biodiversity hotspots. The annual fee that flows into the National Gene Fund has been structured in such a manner that it sustains and promotes agro-biodiversity in perpetuity to enable variety development for all times to come. Following two national debates and wide consultations, a general agreement was reached which has been notified in *The Gazette of India*[11]. It can be summarized as follows:

(1) The annual fee for any variety of the genera and species other than extant varieties and FV as specified in clause (a) of Section 14 of the Act shall be Rs 2000 (rupees two thousand only) plus 0.2% of the sales value of the seeds of the registered variety during the previous year plus 1% of royalty, if any, received during the previous year from the sale proceeds of seeds of the registered variety.

(2) The annual fee for the extant variety shall be: (a) For extant variety notified under Section 5 of the Seeds Act, 1966 (54 of 1966), the annual fee shall be Rs 2000 (rupees two thousand only); (b) For extant variety other than the category specified in (a) above, the annual fee shall be Rs 2000 (rupees two thousand only) plus 0.1% of the sales value of the seeds of the registered variety during the previous year plus 0.5% of the royalty, if any, received during the previous year from the sale proceeds of seeds of the registered variety.

Thus India, a signatory to TRIPS of the WTO, enacted in Parliament a *sui generis* law, namely PPV&FR Act, 2001, framed the rules in 2003 and started receiving applications since 2007. Till now 168 certificates of registration have been issued, out of which 163 are for extant varieties notified under Seeds Act, 1966, three for FV and two for new varieties. *PVJ* is the official notification platform for this Act. Thus, India has effectively put in place an IPR system for plant varieties.

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4. The Protection of Plant Varieties and Farmers' Rights Regulations, 2006. *The Gazette of India*, Extraordinary Part II-Section 3-Sub-section (i) G.S.R. 740(E) dated 7 December 2006.
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The drying up of River Ganga: an issue of common concern to both India and Bangladesh

H. S. Sen

A number of hydel projects and other schemes diverting water in the Ganga–Bhagirathi river system upstream to the Farakka barrage act as an impediment to uninterrupted flow of water into the barrage. This is a major reason besides others, including design aspect of the barrage itself, due to which there is fast deterioration of the hydrology of both Hugli–Bhagirathi and Ganga–Padma river systems. To ensure livelihood security in this ecosystem in both India and Bangladesh, there is need for close introspection and appropriate action in a holistic manner to restore the hydrology of the river system.

The ecological sustainability of both South Bengal (below Farakka barrage) in India and almost the entire Bangladesh (command area under the Ganga–Padma river system) is under increasing threat due mainly to unplanned diversion of water in the upstream of the Ganga–Bhagirathi region under the Indian territory. I propose here that introspection be made and appropriate action taken to ensure uninterrupted flow of water into the barrage to save the ecosystem in both India and Bangladesh.

Neo-tectonic movement

The tidally dominated area (TDA) is located at the tail-end of the Ganga basin. Due to neo-tectonic movement during the 16th–18th century, the Bengal basin had tilted easterly along a hinge

zone starting from Sagar (Indian Sundarbans) to north of Malda (West Bengal, India), finally curving towards Dhaka (Bangladesh). As a result, the flow of River Ganga started coursing through the River Padma in Bangladesh leaving Hugli with the erstwhile course as a mere tidal channel. During the 16th–18th century innumerable distributaries were generated from the Ganga, which formed a large network of creeks and channels within the Sundarbans delta and other parts of TDA in both India and Bangladesh, and many of them now act as brackish-water channels.

Need for a barrage on the Ganges

The construction of a barrage across the Ganga and diversion of water towards the Bhagirathi was first suggested by Cotton in 1853, following which many other British engineers supported the idea, although they were not unanimous about the location of the construction. The construction of the barrage now located at Farakka, West Bengal, 12 km upstream of the diversion of the river into the Hugli–Bhagirathi flowing through India and Ganga–Padma flowing into Bangladesh and their tributaries – all finally terminating into the Bay of Bengal – had started in 1962 and was completed in 1971.

The impact

The hypothesis of arithmetic hydrology that worked in favour of the barrage was subsequently proved inadequate to bring about any positive impact either in flushing out sediment load to increase navigational prospect for the Kolkata Port, or to share dry-season flow between the two countries for their mutual benefits, the very purposes for which it was conceived. It is important to note that the prospects of agriculture and allied activities and livelihood security should depend upon geo-hydrology and, in turn, on the sedimentation and hydrology in TDA. It is thus true that the dynamic equilibrium of River Ganga and its tributaries has been largely disturbed due to inadequate planning for the construction of the barrage. It is not intended, neither is there scope, to discuss all the factors in detail here, but I will touch upon only the issues related to upstream flow of water affecting hydrology downstream, with suggestions for future attempts towards improvement.

There are various sources contributing sediment load into the Bhagirathi–Hugli river. It has been worked out in 2006 that the annual sediment load transported below Diamond Harbour is 23.68×10^6 t, and about 13.20×10^6 t between Nabadweep and Diamond Harbour, whereas about 26.93 t gets deposited or remains in circulation between Diamond Harbour and Sagar each year[1]. The sediment movement is tide-dominated and a part of the total, about $4.9–14.67 \times 10^6$ t, is likely to be pushed back during ebb tide, the exact quantum of which is difficult to estimate. The Ganga–Brahmaputra river system causes largest amount of silt deposition of the order of 1667 mt/yr (ref. 1), although the exact amount is debatable. The large amount of sedimentation load and the resultant reduction in river cross-section have immediate impact on loss of soil due to erosion of the river banks and floods, resulting in loss of human lives and property each year on both sides of the Bhagirathi. Ever escalating amount of dredging is causing significant impediment to navigation in the Kolkata Port[1] and mounting increase in expenditure (Figure 1). This along with significant reduction in water supply is responsible for the deteoriorating soil and water quality, thus affecting agriculture and livelihood particularly in the tidally dominated parts of Bangladesh and, to some extent, the Indian Sundarbans[2]. Deteriorating hydrology of the rivers in both India and Bangladesh caused increasing occurrence of floods in both countries with time (Figure 2)[3].

In Bangladesh, the diversion of Ganga water appears to have reduced the dry-season discharge of Ganga and Gorai, the latter being one of the distributaries of the former that supplies water to the southwest region of the country. This reduction is reported to have increased sedimentation and salinity in the southwestern part of the country. A perusal of the data due to construction of the

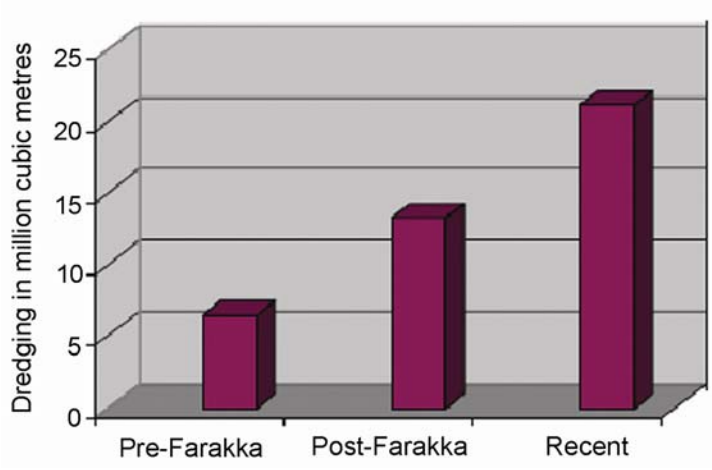

Figure 1. Increasing quantum of dredging in the Hugli–Bhagirathi river system in India (reproduced with permission from Rudra[1]). Pre-Farakka – till 1975; Post-Farakka – 1976–1994; Recent – 1999–2003.

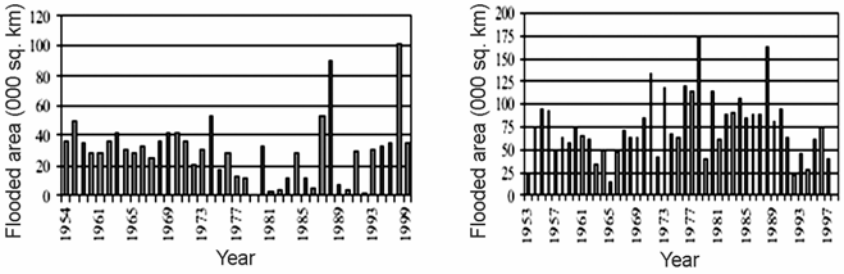

Figure 2. Nature of flood occurrence in India (left) and Bangladesh (right) showing increasing trend with time (reproduced with permission from Mirza *et al.*[3]).

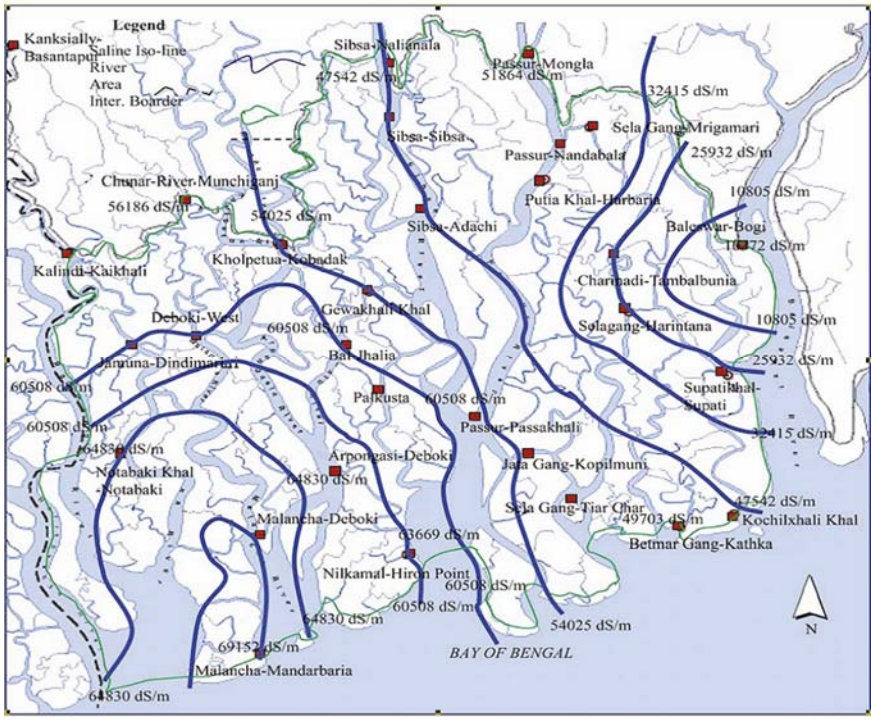

Figure 3. Water salinity isohalines in Bangladesh Sundarbans (reproduced with permission from Noor and Gnauck[4]).

Farakka barrage shows that the river water salinity in the Sundarbans region of Bangladesh is much higher in the southern and southwestern rivers, moderate in the middle, and lower in the northern part (Figure 3)[4]. No such detailed study on soil or water quality parameters was however undertaken in India. A holistic approach is required to ensure security to the inhabitants on either side of the Ganga[1].

Suggestions for the future

Appropriate interventions are needed to resuscitate the Ganga to arrest the adverse trend at the earliest and, in due course, reverse it for improved livelihood through (i) higher productivity in agriculture, aquaculture, forestry, etc. under favourable soil and water conditions, and (ii) reduced hazard due to flooding of low lands and erosion of river banks.

There is need for a study to regulate water flow through construction of structures and diversion of water at strategic points along the river systems upstream in order to ensure that minimal required water flows to and through the Farakka barrage. The role of India in this regard sharing entirely the upstream flow of water passing through a number of states before reaching the Farakka barrage is therefore imminent which, I believe, has been grossly overlooked in as far as its application was concerned till date. The National Ganga River Basin Authority under Government of India should conduct a detailed study and formulate a plan immediately for strict compliance for upstream regulation of water flow before it is too late. If necessary, empowerment through legal action may be sought. The shortcomings in the planning and execution of the much-hyped Ganga Action Plan should be carefully studied.

There are disturbing news of state governments drawing up massive plans for a number of hydel power projects and a number of NGOs even diverting water at will in this stretch of the river in order to meet their sectoral needs[5], thus overlooking the interest of the nation at large and, the ecological sustainability of both India and Bangladesh. Any action on future plans for improvement will be futile if the upstream regulation is not viewed seriously, not only to stop unplanned use of the river water forthwith, but also take positive measures to augment it as far as possible to its original state, no matter how efficient the design of the barrage and the downstream regulation of the water flow are. Finally, there is need for reworking on the water allocation between the two countries round the year based on minimum and assured flow input into the barrage. This can be accomplished with the cooperation of all the states and the Government of India, and realistic inputs received from all concerned with scope for periodical monitoring alongside vigilance to achieve success on a long-term basis.

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