Studies On The Morphology, Discharge And Sedimentation And Its Impact On Riparian Community In The Downstream Of Ranganadi River Dam, N. E. India

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Abstract:— North-east India is endowed with bountiful water resources. The rivers originating in Himalayas are fast-flowing and heavily loaded with sediments. The present study stresses on siltation and erosion in its flood plain that had severely affected the riparian community in the downstream of Ranganadi River dam. The Ranganadi River carries a mixture of big and small objects that includes boulders, cobbles, pebbles, sand and clay. The maximum mean discharge was recorded in monsoon and the minimum mean value was recorded in winter. The maximum mean sediment load value (231878t/day) was recorded in monsoon and the minimum (6044t/day) in winter. The livelihood condition of the riparian community is affected in the valley by sudden floods. Large area of cultivable land had being lost due to sediment deposition; fish catch had gone low and scarcity of alternate employment opportunities was observed. Moreover, there is always threat to lives and animals due to unscheduled and uninformed release of water from the reservoir.

Index Terms:— Downstream, Discharge, Flood, Morphology, Ranganadi River Dam, Riparian community, Sedimentation.

1. INTRODUCTION

River is a lotic body, maintaining all possible connectivity for a landscape. The high discharge and flurry flow in the north-eastern rivers flowing down steep gorges and slopes in the hilly environment provide many ideal locations for hydroelectricity development. As a result, the N. E. India has taken a center stage with respect to futures power generation in the country. The construction of dams for hydroelectric power results in widespread socio-economic impacts on communities. Hydroelectric power project if not used with caution, shall generate adverse impacts on fish, wildlife and other natural resources (Erlanger et al., 2008). If damage caused to this complex system, the livelihoods are fundamentally affected causing immense hardship to inhabitants and loss of income to households. Traditional crops of the area, forests, vegetation, and fauna including micro-organisms show sudden disappearance. According to Gaur, 2007; People displaced from a site adjust to new habitats, where their religion-cultural traditions, socio-economic web and occupation especially agriculture crumbles. Many Rivers no longer support the socially valued native species or sustain healthy ecosystem that provide essential goods and services (NRC, 1992; Naiman et al., 1995). Hence, a large population is replaced, and the original

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- *land use pattern, socio-economic systems, agro-socio-forestry systems, and traditional ecological practices lead to an end.*

2. STUDY AREA

The Ranganadi River is a tributary of River Subansiri. Ranganadi River (27°11′11″ N, 094°03′54″ E) originates from Himalayan foothills of Arunachal Pradesh at an altitude of 3,400 m, flows through the Lesser Himalaya, Outer Himalaya and the valley of the River Brahmaputra. The River enters Assam near Johing (27°20′38.96″ N, 094°01′56.23″ E), traverses another 60 km and joins Subansiri River in Pokoniaghat (27°01′27.72″ N 94°03′05″ E), in Lakhimpur district of Assam. The Ranganadi River experiences the effects of having a Dam namely “Ranganadi Hydroelectric Project” under North Eastern Electric Power Corporation (NEEPCO) with a capacity of 405 MW (27°20′03″ N, 093°49′00″ E) at Yazali in Lower Subansiri district of Arunachal Pradesh, India.

3. MATERIALS AND METHODS

The present study area is confined to the downstream of Ranganadi River Dam with a stretch of about 100kms from Dam Site (just below the RHEP dam) to Pokoniaghat (confluence with River Subansiri). The elevation at Dam site was recorded 318masl; 106masl at Kimin and 87masl at Pokoniaghat. The entire study area was divided into three sectors for convenience. The sector I comprises from dam site to Kimin, Sector II (Kimin to Pohumora) and sector III (Pohumora to Pokoniaghat) respectively. GPS (Garmin 21) was used to record the elevation and positioning of the sectors. Primary as well as secondary data were collected to work on the research problem. Water discharge and sediment load data was provided from Ranganadi Hydro-electric Project (NEEPCO) and Water Resource Department, North Lakhimpur. Data regarding the riparian community was provided by Water Resource Department, North Lakhimpur, Assam, India.

4. RESULTS AND DISCUSSION

4.1 Physical Status of the Ranganadi River

The present study area is confined only in the downstream of the Ranganadi Hydro-Electric Project (RHEP), a stretch of 100kms till the confluence with River Subansiri. The map of the study area is given. The elevation of the river is 538masl at the Dam Site. The elevation decreases to 138masl at the area where it enters Assam which further decreases to 83masl to the point confluence with River Subansiri at Pokoniaghat. The maximum inclination 10m/km is recorded in Sector I (Between Dam Site and Kimin). The inclination of the river in remaining two sites is 1.92 & 0.2m/km which is very less in comparison to the inclination at site 1. The River Ranganadi is wide in the downstream (>280m in monsoon) with a considerable depth. Mean water depth in rainy months varies from 23.9±0.45m to 0.65±1.52m in the study sites, while the mean water depth in winter ranges from 2.3±0.38m to 0.22±1.31m (Table 1).

Location	*Dam Site (Yazali) (A)*	*Kimin (B)*	*Pohumora (C)*	*Pokonia Ghat (D)*
Longitude	*27° 34'22.6" N*	*27° 19'23.5 "N*	*27° 12'20.8" N*	*27° 01'27.7" N*
Latitude	*93° 81'65.8" E*	*93° 58'25.6 "E*	*94° 03'08.3" E*	*94° 03'05.2" E*
Mean sea level (m)	*538*	*138*	*90*	*83*
Slope of the river bed (m/km)	*(Initial spot)*	*10 (A-B)*	*1.92 (B-C)*	*0.2 (C-D)*
Approx. distance (km)	*0*	*40*	*25*	*35*
Depth in winter (m)	*2.3±0.38*	*0.22±1.31*	*0.54±1.91*	*0.80±2.00*
Depth in monsoon (m)	*23.9±0.45*	*0.65±1.52*	*1.25±2.69*	*1.79±2.89*
Width of the river in winter (m)	*32.0±0.81*	*10.67±0.6 2*	*43.02±1.24*	*22.67±0.91*
Width of the river in monsoon (m)	*60.66.0±1.0*	*86.66±1.9 7*	*280.73±3.4 8*	*204.33±2.1 7*

***Table 1**: Physical status of the Ranganadi River in the Downstream of RHEP Dam*

Goswami et al. (1999) has reported four primary causes for morphological changes. Meandering bends are more pronounced in dry season due to its low water carrying capacity. The downstream shows 2-4 channels separated by sand bars under low water flow condition. Decreased river flows affect tremendously the flushing property and also increase sedimentation. The sand bars are a type of platform generally known as "Braided" (Wiebe, 2006). These low level sand bars get submerged in rainy season and might disappear entirely in heavy floods due to heavy discharge and high level of river water. The channel patterns are quite unstable and changes frequently under flood condition which are accompanied by erosion of flood plain river banks and deposition of sand bars.

	Sector 1	*Sector 2*	*Sector 3*
River bed	*Hard, Rocky and partly sandy*	*Sand, Silt and Clay*	*Sand, Silt and clay*
Type of sediment	*Boulders, Cobbles, Pebbles and sand*	*Sand, Silt and Clay*	*Sand, Silt and Clay*
Woody debris in River bed	*Large and medium size*	-	-
River bank	*Stable*	*Unstable*	*Unstable*
Mid channel bar	*Very few*	*numerous*	*numerous*
Riparian Zone	*Woody forest, Shrub and grassland*	*Shrub and Grassland*	*Shrub and Grassland*
Human habitation	*Scanty in both sides*	*Moderate in both sides*	*Moderate in right and scanty in left side*
Agricultural practice in river bank	*Tea Garden*	*Kharif crops and livestock*	*Both Rabi and Kharif crops and livestock*

Diameter (in mm) of recorded objects: Boulder: >256mm, Gravel:256mm-2mm, Cobble: 64-256mm, Pebble: 2-64mm, Sand: 0.06-2mm, Silt: 3-60µm, Clay: >3µm. (Wentworth Grade)

***Table 2:** Geomorphic data of Ranganadi River (2015-2018)*

The river bed composition in the study sites in the downstream of Ranganadi River along with its river bank and riparian zones are depicted in Table 2. The Ranganadi River carries a mixture of big and small objects that includes boulders, cobbles, pebbles, sand and clay. The river bed consists of mixture of boulders, cobbles and pebbles in the Sector 1 (Dam site-Kimin). River bed in Sector 2 (Kimin-Pohumara) and Sector 3 (Pohumora-Pokoniaghat) mainly consists of fine and medium sized sand. The River bank is stable at Sector 1 while Sector 2 and 3 are erosion prone.

4.2 Water Discharge and Sediment Load

According to Osborne, 2000; Rivers and streams usually have a one-way downhill flow and in these lotic environments, flow rate is of prime importance in determining the nature of plant and animal community. Natural flow of any river is influenced over time-scales of hours, days, seasons and years. The Discharge value was calculated seasonally from the data provided. The water discharge in the downstream of Ranganadi River was found closely associated with the climatic factors as a result of which the maximum mean discharge was recorded in monsoon (857982.08cumec) and the minimum mean value was recorded I n winter (40cumec). The discharge recorded in the post-monsoon season was more than that recorded in the pre-monsoon. The Sediment load also showed the same trend. The value of sediment load ranged from 6044t/day to 231878.22t/day. The maximum value was recorded in monsoon and the minimum in winter. Hazarika, 2013 also recorded maximum Discharge and sediment load values in Monsoon and minimum in winter in Subansiri River. Heavy sediment l'oad in monsoon is generally due to sediments carried by river from its upstream as surface runoff. As per reports of Das and Ahmed (2005), average discharge carried by Ranganadi in the lean season (November

to March) was around 200cumecs. But extraction of 160cumecs by diversion leaves only 40cumecs in the dry months, when the contribution of the rain is quite less. Besides, absent of any major tributary in the downstream till the confluence with Subansiri River, the river flows very thinly. The inevitable result is the lowering of ground water table and also deposition of heavy amounts of debris (silt, pebbles, etc.), which has made the river shallow over the years. The River now flows in multiple channels which engulf vast areas on its bank, thus making flood more disastrous. The seasonal variation in Water Discharge and sediment Load from 2015-2018 is given in the Table 3.

Season	*Discharge (cumec)*	*Sediment load (t/day)*
Pre monsoon	*574426.08*	*122582.53*
Monsoon	*857982.02*	*231878.22*
Post monsoon	*381716.66*	*70678.65*
Winter	*40.0*	*6044*

Source: RHEP, NEEPCO, Yazali, Arunachal Pradesh & Water Resource Department, North Lakhimpur, Assam

***Table 3**: Seasonal variation of mean discharge and sediment load of Ranganadi River at Dam Site (2015-2018)*

4.3 Impact on Riparian Community

Building large dams lead to the enclosure of water (Bakker, 2003) that will profoundly impact the livelihood condition of the riverine communities. As Rivers carry sediment, it can be considered as a body of flowing sediments (McCully, 2001). The blockage of sediment and nutrients in it had negative impact on traditional flood-recession agriculture in the floodplains of the river. The diet of the people in the downstream especially Assam consider fish as major source of protein. The changes in water temperature due to severe changes in water levels to meet the demands of power generation, the fishes spawning habitats, their growth and reproductive cycles all are affected which makes unfavorable conditions for the fishes and hence to their decline. The dams also obstruct fish passage and these impacts the life cycle of many fish species. As a result there is sharp decrease in fish population which is due to loss of breeding and nursery grounds that ultimately affects the breeding process of fishes such as Tor, Labeo dyocheilus, Anguila, Glossogobius spp. that migrate long distances in Trans-Himalayan Rivers (Talwar and Jhingran 1991, Das and Bordoloi, 1997). One example is of dolphins that used to come up to Pahumara (Sector 2) in rainy months in the River but after the commissioning of the dam, the dolphins were never seen (Secondary information-Through questionnaire). The River sustains a host of wetlands in its floodplains which are highly productive, very rich in biodiversity and act as sources of natural resources like fish, cane, reeds on which the fisher community depends for their various needs and livelihood. The situation becomes worse in dry months as the feeder channels that usually link the wetlands dry up and the ground water table connecting the river regime to the wetlands recedes. As a result the level and amount of water in the wetlands reduce leaving these rich ecosystems degraded. The consequence is the decrease in population, distribution and diversity of fishes being observed in the area. Sand quarrying in the river that provides income sources to local people is also affected due to decrease in flow of the river in the dry season. Drastic reduction of flow and water level in the dry months is causing serious threats for the forest and wetland ecosystem. The resultant consequence is the loss or depletion of livelihood option of the riparian community which has forced the peoples of the affected area to become daily wage earners doing whatever that comes their way. There is always threat to lives and animals due to unscheduled and uninformed release of water from the reservoir. The same was observed in the floods of 2015 and 2017 that brought huge devastation and created havoc amongst the riparian community. Flood in 2017 breached the right embankment of Ranganadi River on 9th July 2017 at Amtola-Joinpur. Again, on 11th July 2017, the left embankment was breached at Bogolijan which caused massive devastation in the downstream. The data collected so far reveals that two revenue circles were severely affected by the floods and bank erosion. Altogether 5680 and 59, 712 numbers of peoples belonging to 4 and 109 villages were affected by the flood in 2015 & 2017 respectively. 150 & 2165.15hectares of cultivable land turned uncultivable due to sediment deposition. The houses of the majority being washed away or destroyed in the flood and were compelled to settle on the embankment of the river. The data on the damage caused by 2015 & 2017 flood is hereby presented in Table 4.

Year	*Number of affected Villages (Direct/Indirect)*	*Population affected (Direct/ Indirect)*	*Area(ha) of Cultivable land affected due to siltation*
2015	*04*	*5680*	*150*
2017	*109*	*59,712*	*2165.15*

Source: Assam State Disaster Management Authority (ASDMA)

***Table 4:** Damage caused by flood in 2015 & 2017 in the downstream of Ranganadi River Dam.*

5. CONCLUSION AND RECOMMENDATIONS

Humans have been fascinated by the dynamism of free-flowing rivers since time immemorial. It is now a known fact that harnessing streams and rivers costs a great deal. This paper compiles a preliminary study on the Impact of Discharge and Sedimentation on the riparian community in the downstream of Ranganadi River Dam. The water discharge is seen affected by climatic conditions. It is clear that the riparian communities are affected severely where many of them have lost their houses and agricultural lands. After detailed analysis of the problems, following suggestions are hereby put forward for the betterment of the River and of the Riparian Communities that depend on the River for their livelihood.

i) Installation of early alarm system at an interval of 2-3kms in the downstream of the Ranganadi River.
ii) Proper construction of embankments using latest technologies.
iii) Plantation on both sides of the river by plants like Ipomea, Vetivera.

iv) Well planned scientific catchment area treatment programmes in the upstream of the river should be dealt with to minimize the extra sediment load.

v) The technical feasibility should be addressed scientifically before constructing dam/hydel project and special emphasis to be given on the consequences to be borne in the downstream.

vi) A minimum water level to be maintained for fish life in the downstream area of the dam.

vii) Fish ladders are generally believed to re-establish connectivity between critical habitats for migratory species and reduce the anthropogenic stress on the fish fauna, hence fish ladders to be build while considering any hydel project.

ACKNOWLEDGEMENTS: The authors hereby acknowledge the HoD, Deptt. of Life Sciences, Dibrugarh University for his support in acquiring the data; The Principal, D. R. College, Golaghat for providing the laboratory facilities and also to Dr. L. P. Hazarika, Principal, Pt. Deen Dayal Upadhyaya Adarsha Mahavidyalaya, Dalgaon for the guidance in calculation of certain parameters. The author also acknowledges The GM, Ranganadi Hydro-electric Project (RHEP), Yazali, Arunachal Pradesh and Water Resource Department, North Lakhimpur, Assam for providing the requisite data.

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