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SALINE WATER INGRESSION IN UPPER PART OF BALESWAR RIVER NEAR NAZIRPUR UNDER PIROJPUR DISTRICT: A CASE STUDY

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Abstract: A five year project was undertaken to address the salinity problem in the upstream of Baleswar river. The information generated during this period have been presented in this paper. Previously the Madhumati-Baleswar river system was completely non saline throughout the year. Recently upstream fresh water flow from the Madhumati river through the Baleswar river passing in between Chitalmari and Nazirpur *Upazila* is about to cease due to prolonged siltation on the river bed. During intensive monitoring work (1995-1999) some canals such as the Chitra river, Vasa canal, Santoshpur canal, Lara canal etc. are identified as the portals of saline water in the upstream of the Baleswar river in dry season. Due to tidal effect they carried saline water from Daratana river to Baleswar river. As a result high water salinity prevailed in Baleswar river in between February and May. Maximum water salinity EC_w 17.6 dS/m and soil salinity EC_e 4.4 dS/m were recorded in May. Water extraction for irrigation in the riparian area was restricted due to high salinity. To minimize this salinity problem upstream fresh water flow from the Madhumati river to the Baleswar river has to be increased. Increased volume of upstream fresh water flow will push saline water back to downward direction. The major portals namely Chitra river and Vasa canal may be closed seasonally by constructing sluice gate with proper engineering design to prevent entry of saline water in the Baleswar river.

Key words: Saline water; Ingression; Prolonged siltation; Baleswar river; Fresh water flow

Introduction

Saline water ingression in the upstream of the Baleswar river is a recent phenomenon. Earlier all the rivers passing through the study area were non saline (Department of Soil Survey [DSS], 1967). The soil also remained non saline throughout the year and the study area belongs to two physiographic units, Ganges Floodplain and Ganges Tidal Floodplain (DSS, 1967). Fresh flood water kept the saline water limit back almost at the coast during monsoon. The principal rivers flowing the study area are the Madhumati, Baleswar, Shwarupkathi, Katcha and Haringhata carrying a combined flow of the Ganges, Garai and Meghna rivers, the Ganges distributaries. The main flow of the Ganges into these rivers was diverted from time to time. At present the Garai-Madhumati river system is the only active Ganges distributary flowing in the west. The Pashur system shares the Madhumati flow through the Halifax cut (Karim *et al.,* 1982).

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One of the distributary of Madhumati river the Baleswar is flowing towards southern direction in between Pirojpur and Bagerhat district. During the past few years high salinity was noticed in the upstream of Baleswar river passing through the western side of Nazirpur *Upazila*, indicating salinity ingression. The other branch of the Madhumati river is flowing through the eastern side of Nazirpur *Upazila* as the Kaliganga river and joined with Swarupkathi river near Pirojpur district headquarter. The combined flow named as Katcha river flows towards the southern direction to join with the Baleswar and renamed as Haringhata and flows further south to the Bay of Bengal.

For better navigation a wide canal named as Katakhal was excavated during the year 1972-73, joining the Mongla (Kumarkhali) and Ghoshiakhali river (Fig. 1). For that reason the Daratana river become highly saline during the dry season. Daratana river flowing in the eastern part of Bagerhat town is connected with the Rupsha river through Bhairab and Atharabaki river. It is also connected to the upper part of the Baleswar river through Chitra river and different canals/creeks. It is obvious to mention here that lower part of the Baleswar river, near western side of Mathbaria *Upazila* possessed lower salinity in dry season (Table 2). The main objectives of this study were a) to determine the causes of water salinity in upper part of the Baleswar river and b) to propose a guideline to solve the problem of salinity ingression in the area.

Materials and Methods

Description of the Study Area: The study area lies between 22^{o} 11' and 22^{o} 46' N latitude and 89^{o} 41' and 89^{o} 50' E longitude. This area is bounded by Madhumati and Atharabaki river in the north; Kaliganga, Katcha and Haringhata river in the east; Polyhara river, Katakhal and Mongla river in the south and Pashur-Rupsha river in the west. In this paper special emphasis has been given to the upper part of the Baleswar, which is located in between Nazirpur and Chitalmari *Upazila* under Pirojpur and Bagerhat districts respectively. All the rivers flowing within the study area are tidal in nature. Southern part of the Baleswar is still non saline throughout the year and navigable for country boats and motor launch. On the other hand, upper part of the Baleswar river remained highly saline in dry season and is not navigable in dry season. Dominant land type of this area is medium highland and is seasonally flooded with rain and tidal water.

Working procedure: In the coastal areas of Bangladesh increase of soil and water salinity starts in January and reaches its maximum value in April/May. Due to sufficient rainfall in July and afterward soil and water salinity decline gradually. In August-December most of the rivers remains non saline. Sample collection schedule was determined on the basis of the soil and water salinity trend. From January to June water sample collection intensity was at fifteen days interval but from July it was once in a month. River water sampling sites were selected on the basis of a) major source of the saline and fresh water within the study area, b) main canals/creeks that has been considered as portals of saline water to the Baleswar river and c) saline water ingress area in the Baleswar due to saline water intrusion. Within the study area the selected rivers/canals are Pashur, Rupsha, Katakhal, Bhairab, Daratana, Chitra and Madhumati, Vasa canal, Santosh canal and Lara canal. Water salinity (EC_w) was directly determined by the authors using Eijkelkamp

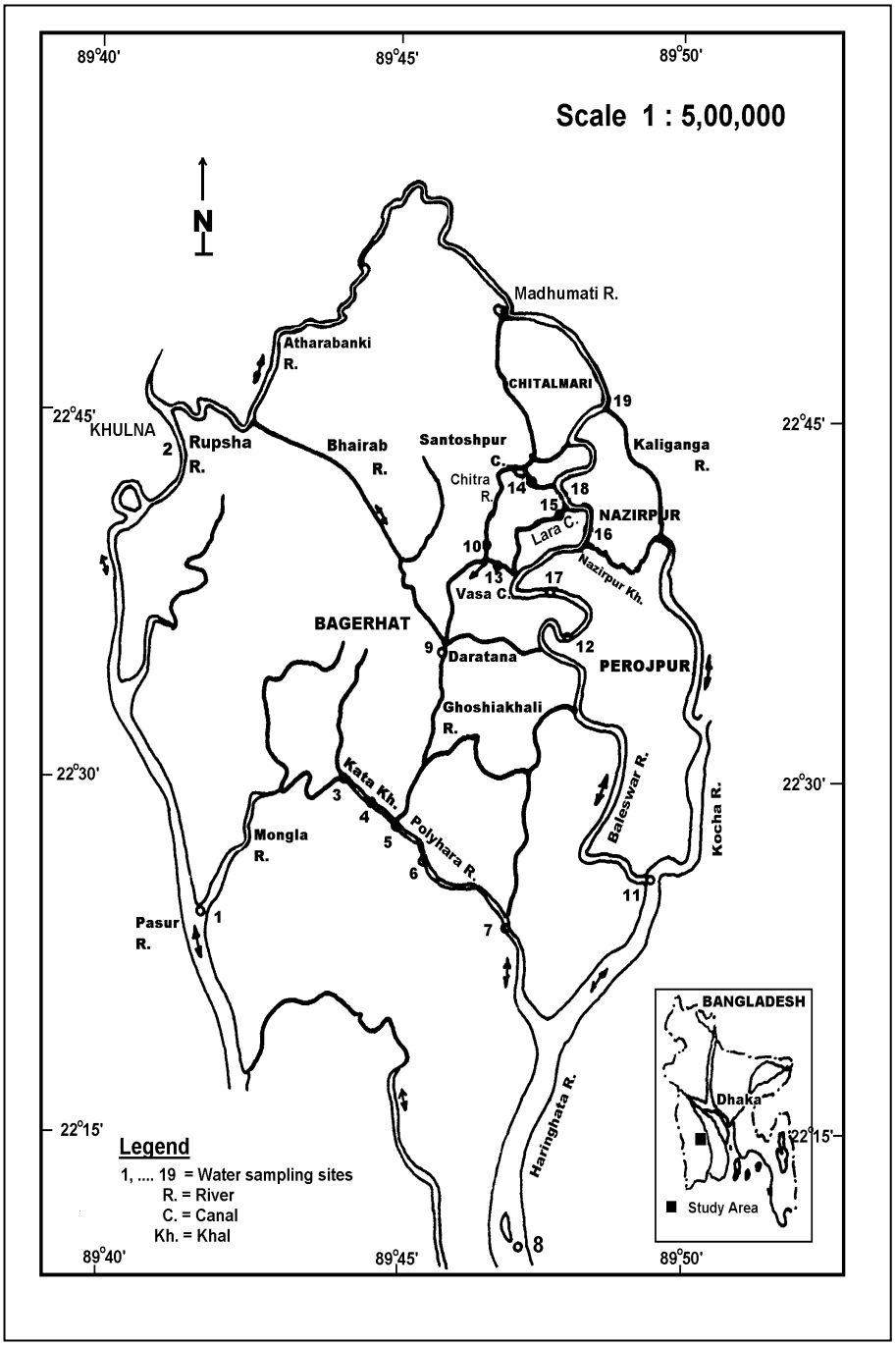

Fig. 1. Study area and water sampling sites.

pH/EC meter 18.38 at different locations of the selected rivers/canals and other tidal creeks and canals within the associated drainage system as shown in Fig. 1. EC_e of some soil samples near the eastern side of the Baleswar river were also determined. To determine the EC_e of the collected soil samples 100 gm dry pulverized soil was taken and then 100 cc distilled water was added to make 1:1 soil-water solution. After shaking half an hour filtrate was collected in a test tube using ordinary filter paper. Finally electric conductivity was measured by EC meter. To convert EC_1 value to EC_e value the following conversion factor was used:

$Y = X * 1.267+1.269$ where, Y = EC_e value, X = EC meter reading

To assess the change of river course and width of the Baleswar river during last two decades aerial photographs of the study area in 1973 (1: 30,000) and in 1983 (1: 50,000) and toposheet of 1964 (1: 50,000) were interpreted (Fig. 2).

Results and Discussion

Causes of water salinity in upper part of Baleswar: In western side of Nazirpur *Upazila* upstream fresh water flow of Madhumati river through upper part of Baleswar is almost ceased due to prolonged siltation on the river bed (Fig. 2.)As a result high salinity prevailed due to gradual saline water intrusion from Daratana/Bhairab through Chitra and different tidal creeks and canals, connecting the upper part of Baleswar river in dry season. EC_w of water samples collected from different places of Katakhal was found 11.5 to 12.0 dS/m in May from 1995-1999. Lower value of salinity was found in Polyhara river near Morrellganj *Upazila* at the same period. EC_w of water samples collected from Katakhal, at the junction of Katakhal - Polyhara and Polyhara river indicated that river water salinity gradually decreased from west to east i.e. from the junction of Katakhal-Polyhara river to Morrellganj *Upazila* headquarter (Fig. 1 and Table 1). During monitoring activities the creeks and canals like Chitra river, Vasa canal, Lara canal, Santoshpur canal etc. were identified as the portals of high saline water into the upper part of Baleswar river (Table 1).

Table 1. Water salinity (dS/m) of different rivers/canals considered as the portals for the intrusion of saline water in Baleswar in May (1996-1999).

Site no.	Name of the river/Canal	Water collection site	Year			
			1996	1997	1998	1999
3	Katakhal	Kumarkhali, Rampal	12.0	12.2	11.7	11.5
4	Katakhal	Ghoshiakhali,Morrellganj	11.4	11.2	10.7	10.5
5	Polyhara-Katakhal junction	Ghoshiakhali,Morrellganj	11.0	10.2	10.7	10.9
6	Polyhara	Sonakhali,Morrellganj	8.8	10.9	11.3	10.5
7	Polyhara	Morrellganj *Upazila* HQ.	7.2	10.6	10.4	9.9
10	Chitra	Char Baniari, Chitalmari	9.0	9.6	9.9	9.6
13	Vasa canal	Depara Bazar, Kachua	10.2	9.8	9.9	10.7
14	Santoshpur canal	Santoshpur,Chitalmari	8.5	9.0	8.0	8.7
15	Lara canal	Chitalmari	8.7	9.2	8.1	8.5

Source: SRDI, 1999.

High salinity of the above mentioned portals during January-May influenced Baleswar river to become saline for a considerable time in dry season. On the other hand it was observed that water salinity of Haringhata river has gradually decreased in the upstream. In May (1995-1999), EC_w of Haringhata river at Baramasua steamer station under Mathbaria *Upazila* varied from 3.9 to 5.3 dS/m but in the upstream EC_w of Katcha river near Parerhat varied from 0.4 to 0.5 dS/m (Table 2).

In the middle part of Baleswar river particularly in the western part of Pirojpur town, remained non saline throughout the year. Haringhata-Baleswar river systems possess less salinity than that of Pashur-Rupsha river systems. So from this data it is clear that high amount of salinity in Daratana river is due to the influence of Pashur river through Katakhal, Rupsha and Bhairab river but not due to the influence of Haringhata-Baleswar river system.

In January to March and June to August Rupsha possessed lower salinity than that of Daratana. At the same time Haringhata (Lower part of Baleswar) river near Baramasua possessed lowest salinity (EC_w 0.6-5.3 dS/m). Salinity intensity of Daratana river showed more or less similar trend that of Pashur river (Table 3). As the lower part of Baleswar river, near western side of Mathbaria *Upazila* possessed lower salinity in dry season, so it was presumed that it has no influence on developing high salinity in the upper part of the same river. Through Chitra river and different adjacent tidal creeks and canals high saline water of Daratana/Bhairab ingress into the upper part of Baleswar river during high tides.

When the flow of the Ganges was diverted from time to time, Madhumati and its distributaries carried a small flow derived from the local rainfall (Karim *et al.,* 1982), caused river bed siltation in the upper part of the Balesaer river. Due to siltation on the river bed particularly from Sailadaha to Char Raghunathpur, water flow was about to ceased during dry season (Fig. 2c). This situation has enhanced gradual saline water ingression in these areas through different portals in dry season. So, opportunity of pushing salt water back from the area by upstream fresh water flow from the Madhumati river to downward direction is very limited.

Soil salinity and present land use: Originally the sediments of Madhumati river system were non saline and ground water table at shallow depth of that area was also non saline (DSS, 1967). But at present high saline water inundation and upward movement of saline perched ground water during dry season caused spatial and temporal variation of soil salinity.

Tidal flooding inundates the soils and impregnates them with soluble salts thereby rendering the soils and water saline (Karim *et al.,* 1982). Soil and water salinity monitoring results showed that some of the soils of these areas were very slight to slightly saline. During soil and water salinity monitoring programme maximum EC_e was observed 4.4 dS/m. Dominant landuse pattern of these areas are fallow- transplanted aman, rabi crops/ fallow-mixed broadcast aus and aman and boro-fallow-transplanted aman. Due to high river water salinity farmers of that area do not use river water as

irrigation source from Baleswar in boro and even in other rabi crops during dry season. They use ground water for the cultivation of boro and other rabi crops.

Table 2. River water salinity (dS/m) of Haringhata- Madhumati river system at different observation points (1995-1999).

Site no.	Name of the River	Year	Location	EC_w dS/m							
				J	F	M	A	M	J	J	A
8	Haringhata (Lower part of aleswar)	1995	Baramasua steamer station, Mathbaria	1.5	3.6	5.3	4.1	2.6	0.2	0.4	0.2
		1996		0.6	3.7	4.4	2.1	1.3	1.3	1.0	0.2
		1997		2.5	2.5	3.9	1.3	1.7	0.3	0.2	0.2
		1998		2.5	3.5	4.0	2.1	1.4	0.5	0.2	0.2
		1999		2.2	2.9	3.9	2.3	1.7	0.3	0.2	0.2
11	Katcha	1995	Parerhat ferryghat, Pirojpur Sadar	0.2	0.4	0.4	0.5	0.3	0.2	0.2	0.3
		1996		0.2	0.4	0.4	0.6	0.4	0.2	0.2	0.3
		1997		0.2	0.3	0.5	0.5	0.3	0.2	0.2	0.2
		1998		0.2	0.3	0.4	0.6	0.3	0.2	0.3	0.3
		1999		0.2	0.4	0.4	0.5	0.4	0.2	0.3	0.2
12	Baleswar (Middle part)	1995	Fultala, Kachua	0.3	0.4	0.5	0.5	0.3	0.2	0.3	0.3
		1996		0.3	0.4	0.4	0.5	0.4	0.2	0.3	0.3
		1997		0.3	0.3	0.5	0.5	0.3	0.2	0.3	0.2
		1998		0.3	0.3	0.4	0.5	0.3	0.2	0.3	0.3
		1999		0.3	0.4	0.4	0.5	0.4	0.2	0.3	0.2
16	Baleswar (Upper part)	1995	Baburhat, Nazirpur	3.0	4.9	10.1	14.7	17.6	2.3	0.5	0.3
		1996		2.4	3.2	3.8	9.0	11.6	2.7	2.1	0.2
		1997		2.3	4.0	8.0	7.2	16.0	0.3	0.2	0.2
		1998		2.4	3.7	8.3	9.0	15.2	1.4	0.4	0.3
		1999		2.9	4.1	8.2	10.1	14.9	2.2	0.4	0.2
17	Baleswar (Upper part)	1995	Char Raghunathpur, Nazirpur	3.0	5.0	10.5	15.6	17.5	2.3	0.5	0.3
		1996		2.3	3.1	4.3	9.3	10.9	2.6	2.0	0.2
		1997		2.5	4.1	8.0	7.8	15.8	0.4	0.6	0.3
		1998		2.4	3.9	8.7	9.1	16.2	1.2	0.4	0.3
		1999		2.7	4.1	8.5	10.3	14.2	2.1	0.5	0.3
18	Baleswar (Upper part)	1995	Garibpur, Chitalmari	3.0	5.4	10.5	15.0	17.1	2.2	0.4	0.3
		1996		2.5	3.1	4.3	9.3	10.5	2.6	2.0	0.2
		1997		2.5	4.1	8.2	7.8	15.8	0.4	0.6	0.3
		1998		2.7	3.9	8.7	9.1	16.2	1.2	0.4	0.3
		1999		2.1	4.1	8.3	10.3	14.0	2.1	0.5	0.3
19	Madhumati	1995	Kalatala, Chitalmari	0.2	0.2	0.7	1.1	0.6	0.3	0.2	0.2
		1996		0.2	0.3	0.7	1.0	0.5	0.3	0.2	0.2
		1997		0.2	0.2	0.8	1.2	0.7	0.3	0.2	0.2
		1998		0.2	0.2	0.5	1.0	0.7	0.3	0.2	0.2
		1999		0.2	0.2	0.9	1.2	0.7	0.2	0.2	0.2

Source: SRDI, 1997.

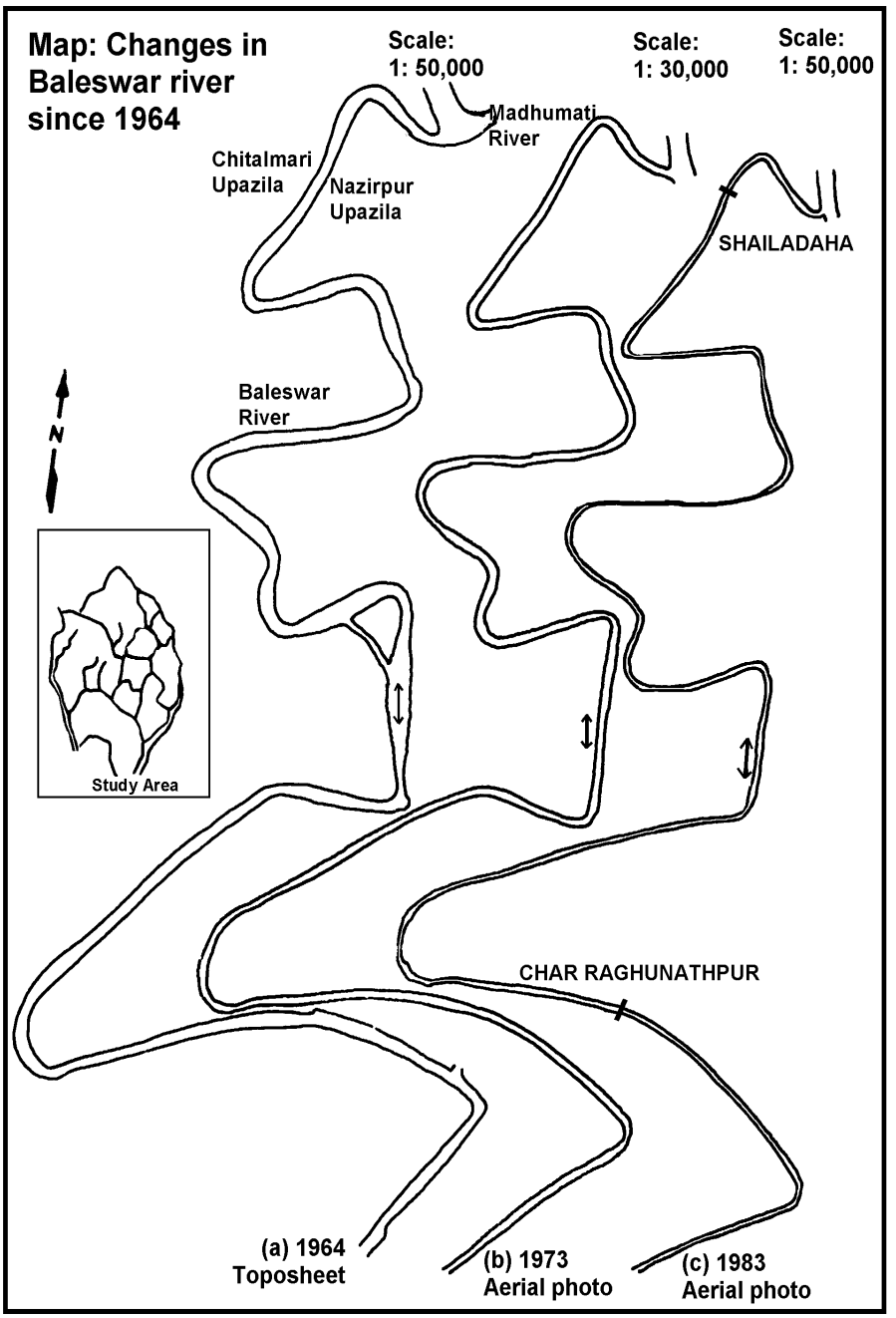

Fig. 2. Map showing the effect of prolonged siltation in the Baleswar river (a) 1964, (b) 1973 and (c) 1983.

Table 3. Monthwise electric conductivity (EC_w dS/m) of three major sources of saline water in the study area (1995-1999).

Site no.	Name of the River	Year	Location	EC_w dS/m							
				J	F	M	A	M	J	J	A
1	Pashur	1995	Mongla	4.5	9.5	10.5	20.0	22.0	13.7	2.8	0.6
		1996	port,	3.7	10.1	-	15.9	17.3	16.3	0.5	-
		1997	Mongla	6.9	14.2	13.8	18.2	23.1	20.5	4.5	0.6
		1998		5.2	8.7	16.5	17.9	17.5	17.6	1.1	0.5
		1999		5.0	7.1	20.6	19.6	20.2	10.8	6.2	0.3
2	Rupsha	1995	Rupsha	1.3	4.7	4.8	18.1	19.0	4.6	0.2	0.2
		1996	Ferryghat,	0.7	4.8	-	11.2	12.3	-	0.3	0.4
		1997	Metro,	1.0	5.0	10.3	11.4	16.5	6.1	0.4	0.2
		1998	Khulna	0.4	0.9	7.8	9.0	14.1	2.1	0.2	0.2
		1999		0.4	1.7	11.2	11.0	3.7	0.4	0.6	0.2
9	Daratana	1995	Bagerhat	2.3	6.9	11.8	16.6	16.2	8.5	3.3	-
		1996	Ferryghat,	2.3	6.6	-	14.8	12.5	8.8	5.5	1.5
		1997	Bagerhat	3.5	8.0	10.8	17.3	17.9	10.2	7.9	1.7
		1998		2.4	4.4	10.7	12.3	13.1	12.4	3.0	1.3
		1999		2.6	5.3	10.3	16.1	17.1	14.5	4.4	1.5

Source: SRDI, 1997.

Conclusion

Previously Madhmati-Baleswar river system was completely non saline. But from five year monitoring activities it was observed that some identified portals such as Chitra river, Vasa canal, Santoshpur canal, Lara canal play a major role to ingress saline water in the upper part of Baleswar river. The information provided in this paper may be used to find a solution for this issue. To address this problem some work regarding river management such as excavation/dredging of the river, construction of some sluice gates etc. has to be done with appropriate engineering design. Excavation of Baleswar river from Shailadaha to Char Raghunathpur is necessary to increase the upstream fresh water flow from the Madhumati river to the Baleswar river by pushing salt water back. It may be suggested that the major portals namely Chitra river and Vasa canal may be closed seasonally by sluice gate to stop the saline water intrusion from the Daratana river. More monitoring activities regarding soil and water environment will also be needed in future.

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