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# Dwarekeshwar River Basin and Anthropogenic Intervention as Sand Mines

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**Abstract:** *The river is an open system. The river Dwarekeshwar holds spatial geological records from Silurian to recent era. But in a last decade, a few anthropogenic interventions in river bed have changed its original attributes. The river Dwarekeshwar has crossed a long path through geological time scale but no remnants of significant palaeo anthropogenic intervention has observed in its catchment. In very recent, a few sand mining sites of river bed and brick kilns in the river bank area have developed with and without legal approval. The planners never discord the ever increasing demand of sand and kilns through time. These indiscriminate anthropogenic interventions of river bed not only violate the river sustainability but the ultimate costs of those activities reflect in irregularities in Dwarekeshwar river system. The consideration of indiscriminate sand mining from Dwarekeshwar bed in the light of 'limit of Growth Concept', the whole riparian system will be collapsed in near future.*

**Keywords:** *sand mining, brick kilns in river bank, riparian system, Dwarekeshwar river Basin*

## 1. INTRODUCTION

The river is an open system. The life circle (in spatial context) of a river has integral association with hydrological circle and landform configuration (Grade.R 1996). A river links both ecological time and geographical space. The river Dwarekeshwar holds a long geological record since Silurian to recent era. But in a last decade a few anthropogenic interventions (sand mining from channel bed and brick kilns of river bank) has been changing the original attributes of surface runoff. The river Dwarekeshwar has crossed a long path through geological time but no remnants of significant palaeo anthropogenic intervention were observed in its catchment. In last two decades, the uneven growth of sand mining sites and brick kilns in the river bank with and without legal approval have become very common facts.

## 2. OBJECTIVE

The basic aim of this study is to identify the sand mining sites of upper catchment and also identify brick kiln sites of the bank of river Dwarekeshwar. This paper covers the recent attributes of channel pattern and riparian conditions of Dwarekeshwar basin zone as the immediate effect of sand withdrawal activities.

## 3. METHODOLOGY

The basic method is empirical and based on intensive field survey. The survey has divided in to two part; post monsoon survey and pre monsoon survey. The location sites of sand withdrawal have been identified. A few simple calculations have been applied to get clear idea about the channel pattern. The impact sites of riparian zones by sand mining activities have been identified by the using of Global Positioning System and those sites are plotted in maps. The information about impact of removal of riparian vegetation has been gathered by intensive survey during the months of September 2014 to 2015 October. On the basis of topographical sheets (73M, 73N, R.F.1:250,000) of Survey of India a few geo information (such as average slope, surface elevation) have been collected. The water turbidity (upto 10cm depth) samples have been collected in post monsoon (month of July) from more than ten sites near the Bankura II Block (DistrictBankura, West Bengal). The available fish types in river water (only includes fish which comes naturally in river water) has minutely observed during the year 2014 to 2015 (pre and post monsoon period).

The riparian faunal information has collected by the perception study and for that purpose an intensive survey has been conducted. On this survey, the perception of senior citizen and who are the resident of that land since at least forty years have been included.

## 4. STUDY AREA

The Dwarekeshwar (Table 1) is a major river in the western part of West Bengal. It originates from Tilaboni hill (geographical extension 86˚31'E to 87˚02'E and 22˚42'30''N to 23˚31'N) in Purulia

District. It covers part of Purulia, Bankura, Midnapore (West) and Hooghli districts of West Bengal (Fig 1). The river Silai meets to the river Dwarekeshwar near Ghatal (West Midnapore) and this combine confluence is known as Rupnarayan. The river Dwarekeshwar originates from the area which has a chronic drought history with very scanty of rainfall and it flows through the area which has chronic flood history (Sinha.M, 2008).

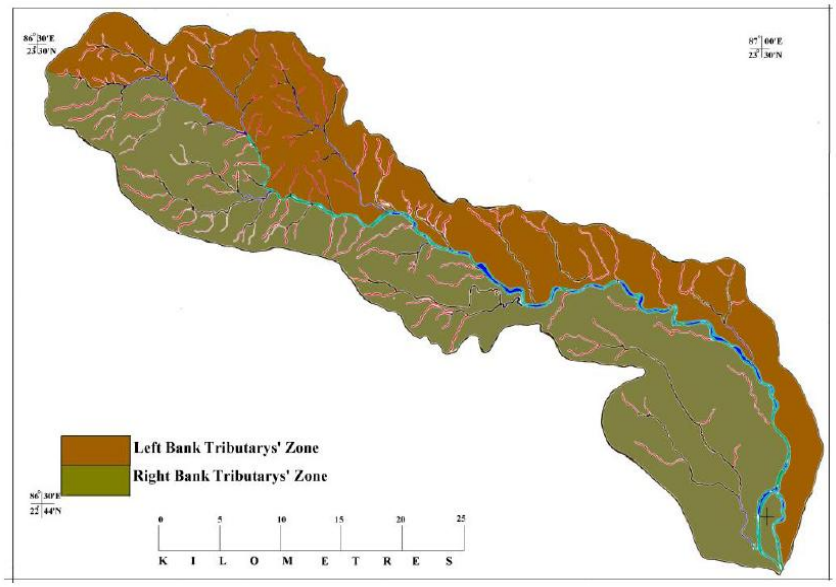



**Figure1.** *Dwarekeshwar river basin*

**Table1.** *Main attributes of Dwarekeshwar river*

| | | |
|---|---|---|
| Length of Main Stream | 200.2 km | |
| Origin | 86˚31'Eto87˚02'Eand 22˚42'30''N to 23˚31'N) | |
| Catchment Area | 4000.5 Km² | |
| Geographical Location | Tropical Region (dominated by MonsoonClimate ) | |
| Main Tributaries | Gandeshwari, Joypada, Kanshachora, Indus Nala, Arakasha | |
| Total Population | 30,74,568 (2011 Census) | |
| Town and Cities in its bank | Bankura District HeadQuater, Bishnupur Sub Division of Bankura District, Arambugh Sub Division ofHooghly Disrict, Ghatal Sub division of East Midnapore District | |
| Minerals Available | Muscovite (white mica) $KAI_2AISi_3O_{10}(OH)_2$<br>Biotite (Black mica) $K(Mg, Fe)_3ALSi_3O_{10}(F,OH)_2$<br>Fireclay (chemical composition consists of a high percentage of silicon and aluminium oxides, and a low percentage of Sodium, Potassium and Calcium oxides)<br>Feldspar ($KAISi_3O_8$-$NaAISi_3O_8$-$CaAI_2Si_2O_8$)<br>Quartz / Silica(types of glass containing primarily silica in amorphous form)<br>Vermiculite (Expands with the application of heat)<br>Fine Sand | |
| Rainfall in Basin Area | 117.76 mm /year (not uniformly distributed through the basin area) | |
| Average Temperature of Basin Area | 1961-2001 | |
| | January | May |
| | 18.98˚C | 32.55°C |

## 5. DWAREKESHWAR RIVER BASIN AND GEO HYDROLOGY

The rain drop possesses potential energy. According to Hackian (1960) concept and Chorley's (Strahler.A.N 1964) opinion, the surface runoff is an open system (Thornbury.D 2002). As an open system river gets input (in terms of energy and matter) from climatic system (Fig.2) and geomorphic system. The river flow is the reflection of kinetic energy. The landform configurations of river channel are the reflection of variation of kinetic energy of surface runoff. The sand and gravel are the natural and renewal resource but the formation time span of sand is quite long in terms of its withdrawal.

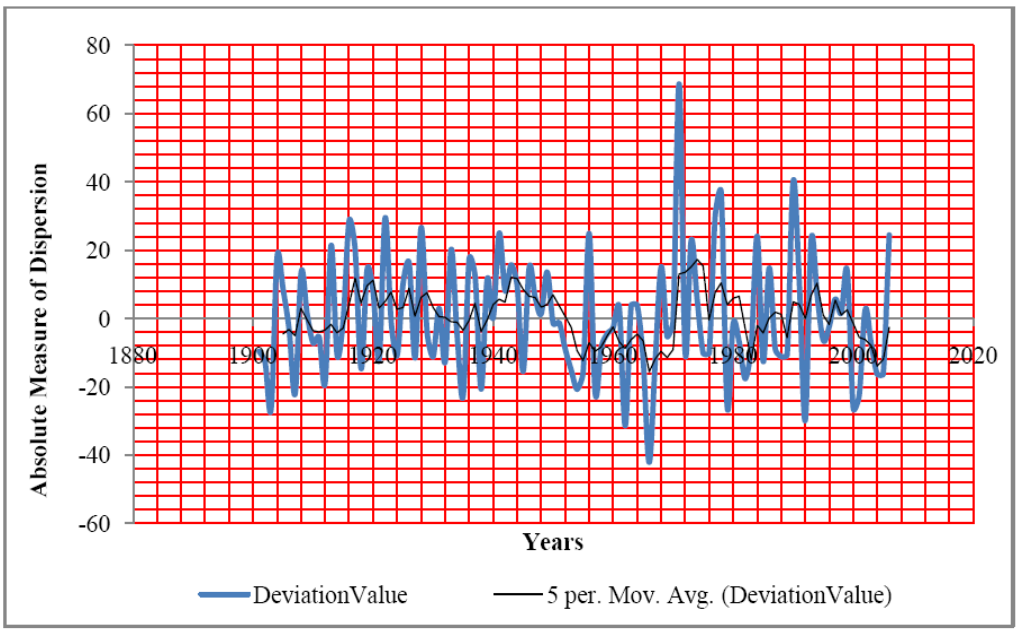



**Figure 2.***Rainfall in Dwarekeshwar basin area in last century*

### 5.1. Stream Order of Dwarekeshwar River

This river covers upto 4$^{th}$ order (Strahler.A.N 1964) of stream and the tentative sedimentary delivery ratio (Table 2) is high in the zone of first order stream (Fig .3), but the bifurcation ratio is high in 3$^{rd}$ order stream zone (Fig 3, Table 2). That fact indicates high sediment delivery ratio in upper catchment but the sand and gravel deposition is high in mid catchment area.

The river Dwarekeshwar is the elongated basin (Table 3, Fig 3) and three stages of changes of its slope has observed (Fig 4). That fact reveals that the river Dwarekeshwar is fault guided river with series of lineaments.

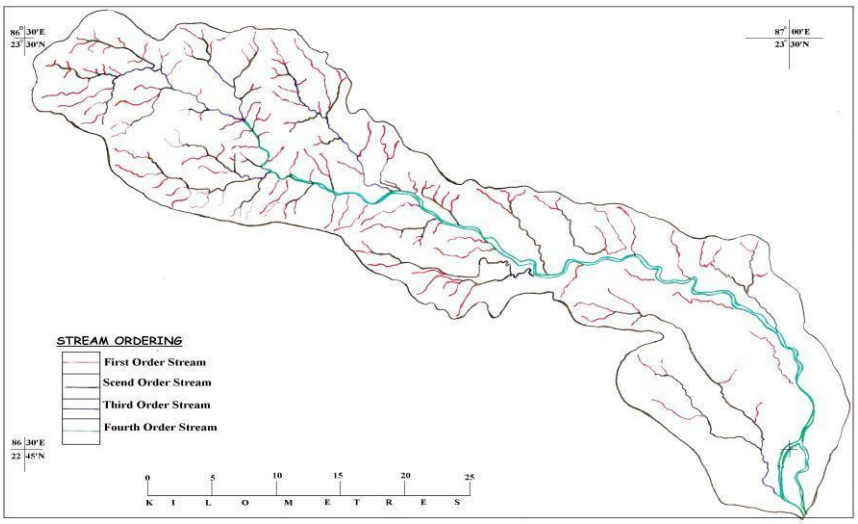



**Figure3.** *Stream order of Dwarekeshwar river*

**Table2.** *Stream Order and Recent Sediment Delivery Ratio of Dwarekeshwar River*

| Stream Order | Number of Stream | Sediment Delivery Ratio in % | Bi frication Ratio Rb=Nu/N(u+1) | Channel Characteristics |
|---|---|---|---|---|
| 1st Order | 157 | 80 | 5.06 | Highly Dissected |
| 2nd Order | 31 | 30-70 | 3.87 | Dissected |
| 3rd Order | 08 | 10-30 | 8 | Highly Dissected |
| 4th Order | 01 | 10 | Nominal | Flat |

**Source:** *Topographical Sheets (73 I/14, 14, 73E/3, 4) and field survey*

The study area consists of rocks different geological era. This area is covered mainly by four geological units belonging to four geological era Archaean to Holocene (Mukherjee. P.K 1995). The archaean formation of the study area mostly composed by ancient gneiss and schist, commonly belonging to the Chotonagpur Gneiss or fundamental gneiss (Pascoe 1975). They are mostly igneous origin and those are highly metamorphosed continental blocks. It contains quartz, microcline, orthoclase, oligoclase, biotite, a little aptite and occasionally some green hornblende (Krishnan, M.S 1960). The greater portion of the surface is covered by laterite and alluvium. The lateritic gravel and calcareous stone are common in surface layer.

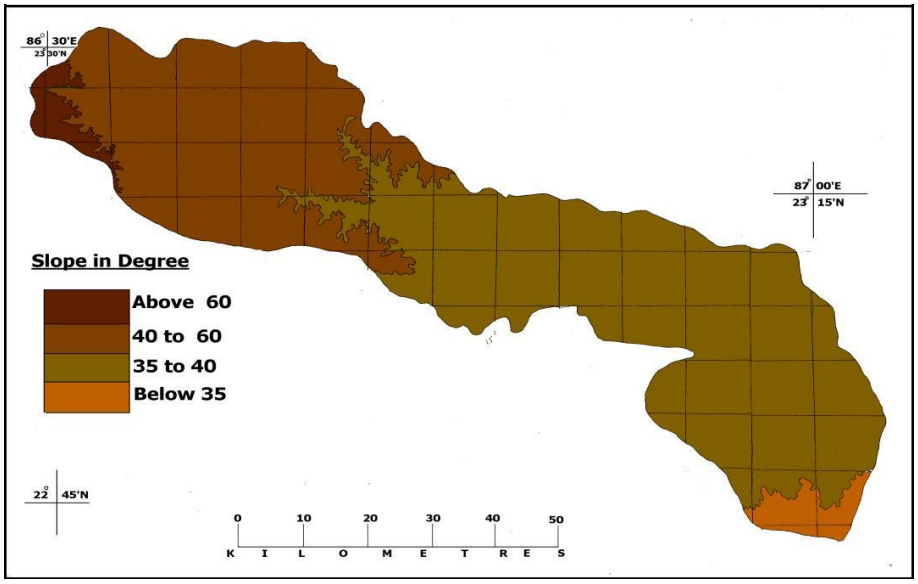



**Figure4.** *Slope of Dwarekeshwar river basin area*

**Table3.** *Hydrological conditions of Dwarekeshwar river*

| | |
|---|---|
| Width of Basin | 120m (on an average) |
| Length of River | 200.2 km |
| Rainfall | 117.2 mm/year |
| Area=(Width of basin X Length of River) | 120m x 200200m= 24024000m² |
| Volume of Total Surface Runoff | 0.0975 x 24024000m² =2342340m³ |
| Water Flow of Basin area | 1405404 cubic metre/year |
| Circular Ratio<br>Rc=4∏ A/P²(A=Area, P=Perimeter) | 1.79 |
| Elongated Ratio (Re)= 2√A.N/Lb<br>A= Area of basin sq km,Lb= Length of basin in km | 0.00305 |

## 5.2. River Bed Sand Mining of Dwarekeshwar River:

The sand and gravel withdrawal from river bed is very common incident in India. Sand is a flow and natural and as well as renewable resource and very fine granular materials composed by the minerals (silica and quartz). The composition of sand is highly variable, depending on the parent materials but sand normally comes out in land river bed, and non tropical coastal setting. . The sand particles range in diameter from 0.0625 mm to 2 millimeters (Negros 2016). An individual particle in this range size is termed as sand grain.

Two types of stream sand mining are practiced here, namely dry pit and wet pit mining. Dry pit is nothing but a sand excavation method from seasonally dry stream bed and on the contrary the wet pit mining involves sand withdrawal from the perennial stream bed (Negros 2016).

Here, the main sand withdrawal sites are lies near the habitat zone (Table 4, Fig 5, 6) and also lies in the zones of smooth road connectivity. Here the river sand mining from active river bed is very common facts. During monsoon, the hydraulic excavators are intensively used for sand withdrawal.

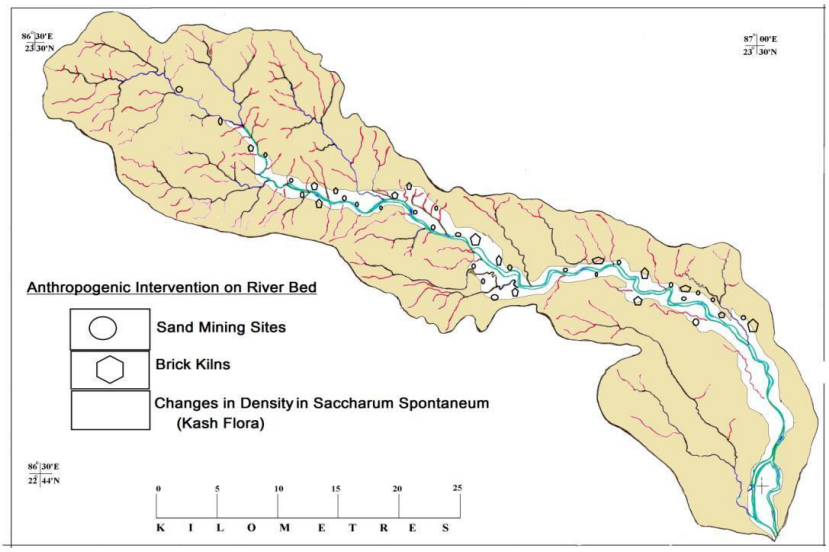



**Figure5.** *Sand mining sites of Dwarekeshwar river*

**Table4.** *Sand mining sites of Dwarekeshwar basin area (Bankura District)*

| Sl No | Sand withdrawal sites | | Brick Kiln Sites |
|---|---|---|---|
| | Block Names | Village Names with Jurisdiction List Number | |
| 1 | Chhatna | Jhikuria (27), Shushunia (89) | ---------- |
| 2 | Bankura I | Jogdallha (141), Patakala (138) | Jogdallaha (141) |
| 3 | Bankura II | Ekteswar (Open pit mining) (118) , Banki (56), Bhuj Sohar (60), Sendra (96) | Ekteswar, Bhadul (59) |
| 4 | Onda | Nabajibanpur (228), Gamidya (192), Sahapur (111) | Gamidya (192) |
| 5 | Bishnupur | Dihar (82), Joykrishnapur (87),Dharapati (58) | Joykrishnapur (58) |
| 6 | Joypur | Hatia (26), Belia (78), Madhupur (93) | Belia (78) |
| 7 | Indus | (Wet pit mining), Bhabapur | |
| 8 | Patrasayer | Dumni (104), Nandpur (115) | Dumni (104), Nandpur (115) |
| 9 | Kotulpur | Chaudanga (63), Ranahal (06), Napukur (53) | Napukup (53), Chatra Krishnagar (42) |

**Source:** *Field Survey, 2015 May (Covers only the Blocks of Bankura District)*

## 6. CONCLUSION

(i) The Dwarekeshwar's sand bed is famous for riparian flora; Saccharum spontaneum / kans grass (a robust, perennial grass) . This grass grows in sandy areas of dry river bed as well as on the river bank. This vegetation is very common phenomenon of the riverine sandy flood plain after immediate retreating of monsoonal floods (P. J 1964). This floral species covers the river bed in the month of each September to October. The intensive sand mining for construction purpose and for kiln hampered the annual growth of this grass (Fig 5, 6 & Table 5). Its extensive rhizome network of this floral species is very efficient binder of soils, and particularly useful for controlling and preventing soil erosion. Numerous medicinal uses have been described in the Philippines (Pancho and Obien, 1983), and young shoots are boiled and eaten with rice in Indonesia (Uphof, 1968). Kash is a key species in the evolution and development of cultivated sugarcane (S. officinarum), and remains a valuable breeding plants which is resistant to adverse climatic conditions (Anon., 1972).The decay in density of Saccharum spontaneum in river bed will leave impact on riparian bio diversity in near future

**Table5.** *Decay in density of Saccharun Spontaneum in river bed (2000 on words)*

| Name of Blocks | | Jurisdiction List number of Villages | | | |
|---|---|---|---|---|---|
| Chhatna Block | District | Location Codes | Name of Villages | Jurisdiction List No. | Area (Hector) |
| | | 02018600 | Brajamohanpur | 129 | 47.5 |
| | | 02018700 | Dhengakend | 130 | 43.1 |
| | | 02018800 | Ghar Mora | 131 | 98.2 |
| | | 02019600 | Dalpur | 139 | 95.0 |
| | | 02025400 | Patjuri A Agaya | 197 | 268.2 |
| | | 02026100 | Mahes Khapari | 204 | 128.1 |
| Bankura I | | 02070800 | Jagadalla | 141 | 207.7 |
| | | 02070000 | Manushmura | 133 | 97.5 |
| | | 02070100 | Dadhimukha | 134 | 211.5 |
| | | 02070200 | Aralbanshi | 135 | 98.4 |
| | | 02070500 | Patakala | 138 | 111.8 |
| | | 02071000 | Dabra | 143 | 85.1 |
| | | 02067600 | Kaludihi | 109 | 86.0 |
| | | 02067700 | Chhatar Dihi | 110 | 119.6 |
| Bankura II | | 02077700 | Bhuj Sohar | 60 | 180.4 |
| | | 02077200 | Garerban | 55 | 134.5 |
| | | 02077300 | Ekteswar | 56 | 188.4 |
| | | 02077400 | Sankarhati | 57 | 83.4 |
| | | 02078800 | Kesekol | 71 | 101.0 |
| | | 02081300 | Sendra | 96 | 112.2 |
| | | 02083500 | Banki | 118 | 55.7 |
| | | 02077600 | Bhadul | 59 | 138.3 |
| Onda | | 02212800 | Sahapur | 111 | 100.5 |
| | | 02213000 | Bathan Tra | 113 | 85.4 |
| | | 02213100 | Elyati | 114 | 170.6 |
| | | 02213400 | Balatakri | 117 | 126.6 |
| | | 02213500 | Nischintipur | 118 | 119.5 |
| | | 02215300 | Rasaira | 136 | 150 |
| | | 02220900 | Gamidya | 192 | 219 |
| | | 02223400 | Phulbaria | 21 | 177.7 |
| | | 02223500 | Nabajibanpur | 218 | 226.3 |
| | | 02223600 | Charuikunr | 219 | 189.3 |
| Bishnupur | | 02186400 | Patalpur | 8 | 48.1 |
| | | 02193600 | Penera | 80 | 227.9 |
| | | 02193700 | Basantapur | 81 | 231.3 |
| | | 02193800 | Dihar | 82 | 174.0 |
| | | 2194200 | Bhatra | 86 | 53.3 |
| | | 02194300 | Joykrishnapur | 87 | 258.3 |
| | | 02191200 | Banamalipur | 56 | 137.5 |
| | | 02191300 | Paikpara | 57 | 101.2 |
| | | 02191400 | Dharapati | 58 | 273.7 |
| | | 02191500 | Paschim Nischinatapur | 59 | 55.0 |
| | | 02190600 | Birra | 50 | 126.2 |
| | | 02190700 | Benda | 51 | 394.2 |
| Joypur | | 02172300 | Basantapur | 6 | 51.8 |
| | | 02172400 | Ruishar | 7 | 140.7 |
| | | 02172800 | Hajipur | 11 | 49.8 |
| | | 02174100 | Brojashol | 24 | 205.5 |
| | | 02174000 | Mohishkhoar | 23 | 74.3 |
| | | 02174300 | Hetia | 26 | 211.8 |
| | | 02174800 | Barasat | 31 | 79.6 |
| | | 02179400 | Dhengartala | 77 | 101.6 |
| | | 02179500 | Belia | 78 | 521.8 |

| | | | | | |
|---|---|---|---|---|---|
| | | 02181000 | Madhurpur | 93 | 96.9 |
| | | 02181300 | Bhabanipur | 96 | 75.7 |
| | | 02181400 | Parashe | 97 | 93.1 |
| KOTULPUR | | 02255400 | Ranahal | 6 | 157.7 |
| | | 02255400 | Matherstapal | 7 | 307.8 |
| | | 02255500 | Gaura | 8 | 68.5 |
| | | 02260200 | Bhagalpur | 55 | 224.3 |
| | | 02260800 | Hati | 61 | 199.9 |
| | | 02260900 | Malakarpota | 62 | 102.6 |
| | | 02261000 | Chuadanga | 63 | 67.7 |
| | | 02261100 | Madhuban | 64 | 56.6 |
| | | 02261500 | Chhoapagla | 68 | 58.9 |
| | | 02261800 | Malikpara | 71 | 83.6 |
| | | 02160000 | Napukur | 53 | 130.3 |
| | | 02158900 | Chatra Krishnanagar | 42 | 540.9 |
| Patrasayer | | 02137100 | Nandpur | 115 | 235.6 |
| | | 02137200 | Akhar Shal | 116 | 224.2 |
| | | 02137900 | Kantour Bankati | 123 | 220.3 |
| | | 02136000 | Dumni | 104 | 250.6 |
| | | 02139000 | Dakshin Gobindapur | 134 | 131.6 |
| | | 20138900 | Chakkabir | 133 | 131.6 |
| | | 02141000 | Rameswar Kunria | 154 | 131.5 |
| | | 02141300 | Mukundapur | 157 | 148.9 |
| | | 02141200 | Bandra Kanda | 156 | 53.2 |
| | | 02141400 | Naricha | 158 | 330.7 |
| | | 02141500 | Baghdahara | 159 | 165.2 |
| | | 02145300 | Bangal Chak | 37 | 117.3 |
| Indus | | 02145800 | Pantrai | 42 | 230.6 |
| | | 02145800 | Tentulmuri | 43 | 186.9 |
| | | 02152700 | Betanal | 111 | 666.6 |
| | | 02152800 | Kunjapur | 112 | 331.4 |

**Sources:** *Survey during 2015 September, (covers only Bankura District)*

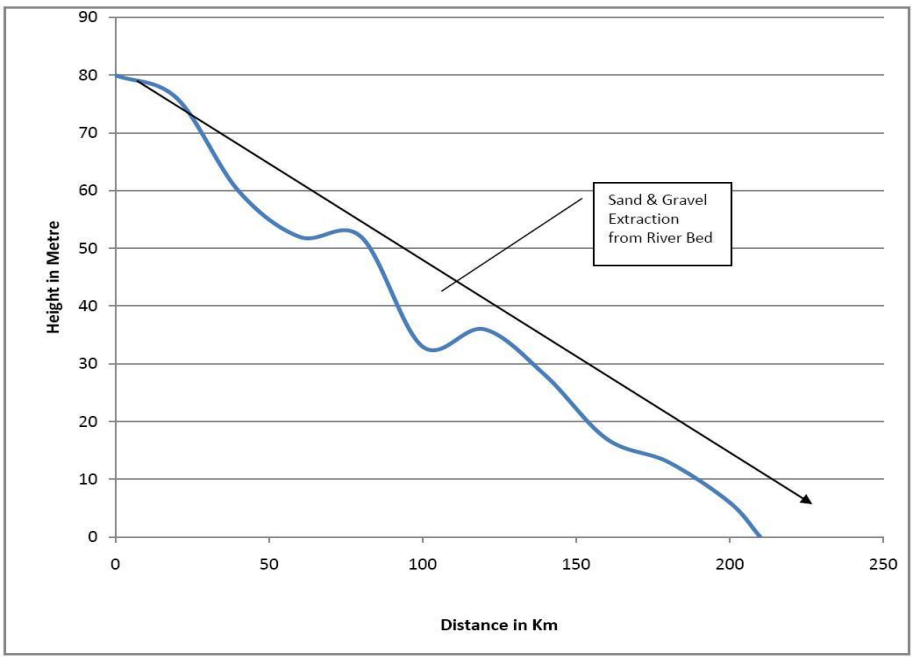



**Figure6.***Changing channel pattern by the anthropogenic intervention*

Excessive in stream sand mining lowers the stream bottom (Negros 2016) (Fig 6, 7 A and B). The depletion of channel floor may susceptible for bank erosion. The permanent lowering of channel bottom due to excessive sand withdrawal leads changes in estuary. There would be a probability to increase the areal extension of river mouth (Negros 2016). The indiscriminate and commercial sand withdrawal has just started in Dwarekeshwar river bed (last two decades) but in long time lag it would be changed bottom configuration of river. Now the incident of flash flood in its upper catchment (meeting point of Gandeshwari) and tidal and monsoonal flood near Gadiara, in Ghatal have increased in last two decades. Here the gradual changes bottom layer of river bed may be the hazardous fact in near future (Fig.7 A and B).

Drinking water collection by excavating the river bed (1 to 1.5 m depth) or by a pit from river bed is an ancient practiced. During scorching summer when the surface run off of river bed has dried up, people use to collect sub surface water by digging the channel bed. Now due to sub surface sand withdrawal by the wet pit technique (for sand and kilns), the subsurface water are not available bed during summer.

Turbidity of river water has increased day by day. The gradual and steady changes in turbidity level in river water lead impacts on adaptation behavior of aquatic small fish and invertebrates and also reduce the permeability of the bed material (Negros 2016).

Tenualosa ilisha (ilish, hilsa, hilsa herring or hilsa shad) is a species of fish in the herring family, and a popular food fish in South Asia (From Wikipedia, the free encyclopedia 2016). This Hilsa was available in upstream of river Dwarekeshwar up to 1980-85 during monsoon. It becomes impossible to imagine about Hilsa in the upper catchment of that river (Purulia District). The gradual changes in turbidity as a result of sand mining (Table 6) and removal sand of river bed have increased the intensity and frequency of flash flood. For that reason, the migratory routes as well as spawning grounds of Hilsa are disturbed, displaced or even destroyed.

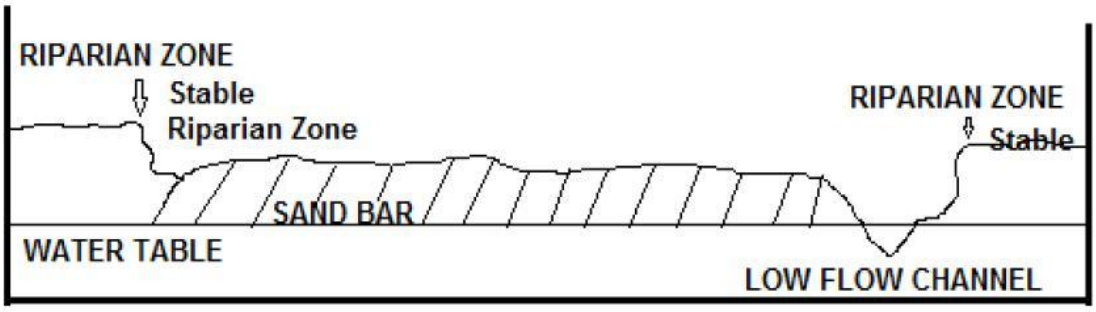
Sometimes the sand withdrawal without proper estimation of quantity leads devastating impact. All unused sand sometimes dumps on that river bed. The excessive use of machine for excavation and also for transport leads to localized change in compactness in river bed and sometimes leakage of liquid fuel of transportation and excavation equipments pollutes the river bed (Negros 2016) Here tentatively 72 brick kiln has observed and those kiln collect water sand alluvium from river bed (without any approval of State authority).

**Table6.** *Level of Turbidity of Dwarekeshwar river water (2015-16 Pre and Post Monsoon)*

| Turbidity (NTU) Nephelometer Turbidity Units | Depth (from the surface layer of water to 10 cm depth) | Pre Monsoon | Post Monsoon |
|---|---|---|---|
| 1. Near Sati Ghat | | 65-73 | 183-192 |

*The standard for drinking water is 0.5 NTU to 1.0 NTU (Centre 2016).*

(iv) The intensive sand mining in upper catchment delivers more loose sediment in lower confluences. Localized alteration in riparian zone by that kind of anthropogenic intervention can leads impact on aquatic ecosystem and as well as river bank configuration.(Fig.6, 7 A and B).




*Channel with Sand Deposit and Stable Riparian Area (A)*

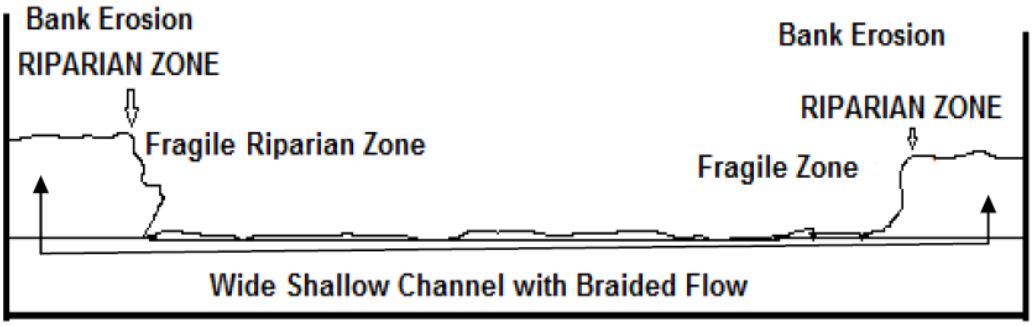



**Figure7.***Channel Bed after Removal of Sand and Fragile Riparian Area (B)*

**(v)** Removal of sand (upto certain depth) from a few desecrated patches of river bed responsible for post monsoon water stagnation. But in time lag this water logged area has dried up. This dried depression area in Dwarekeshwar river bed gives a look like desertic bolson. This type of dried depression ground in river bed is the anthropogenic intervention of river morphology.

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