installed during XI plan were non-functional due to which real time data was not available at these stations. Therefore, CWC did not depend on telemetry data even after investing in modernisation of telemetry station network for nearly 20 years which defeated the purpose of establishment of telemetry stations. There were insufficient number of flood forecasting stations in some of the States. There were deficiencies in installation and maintenance of flood forecasting stations. In Odisha, non-maintenance of water level in Hirakud dam as per the rule curve, and simultaneous opening later on of 50 flood gates caused heavy discharge of water resulting in flooding in downstream areas. In Uttarakhand, the flood forecasting could not be issued in time due to incorrect fixation of warning and danger level.

4.11 Recommendations

We recommend that

i) CWC may devise a time bound action plan to speed up the formulation of flood forecast on real time data communication network by making all the telemetry stations operational and take suitable steps to install all the targeted telemetry stations.

ii) CWC may ensure that the warning and danger levels have been fixed at appropriate level so that flood forecasting could be made correctly and timely.