DEVELOPMENT OF REAL TIME DATA ACQUISITION SYSTEM (RTDAS) AND REAL TIME DECISION SUPPORT SYSTEM (RTDSS) FOR DAMODAR RIVER BASIN

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ABSTRACT

River Damodar was known as "River of sorrow of West Bengal" for its devastating flood in the past.The flood was controlled by constructing series of dams in river Damodar and its tributaries. Flooding can lead to several losses of life and property. At present reservoir operation is being carried out by collecting data manually from different hydrological sites. For better flood management and control it is desirable on the part of dam owner to develop RTDAS and RTDSS for integrated reservoir operation. At present Damodar Valley Corporation is developing the RTDAS system for the entire Damodar basin under National Hydrological Project. The RTDSS system (Flood forecasting Model) has been developed up to Durgapur and it can forecast flood with lead time of 72 hours. Accordingly integrated reservoir operation is being carried out for DV reservoir. Further development of DSS from Durgapur to outfall of Damodar which also includes inundation model is in progress which can determine the inundated area in advance and will be helpful to evacuate the people well in advance.

1. INTRODUCTION WITH BRIEF HISTORY

Before independence, the River Damodar was known as the "River of Sorrows" as it used to flood many areas of Bardhaman, Hugli, Haora and Medinipur districts. Even now the floods sometimes affect the lower Damodar Valley, but the devastations have reduced. The floods used to occur almost every year, causing huge damage in some years. Historically great floods of the Damodar were observed in the years — 1770, 1855, 1866, 1873–74, 1875–76, 1884–85, 1891–92, 1897, 1900, 1907, 1913, 1927, 1930, 1935 and 1943. In four of these floods (1770, 1855, 1913 and 1943) most of Bardhaman town was flooded. In more recent times, severe flooding in the Lower Damodar area was witnessed in the years 1964, 1978, 2000, 2009 and 2014.

In response to the catastrophic flood of 1943, a committee was formed by the Government of West Bengal and following its suggestions to have an authority similar to the Tennessee Valley Authority in the USA, the Damodar Valley Corporation came into existence on 7th July, 1948. Four multipurpose dams were constructed during the period 1948 to 1959 - Maithon Dam, Panchet Dam, Tilaiya Dam and Konar Dam. These dams have designated flood reserve capacity in order to moderate flood peaks to a magnitude below the safe carrying capacity of the downstream channel. This is in addition to storage of water to meet industrial, municipal and domestic requirements in West Bengal & Jharkhand. In addition, a single purpose reservoir (to meet the drinking water requirements of Bokaro and Chas) was constructed on the Damodar, at Tenughat (without flood storage) later in the year 1974. Even through it was not part of the DVC system initially, it became part of the system in the recent years.

Lower Damodar area adjoining the two distributaries of main Damodar, i.e. Mundeswari River and Lower Damodar (Amta) Channel measuring around 1887 km² is spread over 2 Municipalities and 20 Administrative Development Blocks. The area is historically flood prone. Around 0.461 million people and 335 km² of cropped area in this zone are affected annually due to flood related inundation. A map of the catchment area of the River Damodar has been presented in Figure 1.

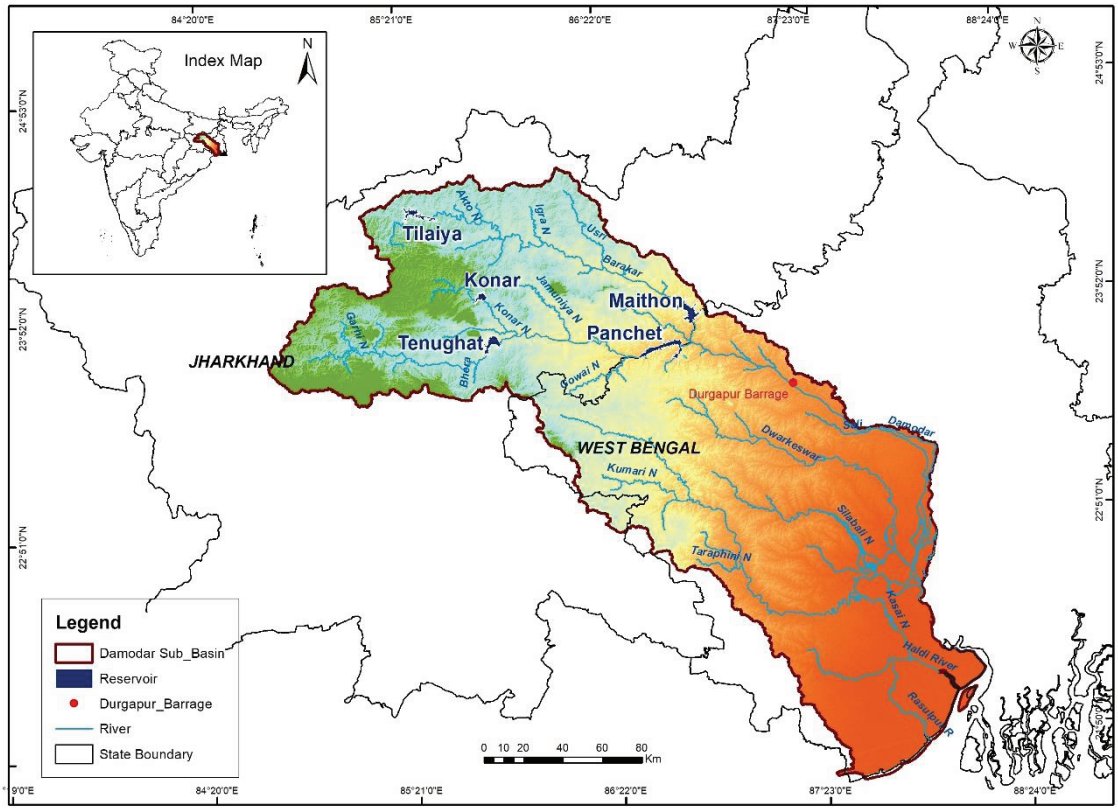

Figure 1 : Catchment of River Damodar

2. CHARACTERISTICS OF THE DAMODAR CATCHMENT

The River Damodar originates from the Kharmarpat hills in the Chotanagpur Plateau at an elevation of about 610 m above the MSL in the District Palamau in the State of Jharkhand. The river has a total length of 541 km and drains an area of about 24,217 km² in the states of Jharkhand and West Bengal. The river flows through hilly regions, cut by numerous deep gullies in its upper reach and through flat deltaic plains in its lower reach. The river has a number of tributaries - Barakar, Konar, Bokaro, Haharo, Jamunia, Ghari, Guaia, Khadia and Bhera. Its principal tributary, the River Barakar, originates near Padma in Hazaribagh district of Jharkhand and flows 225 kilometres across the northern part of the Chota Nagpur Plateau before joining the Damodar near Dishergarh in Asansol, in the District Bardhaman of West Bengal. It drains an area of 6967 km². The upper reaches of the catchment area is in the plateau while the lower reach is in deltaic plains. The catchment is irregular in shape and somewhat elongated towards the lower reach. The catchment area up to Durgapur Barrage is 18,026 km². The lower reaches are covered with silt and are quite fertile.

The annual rainfall over the Damodar valley varies between 1,000 mm and 1,800 mm. The upper and the middle parts of the valley receive about 1,209 mm rainfall annually and the lower parts receive about 1,329 mm. Mean annual rainfall in the area is of the order of 1,300 mm and about 80% of rainfall takes place during the monsoon months of June to September.

The maximum flood recorded in the pre-dam period was in August 1913, having a peak flow magnitude of 18,406 m³/s. The worst flood recorded in the valley occurred in September 1978, with a reported peak flow of 21,900 m³/s. The discharge capacity of the Durgapur Barrage is 15,860 m³/s.

3. NEED OF REAL TIME DATA ACQUISITION SYSTEM (RTDAS)

A Real Time Data Acquisition System (RTDAS) will consist of a sensors & telemetry network of rainfall and water levels along rivers/reservoirs which will be installed to provide inputs to the RTDAS. In the RTDAS there is advantages of modern Data Loggers, data storage, processing and data communication technologies with the requirements of high availability and sustainability required by agency for Real Time Decision Support System (RTDSS). such an important project. Preference will be given to robust, reliable technology. Real Time Hydro-Met data acquired by this network will provide key data required for forecasting Inflows into the Basin and other related activities.

4. CURRENT STATUS OF FLOOD FORECASTING

Currently, four dams are under control of the Damodar Valley Corporation & one dam i.e Tenughat Dam is under the control of Jharkhand Govt. and the flood releases are decided through unified control under the Damodar Valley Reservoir Regulation Committee (DVRRC). Based on the observed water levels at the gauging sites, the flood forecasting for the Damodar catchment has been carried out by the CWC.

Flood forecasting is initiated when the river water level crosses or is likely to cross "Warning Level". This warning level is taken generally one meter below the "Danger Level" which is fixed in consultation with the concerned District Magistrate and state authorities. The CWC office in Maithon receives river water level and rainfall data from the various hydrological observation stations located in the Damodar catchment every day in the rainy season through wireless network. During the monsoon the data received by CWC is made available to the DVC every day. The 'Flood Bulletin' is published every day which is made available to related offices of State and Central Government. The bulletins provide information on daily river levels and trend, daily rainfall, and gauge of reservoirs and quantity of water to be released from the reservoirs along with the rate of discharge. The hydrological and meteorological data required for flood forecasting are presently collected by CWC's field offices mostly manually and transmitted to the forecast centres through a network of wireless/ telephone. Flood forecasts are then formulated using simple or multiple correlations using gauge, rainfall and antecedent precipitation index data. The forecast is formulated based on observed data in the morning, and are issued once in a day. For the forecasting sites where advance forecasting time is of the order of 6 to 12 hours, a second forecast is also issued in the evening.

The flood forecast is disseminated by the CWC to the user agencies over telephone/ fax/ wireless etc. The user agencies include the office of the Chief Secretary, Commissioner for Relief, Project Authorities, District Collectors, Railways, Army authorities etc. Wide publicity is also given through electronic and print media. Daily flood bulletins are also hosted on the CWC website for quick dissemination. Flood forecast bulletins compiled at the Central Flood Control Room, Delhi are transmitted to Ministry of Water Resources (MoWR), Ministry of Home Affair (MHA), National Disaster Management Authority (NDMA) and other concerned officials as per the standard protocols.

Under the task "Consultancy Services for Preparation of Guide Curves for Unified Control Reservoirs in Damodar-Barakar Basin including Tenughat Dam", the DVC has already initiated a system of flood forecast in the catchment of the River Damodar upstream of the Durgapur Barrage. This was carried out by the DHI (India) Water & Environment Pvt Ltd, starting in 2013. The real time forecasting and operation system, a part of the above development, is based on calibrated rainfall-runoff and hydrodynamic models. A functionality has also been developed to send SMS and Email to the concerned authorities. It has been reported to perform satisfactorily, and is expected to become part of the current system after review and due modifications as per requirement.

The Irrigation & Waterways Department, Government of West Bengal has carried out river cross section survey and subsequent flood modelling for the reach extending between Beguahana (the point of bifurcation of River Damodar into distributaries) and outfall of the river into Rupnarayan and Hugli, in around the year 2014. It was done by Consultancy Engineering Services with the help of IIT Kharagpur, and has been reported to yield satisfactory results.

5. NEED TO IMPROVE CURRENT FORECASTS

Sometimes, local runoff generated due to heavy rainfall occurring in the Lower Damodar area synchronising with high water releases downstream of the Durgapur Barrage brings miseries mostly in the Districts Bardhaman and Hugli and parts of Districts Haora and Bankura in the state of West Bengal. Coupled with smaller lead time available with the current system of flood forecasting, this creates higher water levels which could perhaps have been averted if the combined effects of rainfall and releases from upstream dams were well studied and the releases from the dams controlled in a manner that reduces chances of synchronisation with the runoff generated due to rainfall in the lower reaches. The proposed flood inundation forecasting system will include the entire reach of the Damodar River up to its outfall into Hugli and Rupnarayan River, developing a systematic understanding that can lead to better flood management and control.

6. INUNDATION MODELLING

The lower Damodar Valley area downstream of Durgapur barrage up to outfall of branches of Damodar is inundated due to releases from Maithon and Panchet reservoirs, contribution of uncontrolled catchment between Maithon, Panchet and Durgapur Barrage and runoff from uncontrolled catchment below Durgapur Barrage. A two dimensional hydrodynamic model (like the MIKE 21 or HEC RAS/ any other model as deemed suitable) based on high resolution Digital Elevation Model (DEM) shall be developed for the entire lower Damodar Valley area. The model should be linked with the existing one dimensional MIKE 11 hydrodynamic model of the DVC system, with suitable modification/ conversion as may be required. Through repeated simulation runs including those representing the historical floods, the inundation model should be able to generate the flood inundation maps corresponding to the discharges that causes overtopping of the banks and embankments. The calibration and validation exercises for these models may be carried out on the basis of observed records of historical floods, ensuring that over fit-ting is not attempted to. The inundation model shall take the water logging and the tidal lockage areas into consideration while providing the results for the entire lower Damodar Valley area at technically suitable locations, considering all the factors viz. releases from Maithon and Panchet Dams, safe carrying capacity of downstream channels and its tributaries and distributaries, weather condition (QPF), tidal lockage etc. The model should be able to predict inundation extent, maximum depth at a place, time of arrival of flood peak after its release from Durgapur Barrage, maximum velocity of flood water and duration of inundation at any location in the entire lower Damodar Valley area.

7. DEVELOPMENT OF DECISION SUPPORT SYSTEM

Based on the flood inundation model developed in the previous step, a decision support system is to be developed. Depending on the meteorological forecasts and the resemblance of the prevailing conditions to historical records/ library of scenarios depicting inundations corresponding to floods of different return period, an inundation forecast with reasonable accuracy can be made. A decision support system can help in risk-informed decision making, by way of predicting losses, gains and risks in case of alternative scenarios corresponding to different possible management decisions. It would help minimisation of flood losses in Lower Damodar area downstream of Durgapur Barrage through exercise of controlled release from the dams, averting synchronisation of runoff from uncontrolled catchment with upstream releases, while safeguarding the safety of the dam and future water uses in an optimal way.

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