# The Fate of the Gorai River in Relation to Sedimentation at its Offtake

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## 1. Introduction

The Gorai is the principal right bank distributary of the Ganges and a key source of fresh water to the southwest region of Bangladesh. The southwest region of Bangladesh is a part of the Ganges basin inside Bangladesh and covers an area of 40,450 km$^2$, which is approximately 27% of the total area of Bangladesh. During the last decades, the low flow characteristics of the Gorai have been changed significantly due to sedimentation at its offtake. Offtakes or distributaries are common features in braided rivers, which are usually observed in alluvial plains. An offtake is created when a river is split into two or more branches (Fig.1). The hydro-morphological behavior of the river at offtake is not yet a properly understood phenomenon. The complexity lies in the determination of sediments at the downstream branches. At an offtake even if the upstream discharge and sediment transport are known, it would be difficult to predict the discharges and sediment transports in the two downstream branches as it would depend on a number of factors such as the nose angle, cross-sectional areas, slopes of the downstream channels etc.

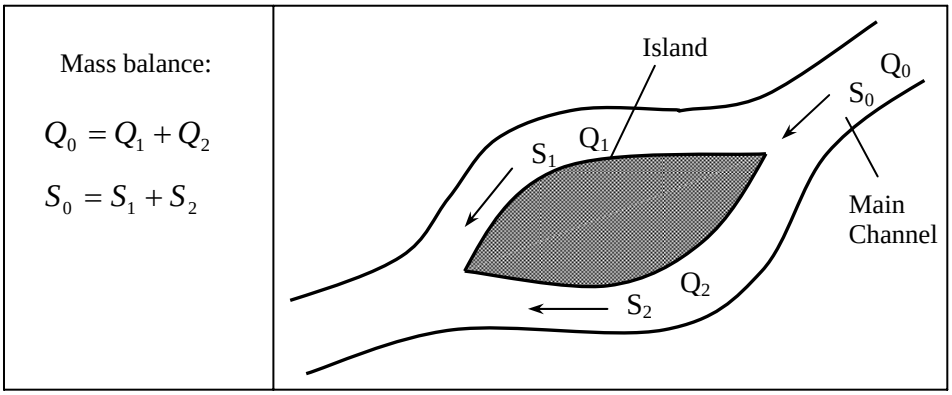


Fig. 1 Schematic representation of offtake in a river

At an offtake even if the upstream discharge $Q_0$ and the sediment transport $S_0$ are known, it would be difficult to predict the discharges $Q_1$ and $Q_2$ and the sediment transports $S_1$ and $S_2$ in the two downstream branches. In this case $Q_0$ and $S_0$ are known and $Q_1$, $Q_2$, $S_1$ and $S_2$ are unknown. As a result two mass balance equations of water and sediment (viz. $Q_0 = Q_1+Q_2$ and $S_0 = S_1+S_2$ respectively) are not sufficient to determine the distribution of flow and sediment in the downstream branches. With this simple description of an offtake the problem arising can clearly be seen: two extra equations have to be found in order to obtain four equations necessary to determine the values of the four unknown quantities: $Q_1$, $Q_2$, $S_1$ and $S_2$. In order to find the values of $Q_1$, $Q_2$, $S_1$ and $S_2$, one has to know how water and sediment distribute over the downstream branches. In other words, one has to know the ratio between the downstream discharges and the ratio between the downstream sediment transports. In this way two extra equations may be obtained. The distribution of discharge and sediment at offtake is a key factor for the long-term morphological development of the distributaries of the main river. The morphological behaviour and the effect of the offtake on the stability of the downstream branches strongly influence the stability of the river system as a whole. This paper examines the fate of the Gorai river in relation to sedimentation at its offtake.

## 2. Development of Nodal Point Relation

The River Survey Project of Flood Action Plan (FAP) measured discharge and sediment transport of the Ganges and Gorai river during 1993 to 1996 (FAP24, 1996) which are used to develop nodal point relation of the Gorai offtake. The nodal point relation is defined as the relation between the ratio of the downstream discharge and the ratio of the downstream sediment transport.

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The discharge and sediment transport data of the Gorai river and Ganges river downstream of the offtake have been fitted to Eq. 1 by regression analysis to obtain the nodal point relation. The coefficient of determination of the fitted equation was found to be 0.89.

$$\frac{s_1}{s_2} = M\left(\frac{q_1}{q_2}\right)^k \quad (1)$$

where $s_1/s_2$ and $q_1/q_2$ are the sediment transport and discharge ratio per unit width of branch 1 and 2, respectively. Thus the nodal point relation developed for the Gorai offtake is:

$$\frac{s_1}{s_2} = 1.42\left(\frac{q_1}{q_2}\right)^{1.10} \quad (2)$$

Fig. 2 shows the variation of $s_1/s_2$ with $q_1/q_2$ and the fitted equation. Using the mass balance and momentum equations of water and sediment and the general nodal point relation, Wang et al. (1995) theoretically investigated the stability of the configuration with both branches open. They found that the offtake is stable (the downstream branches remain open) if k>n/3 and unstable (only one of the branches remains open) if k<n/3 where k being the exponent of the nodal point relation and n the exponent of the sediment transport formula. The theoretical analysis of Wang et al. (1995) predicts that the equilibrium with both branches open is stable for k>5/3 and unstable for k<5/3 when the Engelund-Hansen sediment transport formula is used. As the exponent, k of the nodal point relation of the Gorai offtake is less than 5/3, the offtake appears to be unstable. This means that it would eventually be closed down unless preventive measures are taken. This is in fact the case in the Gorai river. The river is undergoing sedimentation at its offtake. The government of Bangladesh has taken initiative to restore the Gorai offtake by dredging. SWMC/DHI (2000) analyzed the sediment concentration with corresponding velocity distribution near the offtake and upstream of the Gorai Railway bridge. They found that although the velocity distribution at Gorai Railway bridge is higher than at the offtake, sediment concentration at the offtake is considerably higher. This indicates that a substantial sediment inflow from the Ganges has been deposited within the river reach between offtake and Gorai Railway bridge. This substantiates the finding that the Gorai offtake will lead to eventual closer unless intervention is made.

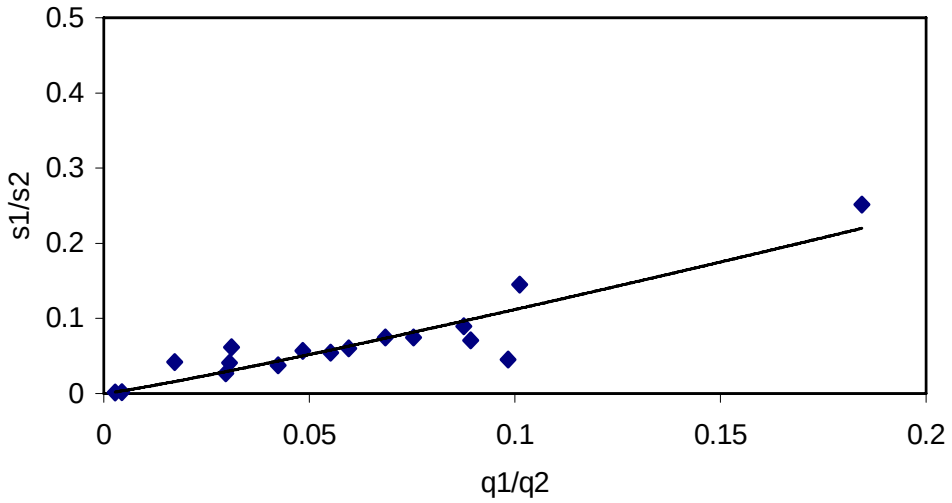


Fig. 2 Variation of $s_1/s_2$ with $q_1/q_2$

**3. Conclusion**

The nodal point relation of the Gorai offtake has been compared with the analytical model. It has been found that Gorai river is unstable and leads to the eventual closure from its offtake unless intervention is made.

**References**

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