Salinity change in the Hugli estuary: can glacial melting be related?

Recession of the Himalayan glaciers is a major concern today with IPCC's Fourth Assessment Report indicating possibility of complete loss of Himalaya's snow cover by 2035 if not sooner[1]. Although wide rebuttal of this date prompted IPCC to declare recently that the statement was poorly substantiated[2], there is little doubt that many Himalayan glaciers are on the retreat, including the second largest of Indian glaciers, the Gangotri[3]. Its implication on maintenance of ice-fed dry season flow of the Himalayan rivers is not fully clear as there is hardly any work that relates accelerated melting of the glaciers with long-term trend of river hydrographs. In this perspective, it was quite interesting to see Mitra *et al.*'s[4] conclusion that the chief reason for steady decrease in salinity at the mouth of the Hugli estuary during 1980–2007 is due to the melting of the Gangotri glacier that is retreating at an average rate of 23 m/yr.

However, not just the Gangotri glacier, but meltwater from a large part of the Himalaya finds its way into the Ganga, of which the Hugli is a distributary. The area ranges from the headwaters of the Tons (Uttarakhand) in the west to the Mechi (Nepal/West Bengal) in the east – an axial distance of more than 1000 km. Therefore, the melting pattern of quite a large ice cap needs to be taken into account if any significant increase in meltwater input into the Ganga is envisaged. The peak flood and ebb discharges at the mouth of the main (western) branch of the Hugli estuary amount to 260,000 and 109,000 cumecs respectively[5]. Compared to this, the meltwater discharge of the Gangotri glacier is negligible. It was directly measured for the May–October period from 2000 to 2003 and found to approximately fluctuate between 5 and 145 cumecs[6].

Mitra *et al.* have also missed the point that the Hugli and the Ganga are no longer naturally connected. In 1975, a barrage was constructed at Farakka to artificially resuscitate the Hugli by means of a feeder canal with design capacity of 1134 cumecs. The Hugli river is now chiefly maintained by augmentation from the Farakka project apart from its west-bank tributaries like Mor, Ajay, Damodar and Kansai that drain the Chhotanagpur highlands of Jharkhand. The Farakka barrage was constructed to improve the navigability of the Hugli above its estuarine part, north of Diamond Harbour. Below Diamond Harbour, the maximum possible discharge of the feeder canal (1134 cumecs) would increase the ebb flux to just 2% (ref. 7), which can hardly have any effect on the salinity conditions at northern Sagar. Moreover, it is widely known that due to shortfall in available water at Farakka and the water-sharing treaties between India and Bangladesh, the feeder canal never operates at its design capacity during the dry pre- and post-monsoon periods.

Thus, to account for the gradual decrease in salinity at the mouth of the Hugli, attention should be focused on the discharge of its west-bank tributaries; not to glacial meltwater or augmentation from the Ganga. The unremitting nature of the salinity reduction during monsoon as well as pre-monsoon seasons also means that input of freshwater into the system increased steadily. However, discharge from the west-bank tributaries, being highly seasonal, would not be able to explain the observed pre-monsoonal decline in salinity.

Apart from the explanation put forward for the salinity conditions, there are two other issues in Mitra *et al.*'s article that need to be addressed. First, it is not clearly explained that the two sampling areas used in the study are hydrologically dissimilar. The one at the northern tip of Sagar island is located at the mouth of one of the largest estuaries of the world having a width of 18.3 km at the sampling point. The place is about 28 km north of the seaface and the tide propagates for another 261 km landward along the Hugli. The second sampling locality is situated close to the landward limit of the Matla river, which is 1.1 km wide at the point of sampling and 87 km north of the seaface. Thus, instead of referring the sampling areas as representatives of western and eastern Sundarban, they could have been portrayed as representing outer and inner estuarine conditions within the Sundarban region.

Finally, it is also not clear why the authors used the term 'water mass' in the title of their paper. In marine science, water mass commonly means an identifiable body of oceanic water having a distinct and narrow range of temperature and salinity and a particular density resulting from these two factors. Water masses are defined by their distinct temperature and salinity (*T*–*S*) diagrams. It perhaps should not be equated with the coastal waters of Sundarban.

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