INTEGRATED BASIN DEVELOPMENT OF DAMODAR VALLEY – DVC AND LOWER DAMODAR

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ABSTRACT

River Damodar originates from Palamau hills in Jharkhand flows through a length of 541 km through Jharkhand and West Bengal. The total catchment area is 24,341 sq. km. After catastrophic flood in 1943 the then Government of Bengal appointed a Board of Enquire. The committee recommended for creation of an authority in line with Tennessee Valley Authority in the USA for all out development of the Damodar valley by constructing dams, reservoirs, irrigation canals etc.

In July 1948 Damodar Valley Corporation (DVC) came in existence. It envisaged construction of 8 dams, 2 no hydroelectric power stations, irrigation of 392,000 hectare of land by constructing a barrage at Durgapur, navigation canal etc

DVC could build 4 dams namely Konar, Tiliya, Maithon and Panchet and another dam by Jharkhand State Government namely Tenughat. Last seven decades there has been considerable achievement in flood mitigation and irrigation in the valley.

Silting of DVC dams is a bone of contention between DVC and State of West Bengal. DVC has proposed a new dam Belpahari over river Barakar at upstream to compensate the storage loss. In recent years Government of West Bengal (WB) has claimed 2015 flood had taken a toll of 120 lives and caused commercial damage to the tune of 4215 million USD mainly in lower Damodar basin area.

The lower Damodar area, which is rich in agriculture is under distress due to frequent flood, post monsoon lack of flow, silted river bed, large scale encroachment etc. The Irrigation and Waterways Department (I&WD), Government of West Bengal plan to undertake comprehensive interventions to rejuvenate the irrigation system and manage floods under the project titled 'West Bengal Major Irrigation and Flood Management Project (WBMIFMP). World Bank is substantively funding the project.

In view of the complex issues in the valley including hydrology, silt management, ground water management, tidal flow at the outfall, downstream flow requirement for sustainability etc. it may be required to manage the total basin as an Integrated Damodar River Basin (IDRB) for planning and design.

1. RIVER BASIN AND HYDROLOGY

River Damodar originating from Palamau hills in Jharkhand and flowing through a length of 541 km between several districts of Jharkhand and West Bengal bifurcates into two channels at Beguahana of Burdwan district near Jamalpur. One channel carrying dominant flood discharge has been named as river Mundeswari which drains into Rupnarayan at Bakshi of Howrah district. The other channel after passing through Hooghly and Howrah districts as Amta channel (Damodar) carries its discharge and outfalls into the river Hooghly through an outfall sluice near Uluberia.

The river causes floods in its lower reaches in the districts of Burdwan (Bardhhaman), Hooghly and Howrah, mainly on the right bank of the river below Beguahana. Earlier known as the 'Sorrow of Bengal' because of its ravaging floods in the plains of West Bengal, the Damodar and its tributaries have been somewhat tamed with the construction of four dams (Maithon, Panchet, Konar and Tiliya) under the control of DVC.

There is another dam at Tenughat across Damodar under the direct control of Government of Jharkhand. This dam has no flood storage provision and dedicated use by Bokaro steel plant and Bokaro industrial area. In the lower catchment there are one barrage at Durgapur and one weir at Randiha under the direct control of Irrigation & Waterways Department, Government of West Bengal.

Barakar and Bokaro are two major tributaries of Damodar in Jharkhand which meet Damodar from its left bank whereas river Shali in Bankura district of West Bengal is another major tributary situated on its right bank. Harinkhola, Short-Cut channel, Kana Dwarakeswar, Hurhura khal are other important drainage arteries of this catchment which play important role in draining out flood discharge into river Rupnarayan, having tidal influence. The catchment area of Damodar sub-basin in Jharkhand is 17,087 sq. km and in West Bengal is 4,325 sq. km up to Beguahana point. The local catchment area of Mundeswari sub-basin is 1,439 sq. km and that of Amta Channel-Kana Damodar sub-basin is 1,490 sq.km. Total catchment of Damodar till its outfall is 24,341 sq.km.

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Figure 1 : As depicted in 2017 flood report of I&WD, Government of West Bengal

The catchment area of river Damodar along with location of dams and barrage are shown in Figure 1 and Figure 2. The river slope is 1.86 m/km for the first 241 km, 0.57 m/km in the next 167 km and 0.16 m/km in the last reach. The lower reaches are silt covered and quite fertile. Irrigation facility has been available in the lower Damodar basin by means of a diversion weir-Anderson weir-at Rhondia on river Damodar and Eden canal to the extent of 89,000 ha in the districts of Burdwan and Hoogly even in pre-DVC era.

Figure 2 : As depicted in 2017 flood report of I&WD, Government of West Bengal

This project was approved in 1947, to be implemented through the DVC, which came into existence in 1948. It resulted in a set of reservoirs at five sites on Damodar and its tributaries, implemented in two phases (four dams constructed during 1953 to 1959 and one in 1978) that moderated flood to the extent of 53 to 80% in the high flood years.

Objectives of DVC are the promotion and operation of schemes for irrigation, water supply, drainage, generation, transmission and distribution of electrical energy (both hydro & thermal); flood control; navigation; afforestation and soil erosion etc. The Durgapur Barrage for irrigation purpose along with canal system of DVC has been handed over to the I&WD Govt. of West Bengal in 1964.

In the original project DVC canal system was designed mainly to provide irrigation in Kharif and Rabi period. The kharif cropping season is from July–October during the south-west monsoon and the Rabi cropping season is from October-March (winter). Now water is provided for Boro cultivation also. The Boro rice is commonly known as winter rice. It is photo-insensitive, transplanted rice cultivated in waterlogged, low-lying or medium lands with supplemental irrigation during November to May (dry and summer months). At present further work for increasing irrigation coverage by reducing transmission losses and changing cropping pattern has been taken up. Hence all the water including late monsoon and post monsoon flow is committed for irrigation.

An irrigation potential of 4,83,500 ha. out of its ultimate irrigation potential of 5,10,110 ha. has been created through the project in the districts of Burdwan, Bankura, Hooghly and Howrah.

The DVC over the years have developed an integrated network of benefits, a brief picture of their achievement is in Table 1 below.

Table 1 : DVC's achievement till date.

Items	**Description**
DVC Service Area	24,235 sq. km.
Thermal Power generation Stations 4 number Capacity	1,950 MW
Hydro Power generation Capacity	144 MW
Gas Turbine Station Capacity	82.5 MW
Major 4 Dams and 1 Barrage (Total Storage.)	1,270 mcm
Total Irrigation Potential Created about	440,000 ha
Canals	2,495 km
Check Dams (Soil conservation.)	1,689 Nos
Afforestation	121,500 ha

It seems DVC's core activity in present days is fossil fuel power generation and as a commercial company it is logical. There are 5 reservoirs across river Damodar and its tributaries in Jharkhand. Of these reservoirs, four reservoirs constructed by DVC and one reservoir by the Government of Jharkhand. Apart from this, a barrage is constructed at Durgapur across river Damodar in Bardhhaman district. Irrigation canal network off taking from the barrage was constructed by the DVC. West Bengal regularly receives its share of allocated and earmarked quantum of water from DVC reservoirs for irrigation (Kharif and Rabi), drinking and other municipal and industrial uses.

The three-member panel, known as Damodar Valley Reservoir Regulation Committee consists of member from Central Water Commission, State Government of West Bengal and Jharkhand. It is a Government committee and may not be tuned to stack holder's requirement in the ground. Committee decides the operation schedule of dams for flood control and release of water from the dams for irrigation.

Apart from the committed allocation, surplus water in the post monsoon season after meeting other committed needs is also released for irrigating Boro (winter/post winter) paddy in West Bengal

Command area of the DVC served by canal network is having total length of around 2730 km in the downstream of Durgapur Barrage and spread over 41 Administrative Development Blocks in the districts of Bankura, East Bardhhaman, West Bardhhaman, Hooghly and Howrah. The DVC canals currently irrigate around 332,000 ha in the Kharif season (out of a design area of 393,800 hectares), 20,000 ha in the Rabi season on the basis of an earmarked allocation, and an average of 28,000 ha in the summer (Boro) season, depending on the amount of water remaining in upstream reservoirs and after meeting the priority needs. The total area irrigated (including all sources of water) is approximately 100,000 hectares in Rabi and Boro season each. The main sources of water of those parts that are not covered by canal water are ground water, household and village ponds.

A substantive part of the water is from ground water including open well and deep tube wells. Resulting in stress in ground water storage and also increasing arsenic concentration in water in this region. As stated in the report by West Bengal Government, continuous withdrawal and deposition of arsenic contaminate groundwater (<0.01 mg/l as is the permissible limit for irrigation water set by WHO and FAO, the USA and European Union) for irrigation purpose may lead to increase soil arsenic level beyond the maximum acceptable limit for agricultural soil (20 mg/kg) recommended by the European Union and can affect the food chain cultivated in those areas.

2. LOWER DAMODAR BASIN

Lower Damodar Basin has been defined covering an area of 2929 sq.km marked with boundary starting around Burdwan town till its outfall, the study area is shown as Figure 3. Upstream of Jamalpur the river takes a right angle turn towards south may be due to high contour, geology and topography of the area. This can be defined as start of the delta formation of Damodar river which some old publications state as older than river Ganges delta. There are two main channels through which Damodar in this part flows and they are Amta (Damodar) Channel which drain in Hoogly River and other Mundeswari which drains in river Rupnarayan. Rupnarayan again drains in Hoogly river. Both are tidal river in this reach and as a result controls the draining capability of both these channels as shown in Figure 3.

With typical character of fluvial delta over and above two channels there are numerous channels which are paleochannel, seasonal channel, dead channel, buried channel, shifting channel etc. The land is rich with silt every year replenished by the flow carrying them down stream. Hence dense cultivation through the year is carried out in this region. But paucity of flow in non-monsoon has resulted in exploitation of ground water by open well, shallow and deep tube well. It has caused the ground water table in the region being unsustainable.

There is encroachment in land and channels by agriculture and human settlement. In number of channels in this region has its bed silted up causing the monsoon flow to spill and subsequent distress mainly in right bank. In post monsoon and dry season, the farming is affected as the river is dry and ground water is under distress.

2.1 Flood in 2015 monsoon

A low-level circulation developed over Gangetic West Bengal & adjoining Jharkhand from 24th July onwards. After transforming into a cyclonic storm 'Komen', it landed on Bangladesh and finally passed over West Bengal and Jharkhand during 30th July 2015 to 2nd August 2015. As a result, all the South Bengal Districts received widespread heavy to very heavy rainfall during the period.

Although West Bengal received an overall 2.20% excess rainfall than its average monthly rainfall during monsoon, 2015 i.e. during the month from June to September, 2015 but rainfall distribution between North Bengal and South Bengal varied largely. While North Bengal (Himalayan and Sub-Himalayan region) has received 14.30% less rainfall than its average monthly rainfall, South Bengal (Gangetic Plains) received 15.01% excess rainfall during this period.

Damodar in West Bengal was already in spate till the storm entered in Jharkhand part of the basin. River carrying heavy to very heavy discharge attained unprecedented levels and flowed above Extreme Danger Level (EDL) for prolonged period, extending for consecutive days as can be seen in Figure 4. The hydrograph shown indicate little flood moderation by upstream dams.

Situation became more serious due to severe lockage at outfall locations on Bhagirathi-Hooghly due to synchronization with spring tide period from 29th July to 4th August, with passage of heavy discharge, impeded flow in the major rivers causing severe downstream congestion and flooding.

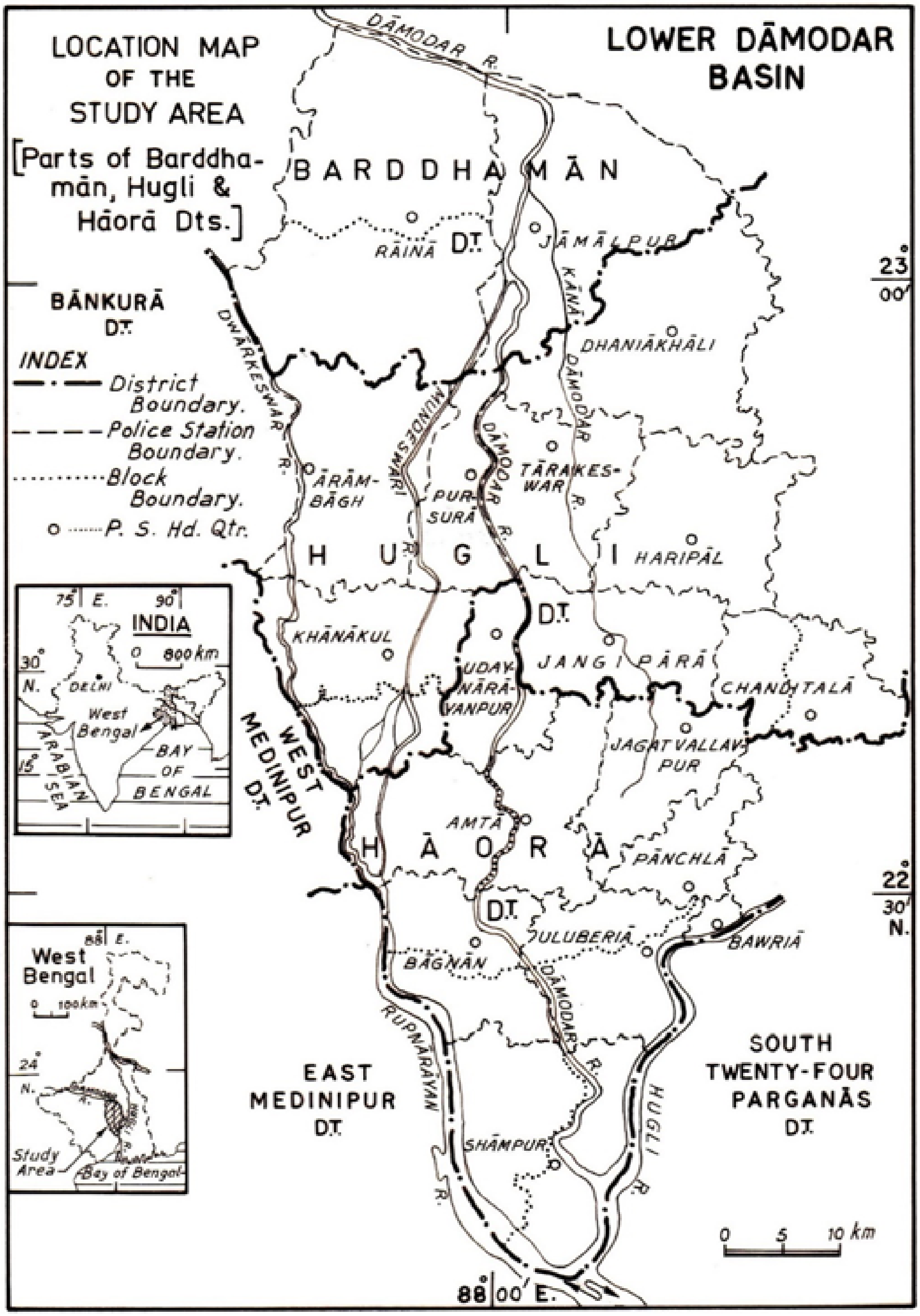

Figure 3 : Lower Damodar Basin provided by Susmita Ghosh *Scottish Church College, 1 &3, Urquhart Square, Kolkata*

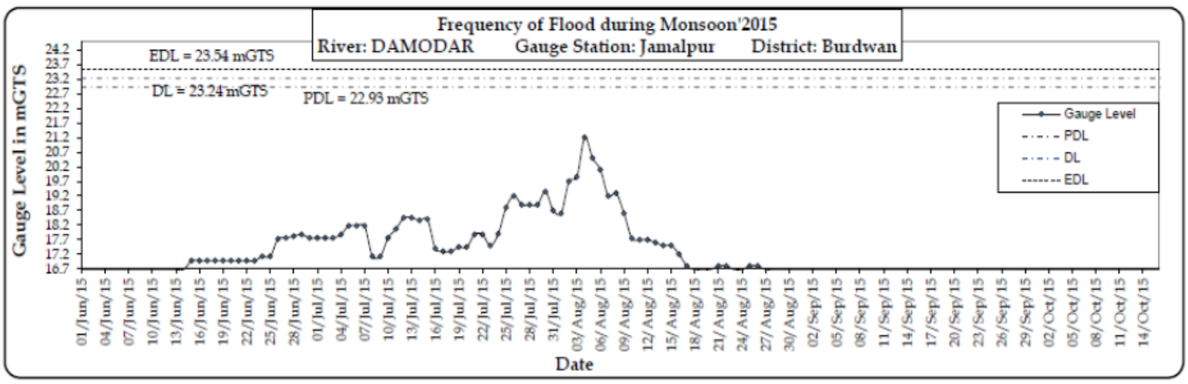

Figure 4 : River Damodar Gauge level from June 2015 to October 2015 Source I & W D.

As a result, there was widespread damage to embankments and other irrigation infrastructures. Figure 5. below indicate one such damage.

Figure 5 : Restoration of subsidence of right bank of river Damodar at Nabagram, Burdwan as obtained from Flood Report 2015 flood, I & W Dept. West Bengal

The combined release on August 3 was 2690 cumec (cum/sec), which is lower than the safe downstream channel carrying capacity of the Damodar river which is 3115 cumec but lower Damodar was already in high flow .It is argued by civil society and downstream authority that DVC operators knew that downstream areas were facing heavy rainfall and flow during Aug 1-4, 2015 under the influence of Komen and that this was also the high tide period and water release could have been delayed as till then sufficient storage space was available in both the upstream dams.

However, DVC is mainly a power generation company and its priority is generating as much as power during high inflow in dams so there is a conflict of priority between flood control and power generation. In such situation probably a reservoir operation system on the basis of advance flood forecasting would have saved the day. High tide at outfall of Damodar is a diurnal phenomenon so should be part of such operation system. But with increased discharge from the dam the loss of power generation would have taken place. So, may be, power generation capacity is required to be enhanced for the dams.

2.2 Flood in 2017 monsoon

Rainfall in July and August was somewhat normal. Release of water from DVC reservoirs combined with run-off of the uncontrolled catchment routed through Durgapur barrage created flood havoc in the vulnerable blocks of Hooghly and Howrah districts during last week of July more due to high tide. From 25th July to 8th August, the cumulative discharge from Durgapur barrage was 3278 million cum of water with the peak discharge of 7064 cum/sec 27th July.

Unfortunately, new moon was on 23rd July, so spring tides obstructed the flow to the lower stretch of various rivers in the tidal zone and this synchronization of high upland flow and high tides, caused swelling of rivers and drainage channels, which often ran above Extreme Danger Level (EDL) for a substantial period of time. Breaches occurred at various stretches in flood embankments in Damodar right, Maja (moribund) Damodar, Rampur Channel, Madaria canal, Bakshi khal, Short-Cut-Channel etc.in the lower Damodar region. Most of the channels in Lower Damodar area ruled high above EDL and river gauge stations reached near to their respective historical values with respect to HFL (High Flood Level) recorded during the flood of 1978 (highest ever flood in last 5 decades). Importance of tide levels at outfall is understandable for reservoir regulation and release.

3. WEST BENGAL MAJOR IRRIGATION AND FLOOD MANAGEMENT PROJECT

The DVCA was developed about seven decades ago and is now degraded. The reduced channel of the lower Damodar is not capable of carrying the regulated discharge due to heavy siltation in the lower Damodar. Infrastructures of irrigation system are in dilapidated condition. The Irrigation and Waterways Department, Government of West Bengal has proposed to construct flood wall, armouring of embankment, river training, desilting of Mundeswari river and other 41 nos. of canal under West Bengal Major Irrigation and Flood Management Project (WBMIFMP) to alleviate flood-water-logging and erosion problems in the districts of Howrah and Hooghly in Lower Damodar Region. Numerous regulating structures including cross and tail regulators, outlet gates, distributaries and minors have been severely damaged. Cross drainage structures, including aqueducts are damaged and are leaking, resulting in a loss of irrigation water. Tail end farmers are not getting the required amount of water at the time of need as per the irrigation schedule, and are using groundwater, especially during Rabi and Boro seasons.

These degraded regulating structures need to be replaced / repaired so that efficiency in irrigation can be achieved. The conditions that determined the original design of the irrigation and flood management infrastructure are no longer in place and the current needs and conditions need to be addressed in a comprehensive manner.

3.1 Proposed irrigation and flood management project

The Irrigation and Waterways Department (I&WD), Government of West Bengal plan to undertake comprehensive interventions to rejuvenate the irrigation system and manage floods under the project titled 'West Bengal Major Irrigation and Flood Management Project (WBMIFMP)' West Bengal Government has submitted the detail project report to World Bank.

3.2 World Bank and WBMIFPM

World Bank documents namely "RESETTLEMENT ACTION PLAN WBMIFMP" and another one "Environmental and Social Management Framework, WBMIFMP" discussed here

1. Component A: Irrigation Management: This component will improve the management of the DVC irrigation scheme. The component includes the following subcomponents: (i) establishment of MIS and performance monitoring, (ii) improving the quality of service delivery, (iii) aquifer management, and (iv) capacity strengthening.
2. Component B: Modernization of Irrigation Infrastructure: This component will invest in the modernization of irrigation infrastructure at main, branch, distributary and minor level. It includes the following subcomponents: (i) Main and Branch Canal Modernization, and (ii) Distributary and Minor Canal Infrastructure Modernization.
3. Component C: Flood Management: This will invest in structural measures to reduce flooding in the Project area. The investments include channel de-silting works, flow regulation structure modification and embankment reconstruction at key locations. In close collaboration with the World Bank-funded Dam Rehabilitation and Improvement Project, the investment would also include measures to strengthen forecasting and analysis capability to improve dam operation and water storage management in upstream reservoirs.
4. Component D: Project Management: This component will strengthen I&WD and the capacity for Project management, monitoring and evaluation through the provision of goods, consultant services, training, and financing incremental operating costs.

The project will be implemented by I&WD and to be co-financed by the World Bank and Asian Infrastructure Investment Bank (AIIB), jointly in equal proportion for USD 145 million each of the total loan amounting to USD 290 million (70% of the total estimated project cost of USD 413 million). Remaining 30% of the project cost, i.e. USD 123 million would be borne by the State Government. Incidentally it is to mention that World Bank was also involved in initial year of DVC project around 1950.

Some of the project components are discussed below.

3.2.1 *Aquifer Management*

One important aspect beyond irrigation system as mentioned in the report is aquifer management. It is understood that for last 7 decades of operation of DVC have generated sufficient data on ground water use and its depletion hence a comprehensive model both physical and a mathematical of ground water and surface water management can be activated. Though annual ground water replenishment seems to be in order but frequent withdrawal and replenishment is causing increase in arsenic concentration.

3.2.2 *Flood Management*

This Component will invest in structural measures to reduce flooding in the project area. About 490 hectares of lower Damodar area is subject to frequent flooding to varying intensity (Average depth of inundation varies between 1.0 M to 2.0 M and duration varies between 7 days to more than a month) due to intense rainfall and reduction of discharge carrying capacity of river resulting from sedimentation of river channel. Overall, the objective is to provide protection of at least 1 in 25-year flood return period for the left side of the Amta Channel and to prevent annual recurrence floods to the extent possible in the right bank and also to manage Amta right bank overspills to pass to channels and areas where resultant damage can be minimized. If possible, the right bank area would be largely protected from substantive damage up to a 1 in 10-year event. The intervention will ensure that flood flow discharge is more evenly shared between the Mundeswari and Amta Channels. May require model study.

Increasing flood discharge capacity in Mundeswari requires desilting to restore/increase the low flow to moderate flood discharge capacity to reduce/limit peak discharge that will still be needed in the Amta for all flood events. The project will also install two inflatable rubber dams at key locations.

3.2.3 *Sedimentation management of Dams and river channels downstream*

This is a difficult issue. Regarding sedimentation of dams it is understood that under sluices of the dams which otherwise are of smaller capacity are not effective and sluice gates are not functioning properly. Such under sluices can be remodelled, enlarged and made effective with today's available technology, Operation of under sluices should be part of flood and reservoir management especially for high sediment carrying rivers. Dams can have dual role, run of the river for power generation and storage for flood management and irrigation.

Regarding sedimentation of river channels in lower Damodar area, issue requires to be studied more deeply. It is understood all the remedies which has been included in the proposed plan is based upon visual observation. This may not be sufficient for such complex issue of river channel sedimentation especially which outfalls in tidal river. River flow in post monsoon season along the channel may be able to flush annual sediment deposited during monsoon. This flow also can help to maintaining flora and fauna.

Proposed Belpahari dam over river Barakar at upstream can help by dedicating some flow for downstream flushing. River channel desilting by manual and mechanised excavation as proposed can be supplemented by flushing flow from upstream dams. It will not be out of context to mention that Sanmenxia Dam over Yellow river in China has changed its operation schedule to include such water release for flushing the river bed downstream on its way to sea.

3.2.4 *Displacement / Relocation*

As per reports all the project activities that require land i.e., embankment strengthening, de-siltation and flood wall construction will be taken up in the existing structures and within the right-of-way / river bed. So, no additional private land is required for the project purpose and no land acquisition is proposed under the project. But, the embankment / the right-of-way has been encroached upon in many places which will require to be managed effectively.

3.2.5 *Model study for Damodar Basin*

In the last 7 decades till DVC project were build, a huge amount of data must have been generated and stored. Those must be hydrological and hydraulic data, gauge and discharge observations at different points on the river, geomorphological data and observations and meteorological data on rain and storm. Hence it may be feasible to build few hydraulic and hydrological model of this basin, both physical and mathematical which will help to quantify the remedies required. Such models once build or established can be a permanent feature of the basin and updated time to time.

4. CONCLUSION

Since inception DVC has done commendable job in development river basin by flood control/ management, irrigation for multiple crops in downstream in West Bengal, water supply to domestic and industry and has been catalyst for all out development of a large part of Damodar valley. But lower Damodar is under distress due to lack of effective flood management, river channel siltation, damage irrigation canals and structures, dry river bed and lack of irrigation water during non- monsoon period, unsustainable ground water availability etc.

I&W Dept of Government of West Bengal has planned to take up a project to alleviate such distresses as elaborated in the report namely WBMIFMP. WB along with AIIB shall be funding a major part of this project. Many of the important part such as reservoir regulation and operation should be reviewed now by involving stake holders and civil society. Silt management of the basin should be seen in totality. Provision of downstream flow requires to be made in the river channel during post monsoon period for long term sustainability.

At the present state with available knowledge it may be wise and also required that the proposed project is planned and designed as Integrated Damodar River Basin Management plan (IDRB).

REFERENCES

1. I & WD, Government 0f West Bengal 2015 Annual Flood Report
2. I & WD, Government 0f West Bengal 2017 Annual Flood Report
3. World Bank 2018 Resettlement Action Plan WBMIFMP
4. Ghosh S 2011 Hydrological changes and their impact on fluvial environment of the lower Damodar basin over a period of fifty years of damming the mighty Damodar river
5. I & WD Government of West Bengal, 2018 Environmental and Social Management Framework, WBMIFMP