Application of Indigenous Floodwater Harvesting Method of Ajoy River in Raipur village: A Micro-level Anthro-hydro-geomorphological Corollary

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Introduction:

In the agriculture-based economy of tropical monsoon India availability of water is a vital decisive factor for its prosperity which in turn is dependent on its production quantity and quality. Monsoon rain in India varies spatially and so also the agricultural methods and cropping patterns. Apart from monsoon water, in India, from time immemorial, the 'hoe-culture' had always preferred riverbank sites mainly because of the fertility factor and obviously for the water procured from the river. The fertility, as we all know, is created through ages from the deposition of silt in the playground (flood plain) of the river itself. Silt, when deposited over the extended land sloping down the river from the stagnant spill out at the time of heavy monsoon downpour, enriches the soil. But in village India the people prefer to inhabit in closer proximity to the river to use its water for multifarious purposes. As the seasonal rain diminishes in the post-monsoon and pre-monsoon periods paucity of water in the agricultural sector becomes prominent. At many places, to combat with the adverse situation, from the government level large and small dams across the channels create well sprawl-out water reservoirs; inundating large tracts of land, turn out to be the obvious solution. Barrages supplying water to far and away places through irrigation canals no doubt satisfy the requirement to some extent. But how far all these huge capital intensive and resource exploitative measures are affordable for the developing countries like India raise a million dollar question about their feasibility and a bunch of disputes amongst planners, scientists, environmentalists and acceptability amongst common people.

At this juncture low capital intensive, people oriented, people developed and people maintained indigenous method seems to be the judicious solution. Though dependent on environment specific micro-level planning yet in any similar kind of flood prone flattish river adjoined land this well practiced fruitful indigenous method can effectively be applied.

As and when the pressure of population increases more marginal tracts are brought under agriculture with a subsequent increase of its water requirement. In a monsoon country like India, where the seasonal distribution of sporadic rainfall predominates the landscape and dominates the rain-dependent agriculture, irrigation in some form or other becomes the only solution. Irrigation itself has varied forms of applicability depending upon its varied parameters existing around. When and where the people's economy spins around agriculture availability of water in no way can depend on precipitation (irregular) alone and other forms of surface and underground water turn important depending upon the character and slope of the land. In the land of extreme flatness or having slight undulations with non-porous or semi-porous soil and consisting of a rain fed stream nearby surface irrigation seems to be the only solution to continuous year round water supply particularly in the pre-monsoon season. With *'seasonality'* and '*irregularity'* being the prime characters for both rainfall and surface water supply (surface runoff and chanelized flow) *'water harvesting'* is the only form of plausible alternative measure for a regular water supply to agricultural land in the dry season. Water harvesting itself has varieties depending on the nature of source and terrain character. Rain water

storage, spring water storage, flood water storage etc are only a few which are at the time of excess water supply could be conserved in reservoirs for its subsequent retrieval and usage at the time of its paucity in future.

In a developing country like India cost effectiveness of a project / method along with a long-term benefit is the key factor of prosperity. People's perception and wisdom gained through ages play a vital role over it. In many instances practically the maintenance free, less effort giving and more beneficial and people need bound measures to store water are practiced through ages and are paid almost no recognition by the administrative authorities and huge capital intensive measures are virtually imposed on the people there in lieu.

Flood Water Harvesting:

Seasonal flood in the rain-fed rivers of deltaic West Bengal is quite a common phenomenon in the monsoon months. People living at river adjoining lands often suffer from its wrath. To tackle the situation low-cost high benefit *'flood water harvesting'* method is an obvious solution to the improvement of agricultural scenario in rural regions in India. When In the river there is a higher annual flood frequency, people are forced to settle away from the water and the fertile land for cultivation lies closer to the stream.

There are copious instances in the ancient river-based civilizations in the world of dealing the higher flood frequency in a river in numerous ways. Example may be cited from Egypt where the land and the agriculture is the 'gift of Nile' river. Today Aswan Dam is taking care of the Nile flood but in ancient times, people used to take the advantage of the excess water (flood) and made its judicious usage in this arid landscape. Monsoon rains in the Ethiopian highlands caused the Nile to swell into a mighty torrent and *the Egyptians then retreated with their livestock to their settlements on the slightly higher land of the desert fringe* in the month of September and then the water subsided slowly in October. By the time land was awaiting for the farmers with a fertile deposition of black silt. *The fertile floods of pre-historic times gradually abated* and *'terrible famine'* occurred. Thus *"in order to use flood water more effectively, canals were built in arable land and the waters stored in broad reservoirs formed from earthen walls*. *When floodwaters subsided again, these reservoirs were gradually opened". 'Basin irrigation'* system fetched only one harvest but *'canal irrigation'* system achieved a second harvest. In the later period canals were built as transport routes from Nile Valley to Red Sea. The most relevant and indigenous incident was *construction of a large reservoir that was created in Ptolemaic times as Lake Moeris. It has a capacity of 275 million cubic meters and a surface area of 114 square Kilometers. From August until September it was filled by water and then emptied from March until May so that from April the lakebed provided an area on which summer crops could be grown.*

Floodwater harvesting has a variety of techniques for many different applications of its own. The techniques differ according to the slope and nature of terrain also. In a hilly area the water usually drains down the hill slopes and the location storage points is preferably in the foothill zone over the plains. At intermittent points also, in addition to these, some storage points may be constructed and linked with each other through a number of canals for the same purpose. In a region of extreme flatness the harvesting system is just the other way round. Here to store water canals are constructed from the river to the storage place. Raipur is an example of the second one.

Bengal delta once had an extraordinary system of inundation canals. Sir William Willcocks, a British irrigation expert who also had worked in Egypt and Iraq, claimed that inundation canals were in vogue in the region till about two centuries ago. Floodwater entered the fields through the inundation canals, carrying not only rich silt but also fish, which swam through these canals into the lakes and tanks to feed on the larva of mosquitoes. This helped to check malaria in this region. According to Willcocks, the ancient system of overflow irrigation had lasted for thousands of years. Unfortunately, during the Afghan-Maratha war in the 18th century and the subsequent British conquest of India, this irrigation system was neglected, and was never revived.

According to Sir Willcocks, the distinguishing features of the irrigation system were:

a) The canals were broad and shallow, carrying the crest waters of the river floods, rich in fine clay and free from coarse sand.

b) The canals were long and continuous and fairly parallel to each other, and at the right distance from each other for purposes of irrigation.

c) Irrigation was performed by cuts in the banks of the canals, which were closed when the flood was over.

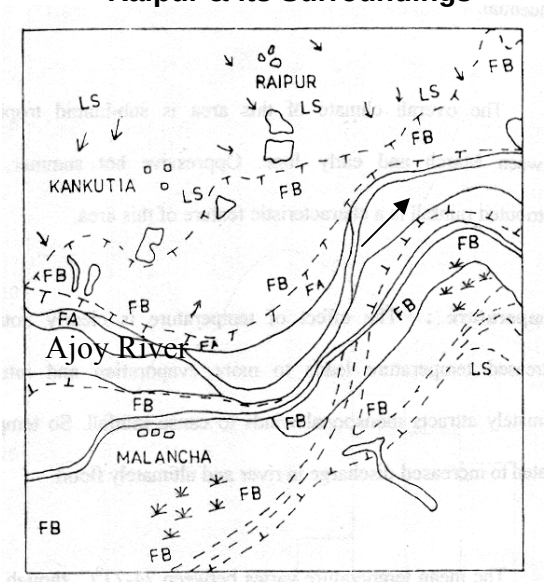
Sir Willcocks though highly advocated for the construction of canals, on the contrary, in 1927, called these earthen embankments (preventive measure to restrict flood water flow) as 'satanic chains', which according to him have ruined the natural drainage and irrigation system in the country.

Raipur (Jurisdiction List No. 109; Bolpur Sub-division, Birbhum District, West Bengal, India; Location 23°37' North and 87°40' East), a tiny village on the left bank of Ajoy River in Birbhum District in West Bengal, even today is following almost the same practices since a long period of time when in many regions the process has almost been abolished. From time immemorial, Ajoy River in its middle reaches is flood prone.

A Brief Historical Background of Water / Flood Water Storage in Raipur village:

Oncoming monsoon showers heavy down pours adequate for growing monsoon and to some extent post - monsoon crops in this region. But pre – monsoon crops, even if they are sown might face paucity of water if there is no rainfall. Besides these crops have more water requirement than other crop types grown in the rest part of the year. Ajoy is nearest river that flows to the south of the mouza. Basically this river is rain fed as it has originated from the southeastern part of Chakai plateau, in Jharkhand State, a part of the Chhotanagpur plateau in the west. The gradient of the river is from west to east. It is a perennial river but its tributaries are ephemeral in nature. Pattern of the river is dendritic or sub-dendritic. Meander is noticed below 50-meter contour. Some of these meanders have been cut off from the main channel and has become palæo-channels. Previously this river, at the time monsoon months, used to fulfill both agricultural and other necessities of the village particularly during the monsoon months. The village 'zamindars' (local administrative heads and big land owners through generations), by dint of their previous knowledge and experience, excavated a few water storage reservoirs within the village to store direct rainwater, sub-surface seepage and surface water flow. These reservoirs (locally known as 'bil') used to quench thirst not only of the humans but also of the huge livestock population.

FIG.1
Geomorphic Map
of
Raipur & its Surroundings



LS	Latosol	⊓	Settlement
FB	Older Flood Plain	→	Local Slope
FA	Younger Flood Plain	= =	Abandoned Channel
* *	Back Swamp	TTTT	Boundary of Geomorphic Unit

Only the flowing water of the river itself creates variations in morphological features in the lower Ajoy Basin (Fig.1). Ajoy River in association with its tributaries present mosaics of meso and micro landforms in different altitudinal zones. The river lies below 50-meter contour. A morphological study on Ajoy River by Dr. M. Mukhopadhyay observes that at the points of the river curvature even erosion has slightly exceeded

deposition and there are points in the lower reaches where deposition exceeded erosion. Little deposition has occurred over the flood plain. At places, on both the banks of the river, sediments were deposited within the channel itself and on the islands rather than spreading over its floodplain. At places the embankment is so close to the river that it does not allow the suspended particles to spread out. So, the former younger floodplain is restricted between the riverbank and the embankment (instance of Raipur only). It is the embankment that restricted the excessive sand spray over the area beyond the embankment periphery. The flood plain of the river is covered with alluvium with both alluvium loam and calcareous clayey. The channel bars in the river valley consist of loose, non-sticky, well-grained sandy loam. The riverbank with loose-grained soil is responsible for excessive bank erosion in different parts.

Climatically the area experiences high temperature (often reaches > 42°C in summer) with less amount of moisture. Extreme dryness prevails everywhere at this period of time. Ponds and the river even dry up and there is a large scarcity of water causing occasional death of cows and goats that wander around in search of fodder. Raipur settlement itself was located closer to the river to obtain water from there. Relics of masonry houses close to the river depict its past history and glory. Ajoy riverbed at that time was much below the present height. Naturally the monsoon excess water rarely spilled its banks. As time passed by owing to much anthropogenic interferences, like deforestation in the catchment area, construction of rail and road bridges (two bridges in close proximity) across the river which is very near to the village, accelerated soil erosion etc., degradation in the capacity of the river occurred. The obvious consequences happened by spilling and sprawling of river water over a large territory where it never had penetrated before. The previous location of the settlements therefore receded but not before the vast flood devastation occurred in the year 2000.

Combat with Flood and Ensuing Floodwater Harvesting:

Major flood occurrences in Ajoy in the post-independence period were in 1956, 1959, 1970, 1971, 1973, 1978, 1984, 1995,1999 and in 2000. Normally flood occurs mostly in the post-monsoon months (September) and in exceptional cases it may happen even after this period. Ajoy is a right bank tributary of Bhagirathi River in the deltaic West Bengal. Though flood affected villages in this part of Ajoy are quite large in numbers yet very few of them have adopted or maintained the indigenous floodwater harvesting process. Possibly it is due to the existence of a royal family in the village and its wisdom and care for the villagers (its subjects) to procure water from the well-kept water reservoirs in the vicinity in the summer months. This royal (zamindar) family gave birth to Sir S. N. Sinha and in 1862, Maharshi Devendranath Tagore (Father of Shri. Rabindranath Tagore), while on a boat journey to Raipur, came across a landscape with red laterite and meadows of lush green paddy fields. The journey resulted in the selection of a place for International University (Visva Bharati) at Santiniketan, only 7/8 Kms. north of Raipur.

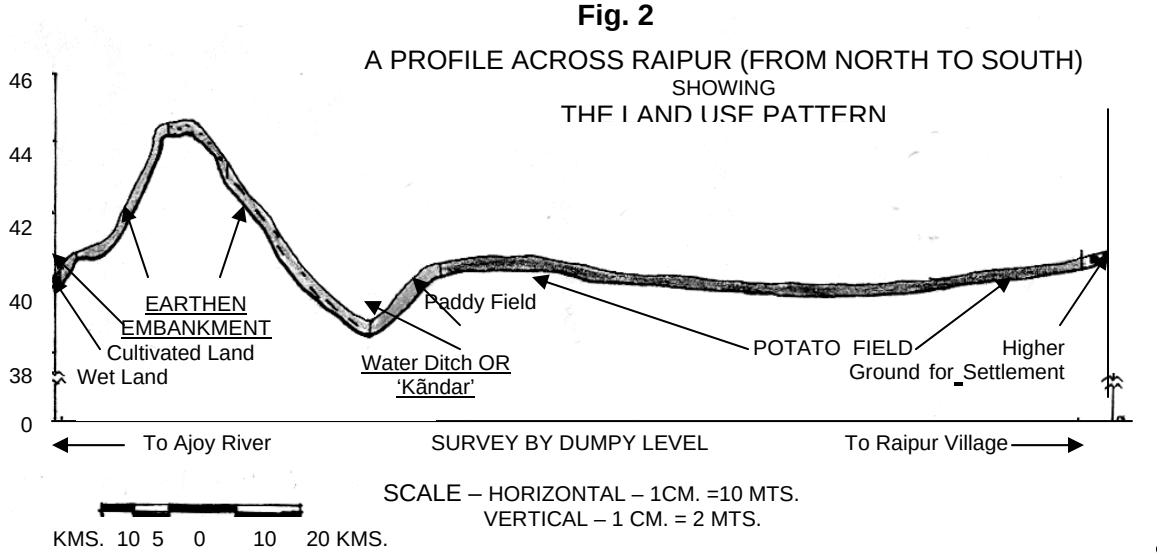
The monsoon rainfall rhythm affects the hydrological character of the river. In the months from November to mid-June (pre-monsoon season) the surface flow disappears and the river trickles through its sand bed and thereafter the onset of monsoon suddenly spurts out the fresh volume of water which the river is unable to carry through and flood occurs. The river regime of mean monthly maximum of 247 cumecs (due to heavy downpour in its upper catchment), monthly minimum of 1.32 cumecs and monthly average of 45 cumecs discharge reflect the influence of weird monsoon rhythm character on the river. The peak flow discharge at the time of flood is abnormally high over 8000 cumecs. A near by gauge station of river water at Gheropara (close to Raipur village) shows he hydrological characteristics of this part of the river in the major years of flood occurrences (Table - 1).

Table – 1
Month wise (Monsoon Season) Flow Level (Meter):
(Gauge Station - Gheropara)

GHEROPARA					
Years	**June**	**July**	**Aug.**	**Sept.**	**Oct.**
1956	36.50	37.20	38.40	40.89	39.10
1959	37.71	38.21	39.80	41.39	38.80
1970	37.23	39.10	36.40	40.51	39.20
1971	36.42	37.92	38.60	40.29	37.80
1973	36.81	38.82	37.21	40.63	38.50
1978	38.81	37.50	39.95	42.82	39.70
1984	38.40	38.21	39.02	37.50	37.45
1995	38.40	36.86	37.19	42.50	37.20
1999	36.00	37.17	38.00	43.25	39.59
2000	36.54	38.78	35.96	42.97	37.00

Source: Irrigation and Waterways Directorate, Government of West Bengal

Fig. 2



The above data reflect the flow pattern of normal / flood water in the monsoon months in the Ajoy River. Magnitude of flood level varies when September exhibits the peak month with accumulated water of the monsoon rain, surface / sub-surface drainage along with the water discharge from its dams. After which a sharp fall in the discharge flow follows. All the highest floods in each year had happened in the month of September only and in the two years of 1978 and 2000 maximum level had reached. It is pertinent here to mention about the flood in 2000 when on 21st September the water level reached to 42.97 meters at 6.00 A.M., which is considered to be the highest, flood level in this area. The frequency of flood at Gheropara annually on an average is 49, which is considered to be one of the most vulnerable points in the flood map of Ajoy River.

The recurring hazardous flood situations in the village (Raipur) compelled them to construct an earthen embankment (Fig.2) parallel to the river but at a distance of approximately 100 – 300 meters away from the main channel leaving a space between the two that might be used for agricultural purposes. This new embankment was an extension of an existing one from its neighbouring village Kankutia located on the west (Topographical Sheet No. $73^{F}/_{10}$) of Raipur. The

height of the embankment is approximately 4 – 5 meters and its length covers the whole southern part of the village.

This embankment was constructed in the late sixties and plays a kind of *dual role* here. Its prime role is to protect the village from flood and secondly it helps irrigating the agricultural fields in combination with a pre-existing drainage channel *('kãndar'*) which after crossing the adjoining village in the Supur village in the north enters Raipur and cuts it across in a north – south direction finally to meet Ajoy. This drainage channel ('kãndar') used to trickle out a faint water flow in the pre-monsoon season, as it is rain-fed. After construction of the embankment it cuts it perpendicularly across to join Ajoy and at the point of cutting a sluice gate was erected. *The main function of the sluice gate was to control floodwater in and out for the purpose of harvesting.*

The whole operating system is followed seasonally. In the monsoon months huge volume of water gushes down the Ajoy River from its catchment area. The excess water thereafter naturally spills over its banks causing flood in its middle and lower reaches. The existence of a perpendicular channel here allows this spilt water to enter inland. The sluice gate during this period of time remains open through out until the floodwater recedes. At the point of its recession the gate was instantly closed down. The gate might be opened if the water level inside becomes so high as to inundate the surroundings. The captive floodwater is accumulated not only within the channel itself but also well conserved in reservoirs far inside the village away from the main river. These reservoirs were the judicious creation of the local '*zamindars*' and are meant primarily for water storage in the dry season. Locally these are called *'bils'* and were named as '*Mondal Pukur'* and *'Dikshit Pukur'* ('*pukur'* means ponds or water reservoirs) etc.

In the pre-monsoon (dry) season the direction of water flowing through the narrow channels of 'kãndar' is from north to south. But for most of the times the gate is kept closed and the water remains stagnant within the channel itself and also within the 'zamindar'-excavated *'pukurs' ('bils'*). This stagnant water is thereafter lifted and distributed to the surrounding agricultural field with the help of diesel pumps through PVC pipes. The flow of flood/rain water through 'kãndar' follows the general slope of the land, which is from the embankment to the river (south) and again from the embankment to the village (north). After crossing Mondal Pukur reservoir 'kãndar' enters further north to Supur village. In this village once existed a famous river port from a variety of items were exported or imported *'Kãndar' thus performs a dual role by protecting the people from flood disaster and by supplying irrigation water to the winter crops in the lean period.*

Agricultural / Demographic Scenario:

Raipur, in the year 2000, was affected by the flood situations in many ways. As Ajoy spilt over the land a huge deposition of sand, quite a few meters high, enveloped not only the once fertile agricultural land but also savagely destroyed the river vicinity habitations. As a result people shifted more towards the north near the metalled Illambazar to Bolpur roadways (Fig.3). Northern part of the village remained as the rice producing land and the river adjacent land slowly turned towards the cultivation of sand mixed alluvial soil (loamy or '*doash'*) vegetables like potato, cabbage, cauliflower etc. and also oilseeds like mustard and other types are grown. Potato is the most important vegetable here, which also the main item of export of the village. Coconut trees in this part of Birbhum District near the Ajoy River are not uncommon. Here the soil character and composition has changed due to the invasion of profuse floodwater. Soil now has become more coarse and saline encouraging the salt loving trees like coconut. Out of the total area of 186.37 hectares of land about 75% of the area is under agriculture. Agriculture is now practiced mainly along the banks of the Ajoy River due to the water availability from the 'kãndar'. 'Kãndar' irrigates about 34.42 hectares of land and 8.09 hectares of land is irrigated from tank irrigation.

Stored water inside 'Kãndar' has given an enormous boosting of agricultural crops (particularly the winter or *'rabi'* crops) as observed in consequence. The effect is reflected in the character of the cropping pattern of the agricultural fields. The plots lying north of Raipur nearer the roadways are single cropped due to scarcity of sufficient water supply. On the contrary, the plots

located to the south and closer to the river and 'kãndar' is doubly cropped and winter crops are abundantly produced. Flood is boon in disguise to the people of Raipur as it is due to the repeated flood intervention in their lives they had shifted to the north of the village, thereby resulting in an increase in the availability of agricultural land. Still now about 96.32 hectares of land is un-irrigated and mainly depends on rainfall and 121 hectares are lying as cultivable waste. About 98.32 hectares of land is not available for cultivation due to different infrastructural use.

North of Raipur particularly the area to the north of the Illambazar-Bolpur metalled road is mono cropped producing only rice. There is approximately 400 – 500 acres of paddy field in this area. No other crop cultivation is possible due to the paucity of water. Wheat is also cultivated here.

Potato cultivation is quite plentiful here till mid- February. Approximately in 100 hectares of land potato is cultivated. Annually some 40/50/60 quintals of potato are available per hectare from the field. The yield increases more towards the river. Potato fields are there even beyond the embankment periphery in the vicinity of the river and a high yield also comes out from there. In the same potato growing field vegetables like pumpkin is cultivated till mid-April following its reaping. Mustard oilseeds are cultivated in some 8 to 10 hectares of land from where ± 10 Kg. Is obtained. Near to the river, in about 12-15 hectares of land, cabbage growing is common and the yield of it is 400-500 pieces per hectare. Due to more supply of water here HYV (High Yielding Variety) of *'aman'* rice (summer rice) of a coarse variety is cultivated and is harvested in the month of mid-August/September yielding approximately of 100 sacks per hectare each containing about containing about 50 kg. *'Boro'* another water loving variety of rice is also being sown in the area.

Pisciculture in 'Mondal pukur' is a signature of self-reliance economy by the villagers and an evidence of a wise use of the confined floodwater.

Raipur has a population of 2063 persons where 1094 are Male and 969 are Female (Census of India, 2001) and most of the working people are agricultural labourers (36.4%; 31% Male and 51.2% Female). Going through the cadastral map of the village it has been found that there is a spectacular shifting of settlements from the river to its opposite direction. These settlements were primarily located on the higher ground within the guard wall of the earthen embankment. Dilapidated relics and remnants of the previous settlements are still standing upright at places. The cultivated land area simultaneously also had stretched out offering provision for typical soil oriented and season controlled crop types.

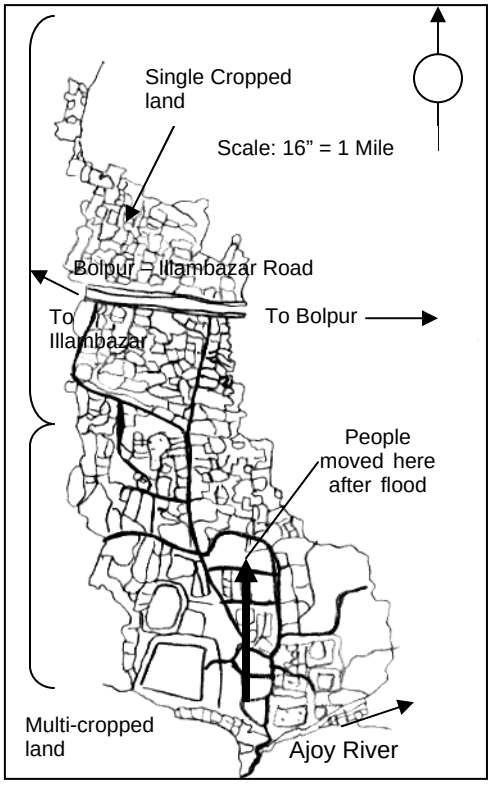


Fig.3

Raipur Mouza (village)

showing

Land use and

Movement of

people after

repeated flood

occurrence

Direction of movement of people from riverbank to the north.

The following set of data (Table – 2) enlightens the demographic and related economic status of Raipur through ages. The occupational structure indicates the engagement of a person in any productive and economic activities. This also characterizes agricultural as the mainstay of the people of Raipur. Only male are engaged in livestock and forestry and there are no people engaged in mining and quarrying activities. Transport and business have gained importance now a day.

Table - 2
Demographic & Economic Character of Raipur through Decades

Year / Population	1951		1961		1971		1981		1991		2001	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
POPULATION (Total)	1105	100	1333	100	1494	100	1604	100	1802	100	2063	100
Male	NA	NA	677	50.79	762	51.0	807	50.31	832	46.17	1094	53.03
Female	NA	NA	656	49.21	732	48.99	797	49.69	870	48.29	969	46.97
TOTAL WORKERS	-	-	361	100	415	100	431	100	591	100	869	100
Male	-	-	339	93.90	364	87.71	386	89.56	493	83.42	623	71.69
Female	-	-	22	6.09	51	12.29	45	10.44	98	16.58	246	28.31
Cultivators (Male)	-	-	175	100 (100)	148	100 (98.01)	155	100 (85.68)	162	100 (96.43)	96	100 (96.0)
Female	-	-	00	00	3	1.98	7	4.32	6	3.70	4	4.0
Agricultural Labourers (Male)	-	-	79	100 (83.16)	149	100 (80.11)	139	100 (88.54)	144	100 (71.64)	176	100 (77.89)
Female	-	-	16	16.84	37	19.89	18	11.46	57	28.33	50	22.12
Marginal Workers (Male)	-	-	-	-	-	-	00	00	11	6.80	29	54.7
Female	-	-	-	-	-	-	110	100	151	93.21	25	46.29
Non-Workers (Male)	-	-	338	100 (34.77)	398	100 (36.89)	421	100 (39.60)	428	100 (40.80)	471	100 (40.45)
Female	-	-	634	65.23	681	63.11	642	60.40	621	59.20	723	60.55

Source: District Census Hand Books (Birbhum District)- 1951,'61,'71,'81,'91,2001

Decade wise total population has increased at the same pace. Total number has maintained almost the same pace except for the last decade where the rate has slightly increased. Total number of cultivators is on the wane whereas both agricultural labourers and marginal workers (both male and female) have increased to a large extent. Dependence on tractor is one of the factors for the decrease in the number and many have shifted to transport and other tertiary sectors.

Problem identification and conclusion:

The hydrological characteristics of the river have brought about some changes in the present day flood situation in the Ajoy Basin. The water level in the recent flood has reached an unprecedented top gauge. There happened breaches in the embankment in other areas too. The problem people are facing is siltation and crack near the sluice gates, which require repair, regular monitoring and proper maintenance. The eroded material from the embankment is transported to the main river resulting in upheaval of the riverbed and decrease in the water holding capacity and stream velocity. Population pressure over the agricultural land also threatens the situation.

With the application of this self-sustainable indigenous low-cost technology, Raipur people have not only overcome the wrath of flood in the monsoon rainy season but also by its judicious use, in the dry post-monsoon period, have turned the non-productive land into smiling carpet of varied crops.

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