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Event, Process and Pulse: Resituating Floods in Environmental Histories of South Asia

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ABSTRACT

The notion of the flood in South Asia is no longer solely characterised as the archetypal natural disaster. This perceptual shift, as this essay will point out, draws from a conceptual turn within the field of environmental histories of South Asia. In the course of exploring and debating ideas about environmental change, environmental historians have drastically reconsidered the role and impacts of flooding in South Asia through three distinct narrative frameworks: (i) extreme hydraulic events; (ii) geomorphological process; and (iii) biological pulses. Environmental history as a field has thus helped to flesh out and radically revise our understanding of flooding, which has changed from previously being seen as an ahistorical calamitous event to instead providing contexts for revealing complex relationships between geomorphological processes, biological pulses and livelihood strategies. The notion of the flood in South Asia, consequently, is now acknowledged as an ecological force that is mediated by social, cultural and political interventions rather than exclusively borne out as an effect of nature.

KEYWORDS

Floods, South Asia**,** biological pulse, geomorphological process, environmental change

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Ramachandra Guha's *The Unquiet Woods* is widely considered to be the work that self-consciously initiated the environmental history of South Asia as a

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disciplinary field.[1] While Guha explored how peasant resistance was aimed at defending traditional village forests from British colonial authorities and the Indian government following independence, a flood finds prominent mention for heralding a 'turning point in the ecological history of the [lower Himalayan hills] region'.[2]

> The unusually heavy monsoon of 1970 precipitated the most devastating flood in living memory. In the Alakhananda valley, water inundated 100 square kilometres of land, washed away 6 metal bridges and 10 kilometres of motor roads, 24 buses … 366 houses collapsed and 500 acres of standing paddy were destroyed. The loss of human and bovine life was considerable.[3]

For Guha, following the devastations of the flood of 1970, villagers, informed by their 'folk sense', saw strong links between soil erosion, the mass felling of trees and the intensity of monsoonal downpours. The villagers' realisation, Guha argued, proved crucial in setting off a chain of protest by them to save their local forests, and ultimately led to the founding of the Chipko Andolan 'tree hugging movement',[4] acknowledged as one of the most celebrated environmental movements in the Third World for its time.[5]

While the 1970 flood was undoubtedly an ecological inflection point in the Uttarakhand hills, the 'folk sense' that saw connections between deforestation, erosion and floods, however, bore an uncanny overlap with earlier 'alarmist discourses' that were propagated by several Indian foresters. The causal links between climate, forests and erosion, as Vasant Saberwal notes, was actually first debated by foresters, environmentalists, soil scientists and civil engineers in the United States in the early decades of the twentieth century.[6] At heart, the disagreements over the impact of deforestation on stream flow were shaped by

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1. Ramachandra Guha, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalayas* (Ranikhet: Permanent Black, 2010 [1989]). South Asia rather than the nation-state perhaps better captures the environmental scale of the subcontinent that was steadily brought under British colonial domination between 1756 and 1947. Following the period of decolonization from the late 1940s onwards, however, this vast territorial expanse of erstwhile British India now comprises the independent countries of Bangladesh, Nepal, Bhutan, India, Pakistan, Afghanistan and Sri Lanka.
2. Ibid., p. 156.
3. Ibid., p. 155.
4. Ibid., pp. 156–84.
5. For critiques of the 'romanticized' understanding of the Chipko Movement, see Haripriya Rangan, *Of Myths and Movements: Rewriting Chipko into Himalayan History* (London: Verso, 2000.); Emma Mawdsley, 'After Chipko: From environment to region in Uttaranchal', *Journal of Peasant Studies* **25**, 4 (1998): 36–54. For a recent rehabilitation of the Chipko legacy as a significant environmental imagination and intervention, see Shinya Ishizaka, 'Re-evaluating the Chipko (forest protection) movement in India', *South Asianist* **2**, 1 (2014): 9-27; Trent Brown, 'Chipko legacies: Sustaining an ecological ethic in the context of agrarian change', *Asian Studies Review* **38**, 4 (2014): 639–57.
6. Vasant Saberwal, *Pastoral Politics: Shepherds, Bureaucrats, and Conservation in the Western Himalaya* (New Delhi: Oxford University Press, 1999), pp. 113–41.

turf wars between the Army Corp of Engineers and American foresters. While engineers wanted dams and embankments to impound flood waters, foresters vigorously argued that forests could more ably soak up a heavy precipitation event. Over time, the 'exaggerations' of the American foresters, however, became difficult to support with quantitative and evidence-based scientific studies. On the other hand, during the same period, environmentalists in the United States increasingly began to argue that water run-off depended on complex interactions between soils, water, climate and vegetation. Consequently, no easy correlation existed between deforestation and floods in the lower plains.

In British India, however, much of the nuance and disagreement within the United States over the relationship between floods and forests seemed lost in translocation. Particularly from the 1920s onwards, Indian foresters selectively drew upon the American debate to argue that there was enough clinching evidence to prove that flood intensity could be checked by increasing forest cover. In great measure, these loud assertions for protecting forests by Indian foresters, Saberwal suggests, were actually intended to limit and overturn the powers of the colonial government's revenue departments, which were then actively campaigning to bring forests under their control as revenue-paying units.[7]

It is most likely, therefore, that Guha's understanding of the 1970 floods was not exclusively put together from folk sense. Rather, it is equally probable that the villagers of the Uttarakhand hills might have been influenced, partly if not wholly, by how Indian foresters debated the links between floods and deforestation. It bears mention here, nonetheless, that in both Guha's *Unquiet Woods* and Saberwal's *Pastoral Politics*, floods are overwhelmingly acknowledged as natural disasters. That is, floods are exclusively natural calamities – an extreme hydraulic event that inundates human settlements.[8]

In 1991, the New Delhi-based Centre for Science and Environment (CSE) – arguably one of Asia's most celebrated and pioneering environmental NGOs – published its third report in the State of the Environment in India series.[9] In this report, known as SOE3, CSE was exhaustive in collecting, collating and making sense of the reams of data on floods, flood damage, river behaviour and flood control measures that the Indian government had thus far accumulated from its many administrative and disaster management departments.

What strikingly emerged was that both flood-affected and flood-prone areas in India were on the rise, despite increased investment in flood protection measures. It was noted, for example, that the flood-affected area had jumped from

7. Ibid., pp. 124–39.

8. Floods as natural disaster events are similarly reproduced in Meena Bhargava, 'Changing river courses in North India: Calamities, bounties, strategies – sixteenth to early nineteenth centuries', *Medieval History Journal* **10**, 1/2 (2007): 183–208.

9. Centre for Science and Environment (CSE), 'Floods, flood plains and environmental myths: A citizen's report', State of India's Environment No. 3 (New Delhi: Centre for Science and Environment, 1991).

an annual average of 6.48 million hectares in the 1950s to over 9 million hectares in the 1970s and 1980s; and likewise, the flood-prone area had leapt from 25 million hectares during the 1960s to about 34 million hectares by 1978.[10] Having thus arrived at a puzzle via statistical reasoning, CSE systematically re-examined the various official and standard narratives, and concluded that two 'environmental myths' needed to be dismissed: first, that large dams and embankments could control floods; and second, that forests acted as sponges that could reduce the impacts of flooding. Floods, CSE argued, were 'not entirely a bad phenomenon': they brought 'ecological advantages', and seasonal fluvial bursts were integral to river behaviour.[11] Bluntly put, 'even when the Himalayan mountains were uninhabited and the forest cover was intact, major floods visited the valleys and disrupted human civilization'.[12]

CSE then put forward two major correctives to the standard narrative. First, afforestation in the Himalayas would only make a very minor difference to the flood situation in the sprawling plains. There was 'no evidence to believe that ecological solutions like afforestation will control floods any more than engineering solutions like dams and embankments have been able to'.[13] Landslides and volatile river behaviour in the higher reaches of river systems were thus only to be expected as facts of everyday life. Second, the continued construction of embankments, a range of obstructions and the steady encroachment of wetlands had blocked off and choked much of the natural drainage patterns of India, and this needed to be recognised as being one of the chief causes for aggravating flood impacts. In effect, the people of the Himalayan region were unfairly being held 'hostages' of the presumed ecological needs of the plains.[14] While CSE's report was not intended to be a contribution to the field of environmental history and was published much earlier than the works of Guha and Saberwal, it had nonetheless already laid the basis for questioning the assumption that floods could only be grasped and described as extreme hydraulic events.

UNSETTLING THE EVENT: FLOODING AS A EUROCENTRIC CONUNDRUM

Christopher V. Hill, in a striking essay on the rivers of Bengal in colonial India, was the first to draw compelling links between river behaviour, disastrous

10. Ibid., 5–6.
11. Ibid., 147.
12. Ibid., 153.
13. Ibid., 148.
14. For Bangladesh, there is a similar delinking of deforestation in the uplands and flood intensity in the lowlands (deltaic segment) in Thomas Hofer and Bruno Messerli, *Floods in Bangladesh: History, Dynamics and Rethinking the Role of the Himalayas* (Tokyo: United Nations University Press, 2006).

flooding and what he termed 'Eurocentric riparian legislation'.[15] Hill began by underlining how the familiarity of the officials of East India Company in the late eighteenth century with their own British rivers – steady rainfall and predictable channels – often hobbled their efforts to fully grasp the volatile energies of the monsoon-fed rivers in the Bengal region. In particular, they failed to make sense of how the copious rains of the summer months caused the rivers such as the Ganges and Brahmaputra and their various tributaries to repeatedly burst their banks and even dramatically change channels. These volatile rivers, as they began to hurtle from the Himalayan mountains and high hills, tore up and carried vast quantities of soil, silt, rocks and detritus, which were then sprayed across the plains and the deltas with devastating impact on the surrounding lands.[16]

For Hill, what really confounded and perplexed many of the company's officials was not merely the inherent dynamism of Bengal's rivers but the several contradictory ecological impacts created by fluvial behaviour. For one, when the currents were not too violent, the rivers could end up fertilising vast tracts of land with their silt deposits. Second, the rivers were capable of swallowing up huge chunks of land within a single season in the course of their meanderings and, equally, in a reverse action, could spit out and create altogether new islands or fresh lands.

This 'capriciousness of the river systems of Bengal', Hill points out, had a 'profound affect on land control'.[17] Colonial revenue officials met with much grief as they sought to transfer almost without qualification English legal practices into the Indian countryside. Notably, the defining piece of colonial legislation for controlling land, the Bengal Permanent Settlement Act of 1793, was based on exclusive ownership over land and a consistent revenue demand. The Permanent Settlement, in fact, as Hill argues, soon began to fall apart during efforts to implement it on the ground: 'How could a government, determined to instil the sanctity of private property, legislate a land revenue settlement in an area that yearly changed in size, shape, fertility, and even location, on a revenue payment which was to "remain unaltered forever"?'.[18]

Hill goes on to insightfully discuss the many troubled attempts of the colonial authorities to stabilise their revenue collection system by instituting various pieces of legislation, such as the Bengal Alluvion and Diluvion Regulation (BADA) of 1825 and the BADA Act 9 of 1847. At heart, these attempts were aimed at putting in place a standardised protocol for carrying out regular surveys, inspections and ground-level negotiations that could then administratively make legible the sudden emergence or disappearance

15. Christopher V. Hill, 'Water and power: Riparian legislation and agrarian control in colonial Bengal', *Environmental History Review* **14**, 4 (1990): 1–20.
16. Ibid., 2–3.
17. Ibid., 7.
18. Ibid., 8.

of accretions, lands and islands (*diaras* and *chars*). These legal adjustments, however, Hill notes, ended up only further empowering colonial landlords (zamindars), enabling them to rapaciously rack rent their tenants and hide the full extent of their actual holdings. In time, the colonial authorities simply found it both convenient and expedient to entirely abandon any pretence of settling the *diara* lands with tenancy acts or rights and accepted a full retreat of sorts by preferring a light administrative or 'limited raj' presence in such territories.[19]

For Hill, the entire British colonial project of settling the riverine plains and deltas of Bengal using Eurocentric notions of property and revenue collection strategies thus came to grief because of the flood regime. What Hill is particularly keen in noting is that floods were not solely natural disaster events. Rather, the volatile rivers, he points out, were capable of potentially realising a range of possibilities: devastation, disruption, creating fresh lands, fertilising land through silt deposition and swallowing up vast chunks of land in a single season. For Hill, the deltaic flood in British India was consequently not a singular event that dislocated social and economic arrangements but was instead a complex ecological phenomena with diverse implications for both nature and society.

Hill further developed his analysis in a subsequent work, examining colonial efforts to anchor their rule in the *diara* belt of Purnia district of Bihar in eastern India, through which flowed the intensely temperamental and volatile Kosi river.[20] Hill retained much of his previous argument that the British colonial authorities pursued a 'policy of intentional neglect'.[21] That is, in the ecologically dynamic riverine zones the colonial administration mostly yielded control to local landlords, who not only rack rented their tenants but proved skilful in dodging revenue demands and concealing the actual size of their holdings.

GEOMORPHOLOGICAL PROCESS AND FLOOD CONTROL

In contrast to Hill's claims about the environmental origins of the 'limited raj' in the Kosi region, I have elsewhere argued the reverse: British colonial authorities energetically strove to prevent the flooding of the Mahanadi river system in Orissa, eastern India, with infrastructures such as embankments, canals and even a large dam.[22]

19. Ibid., 14–16.
20. Christopher V. Hill, *River of Sorrow: Environment and Social Control in Riparian North India, 1770–1994* (Ann Arbor, MI: Association for Asian Studies, 1997).
21. Ibid., p. 161.
22. Rohan D'Souza, *Drowned and Dammed: Colonial Capitalism and Flood Control in Eastern India* (New Delhi: Oxford University Press, 2006).

This singular quest to suppress, if not eliminate, 'seasonal inundations' within the dynamic hydraulic environs of the Orissa delta did not emerge, I suggest, solely from the colonial imperative for maximising tax receipts. Consolidating British rule in Orissa, especially in the initial decades of the nineteenth century, was critically premised upon replacing pre-colonial social and political arrangements with a distinctly colonial political economy. More precisely, colonial rule sought to create the loyal 'improving landlord' through the creation of bourgeois landed property owners with the passing of the Bengal Permanent Settlement Act of 1793. Settling land through exclusive legal ownership, however, also set the context for the British response to the deltaic environment; flood impacts were overwhelmingly documented either as a loss to private property or as severe disruptions to revenue collection. The bourgeois notion of land thus turned the colonial administrators towards viewing the seasonal inundations as 'natural calamitous events'.

In thus treating all river inundations as wholly natural disaster events, colonial administrators failed to grasp the ecological significance of deltaic flooding. In particular, they missed the fact that inundations – when not raging as powerful currents – usually deposited fertilising silt, which increased crop yields. In addition to which, it was also becoming apparent to many keen colonial observers that floods, as they unburdened their charge of rock, soil and silt, were steadily raising the flood plains above the main channels of the rivers and thereby also building up the entire delta. River flooding consequently behaved more as a process rather than as a one-off extreme disaster event.

Thus floods should be reconceptualised as a geomorphological process – the net transfer of muddy material from the hills and hinterlands to the cavernous mouth of the delta, a process that cultivators in pre-colonial times tapped for silt to fertilise their crops and create an agrarian world that was flood dependent. Colonial flood control measures, on the other hand, amounted to interrupting these recurring waves of erosion and deposition, and forced an unprecedented social ecological rupture in the delta – from previously being a flood-dependent agrarian regime to becoming instead a flood-vulnerable landscape. Deltaic flooding and efforts at controlling it were thus not a neutral backdrop or a mere disruption to the rough and tumble of colonial rule in Orissa.[23] Rather, flooding and flood control measures such as embankments, canals and a large dam by the late 1940s were intricately wrapped within colonial efforts to sustain bourgeois private property in land.[24]

By viewing flood control essentially as a top down imposition by colonial administrators and engineers, in my earlier work I failed to capture the complex negotiations over floods and their varied impacts that played out at the local level. Praveen Singh's detailed explorations of flood control at the 'ground level' in north Bihar in fact advances this much needed corrective to

23. Ibid., pp. 20–96.
24. Ibid., pp. 215–25.

my own over emphasis on the exclusive and specialised worlds of technical experts and revenue administrators.[25]

According to Singh, the flood plains that made up colonial north Bihar – stretching between the districts of Saran and Purnea – were traversed by numerous streams, rivulets and muscular rivers, which gave the vast plains the morphological character of an 'inland delta'.[26] Originating in the mountainous Himalayas, these rivers crisscrossed the bowl-shaped plains before emptying their waters into the main arm of the Ganges, and when filled up with precipitation in the monsoon months they exploded into raging torrents and threw up several temporary land forms called *diara* or *char*. The reverse process was also possible, with cultivated land swiftly swallowed up by river action.

Unsurprisingly, given the rapidity with which land could appear or disappear in the *diara* zones, intense and bitter conflicts were almost inevitable between cultivators, tenants, zamindars (colonial landlords) and revenue collectors. Much of the violence and litigation was further aggravated, as Singh explains, by the haphazard construction of flood control embankments. While it was widely believed that such structures would protect cultivated land from the full force of recurring floods, in time it became apparent that such protection was only being achieved by the transfer of flood currents onto unprotected land and destroying the crops grown there. Several ecological complications also resulted, such as waterlogging from the interruption of drainage lines by embankments, as well as endless court battles over whether it was the obligation of the zamindar or the colonial state to pay for flood protection.[27]

For Singh, the construction, location and proliferation of embankments was essentially driven by local politics and zamindari initiatives rather than determined by top-down technical interventions. Flood control infrastructure in the *diara* tracts was thus spurred onwards essentially by 'vested interests' and alliances forged by zamindars, local civil and revenue officials and irrigation engineers.[28] Put differently, the 'environmental context in the locality … became a delicate arrangement … between various social, technical, administrative and economic forces'.[29] In effect, for Singh, flood control became a means for enhancing the power of local elites, and it marginalised the weak by

25. See Praveen Singh, 'Colonising the rivers: Colonial technology, irrigation and flood control in North Bihar, 1850–1950' (PhD diss., Centre for Historical Studies, Jawaharlal Nehru University, New Delhi, 2003); Praveen Singh, 'The colonial state, zamindars and the politics of flood control in north Bihar (1850–1945)', *Indian Economic and Social History Review* **45**, 2 (2008): 239–59; Praveen Singh, 'Flood control for north Bihar: An environmental history from the "ground-level" (1850–1954)', in Deepak Kumar, Vinita Damodaran and Rohan D' Souza (eds), *The British Empire and the Natural World: Environmental Encounters in South Asia* (New Delhi: Oxford University Press, 2011), pp. 160–80.

26. Singh, 'Colonising the rivers', 14–56.

27. Singh, 'The colonial state', 239–49.

28. Ibid., 252.

29. Singh 'Flood control', 161.

degrading their unprotected environments. By treating river flooding as a geomorphological process, Singh and myself could argue that the project of flood control in eastern India was ideologically driven and intended to create and defend bourgeois landed property. Flooding as a process, hence, helped reveal colonial imperatives for transforming environments, the play of infrastructure as power at local levels and how dominating rivers became crucial to anchoring the British presence in eastern India.

This perspectival turn to geomorphological process soon spurred two particular themes in environmental histories of South Asia: the impacts of the flood regime of the Brahmaputra river in the making of a colonial agrarian and social world; and debates over the role of hydraulic volatility in constraining colonial revenue strategies in the deltaic regions of Assam and East Bengal.

FLOODING AND THE MAKING OF COLONIAL SOCIETY IN ASSAM

The Brahmaputra river, which drops precipitously from the eastern flanks of the Himalayas and hurtles down the narrow flood plains of the state of Assam, is today substantially embanked on either side of its many braided channels. The Brahmaputra, nonetheless, still remains the source of some of the most vicious and devastating flooding in the valley, with heavy losses brought about almost annually to life and property.

Ritupan Goswami, arguably, made the first attempt to discuss the flooding of the Brahmaputra as a concern for environmental history.[30] Goswami stated that his aim was to 'historically examine the metamorphosis of this benevolent river' from a time when it made 'cultivation possible by fertilising the land with silt' to its current status as a 'problem' river.[31] Goswami, in other words, intended to underscore that the flooding of the Brahmaputra river was not simply a natural event but a hydraulic feature that was historically mediated by a range of political and social interventions.

According to Goswami, three distinct ecological zones lay on either side of the Brahmaputra. The first zone, extending for a few kilometres away from the riverbank, is referred to as the *char* or *chapori* – made up mostly of the fluctuating flood plain in which annual floods often threw up islands or swallowed up large chunks of existing land. Riverine communities such as the Mishing, Kaivarta and Nadiyal mostly inhabited these marshy and temporary *char*s and *chapori*s till late into the nineteenth century. These socially marginal groups in the main subsisted by employing a type of risky cultivation (*pam*) of rice

30. See Ritupan Goswami, 'Rivers and history: Brahmaputra valley in the last two centuries' (Ph.D. diss., Centre for Historical Studies, Jawaharlal Nehru University, New Delhi, 2010).

31. Ritupan Goswami, 'Floods and fields in the Brahmaputra valley: Twentieth century changes in historical perspective', in Sumi Krishna (ed.), *Agriculture and a Changing Environment in Northeastern India* (London: Routledge, 2012), pp. 27–52.

(*Oryza sativa*) and cash crops such as mustard (*Brassica nigra*) and pulses (*Lens culinaris*). The second zone, or *rupit* lands – beginning from where the *chapori* or *char* ended – were relatively immune to flooding and were cultivated by dominant and powerful castes, who grew the famed transplanted rice of the valley. And the third ecological zone that comprised the tracts that hugged the foothills, Goswami suggests, were predominantly populated by indigenous tribal communities.

Interestingly enough, Goswami points out that during much of the colonial period the annual floods were more or less viewed both by the local communities and government officials in a positive light and considered helpful for rice cultivation as the annual flexing of the river caused the deposition of fertilising silt in the Brahmaputra valley. The riverine communities, in fact, were well attuned to handling these recurring inundations by devising innovative cropping strategies and remaining mobile enough to temporarily abandon their holdings and return to the chars when the flood waters retreated. By the last quarter of the nineteenth century, however, the understanding of colonial officials began to dramatically change and they began to urge people to reclaim the uncultivated 'wastelands' within the riverine tracts of the Brahmaputra valley.

From 1910 onwards, however, colonial officials began aggressively encouraging peasants (also victims of high rents and land exhaustion) to move from their villages in East Bengal (mostly Mymensingh) and settle within the riverine tracts 'on the north and south banks and the chars and chaporis from the westernmost district of Goalpara through Darrang, Kamrup and Nowgong to parts of Lakhimpur'.[32] By the second decade of the twentieth century, Goswami informs us, the government even decided to systematise and direct the settlement of these immigrants through a 'colonisation scheme'. Since the new immigrants originated from the flood-prone deltaic tracts of Bengal, colonial officials confidently presumed that these inundation-hardened peasants would be quick to adapt to the seasonal flooding. The annual ferocity of the Brahmaputra, however, proved to be so full of surprises that the immigrants were soon found to have lost their crops and their land was regularly covered in sand from violent floods. Soon enough, the British administration found themselves on a treadmill of sorts in having to repeatedly shuffle the flood-affected communities to more stable and relatively flood-immune tracts.

By the 1940s, a clear and discernible shift in the official view towards the annual flood regime of the Brahmaputra became visible. Henceforth, flood imagery, Goswami observes, tended to be evoked in alarmist and adversarial notions such as 'disaster, destruction, problem' and, inevitably, a 'curse' of nature. This stark perceptual transition, Goswami is keen to underline, was not a result of a natural shift in the Brahmaputra's behaviour but borne more profoundly by a change in the 'production relations within society'.[33]

32. Ibid., 35.
33. Ibid., 48.

In an article on the origins of flood protection and control in Assam, Arup Jyoti Saikia chose to interpret the immigration story differently.[34] For Saikia, the 'arrival of millions of small-holding peasants' from East Bengal in the flood plains of the Brahmaputra were driven in large measure by colonial efforts to commercialise and increase the production of jute (*Corchorus olitorius* and *Corchorus capsularis*). Jute, Saikia explains, especially from the last quarter of the nineteenth century onwards, became critical to the global packaging industry and fast became one of the highest export earners for the government of British India. This 'golden fibre', it was repeatedly noted, was ideal in regions of high flooding as it was able to grow as tall as 3.65 metres.[35]

But the reclamation of the riverine tracts for growing jute also increased the vulnerability of the flood plains to sudden and intense inundation. These inundations were further aggravated by the continuing effects of the earthquake of 1897 in the Brahmaputra valley, which had caused the bed of the river to rise and sharply altered the movement of silt and sand. In 1929, Saikia tells us, an unusually destructive flood ravaged the valley and finally brought home to the colonial authorities the fact that much of the commercialised jute crop was dangerously situated in the low-lying flood-prone zones. By the early 1940s, jute production, nonetheless, reached an 'all-time high', and Assam soon became the third largest jute producing region in British India.[36] By the late 1950s, Saikia argues, the mix of immigration, jute production and crop losses from recurring floods inevitably compelled the government of newly independent India to begin heeding the advice of several river technocrats, who were by now loudly arguing for erecting flood control embankments to prevent flood overspill and thus protect agricultural cultivation and human lives.[37]

While Saikia argued that comprehensive flood control in colonial Assam was driven by British efforts to create the 'empire's eastern-most jute frontier', he kept in step with the earlier claims of D'Souza, Singh and Goswami that the deltaic tracts of eastern India prior to colonial rule were overwhelmingly harnessed for flood-dependent agriculture. In the plains of the Brahmaputra, Saikia reiterates, pre-colonial cultivators viewed the annual floods as having 'dynamically united the river, its islands, and floodplains', bringing nutrients and fertilising soils, flushing out stagnant water, supporting fisheries and destroying mosquito breeding grounds.[38]

The dominant narrative that emerges from environmental histories of the flooding of the Brahmaputra river, the various interfluves of the Ganges and the Mahanadi system, is that British colonial interventions ended up arresting

34. Arup Jyoti Saikia, 'Jute in the Brahmaputra valley: The making of flood control in twentieth-century Assam', *Modern Asian Studies* **49**, 5 (2015): 1405–41.
35. Ibid., 1410–11.
36. Ibid., 1420.
37. Ibid., 1430.
38. Ibid., 1413–17.

a geomorphological process by introducing landed property and the intensive commercialisation of crops. The colonial agrarian world, in other words, according to the authors discussed above, could only be created and sustained by flood control infrastructure and by agricultural production that remained vulnerable to flooding rather than being dependent on it.

In his study of the Bengal Delta, however, Ifteqar Iqbal has argued that British flood control measures were not overwhelmingly carried out nor so widespread across the deltaic tracts.[39] The Bengal Permanent Settlement Act, in fact, could not be effectively implemented in a good part of Eastern Bengal (much of which lies today in Bangladesh). For Iqbal, the sheer ferocity of the Ganges river system, especially in the *sundarbans* (mangroves) forced the British to entirely retreat from reproducing their signature agrarian order. Instead of attempting to institute private property in the volatile delta, colonial authorities instead actively sought to encourage 'occupancy *raiyats*' (independent peasants) to cultivate rice and jute in the marshy and estuarine zones.[40] Despite this more or less hands-off approach, the hydraulic integrity of the river systems in the Eastern Bengal delta was nonetheless disrupted with the introduction of the railways and the construction of the required supportive infrastructure in the region. Notably, with the crisscrossing of river channels by ill planned railway tracks and by numerous poorly designed embankments, culverts and bridges, the delta's intricate natural drainage patterns were invariably interrupted. And amidst the steady clogging of the fluvial circulation regime, water hyacinth (*Eichhornia* spp., originally from South America) began to proliferate and fatally ended up deoxygenating and fouling the wetlands and a vast number of other connected water bodies.[41]

But were British revenue calculations in Eastern Bengal truly thwarted and disoriented by the rivers? Put differently, can colonial rule minus the Bengal Permanent Settlement Act be reduced to a version of the 'limited Raj' in deltaic eastern India ? Not so, argues Nitin Sinha, who specifically takes issue with Iqbal's claims.[42] Upon a careful and detailed review of British revenue collection strategies in the middle Gangetic *diaras* of Bihar from the late eighteenth and early nineteenth century, Sinha concludes the opposite: the colonial government, in fact, deliberately chose to opt out of implementing its property based 'standardising' revenue practices in the volatile riverine regions. This striking decision, Sinha suggests, was mainly brought about by the fact that colonial officials found speculative farming exceedingly profitable in the middle Gangetic *diaras* as they were often able to force cultivators to accept

39. Iftekhar Iqbal, *The Bengal Delta: Ecology, State and Social Change, 1840–1943* (New York: Palgrave Macmillan, 2010).
40. Ibid., pp. 18–66.
41. Ibid., pp. 117–60.
42. Nitin Sinha, 'Fluvial landscapes and the state: Property and the Gangetic *diaras* in colonial India, 1790s–1890s', *Environment and History* **20** (2014): 209–37.

short-term leases and thereby allowed the administration to seasonally reassess the revenue paying cultivable areas. In sum, Sinha surmised that in the middle Gangetic region the colonial government, rather than being defeated or dissuaded by the ferocity of raging rivers, ended up instead harnessing the volatile ecology to good effect by further refining their speculative capacities and even managing to craft a special bureaucratic agility to adapt, adjust and enhance revenue collection. In effect, deltaic flooding did not halt the colonial project in the fluvial tracts, as Iqbal claimed. Rather, river volatility, for Sinha, helped spur a range of colonial administrative innovations and bureaucratic abilities for maximising their revenue agendas.

An outline of the studies presented above reveals flooding to be a geomorphological process rather than a singular disaster event, and helps us explore and situate colonial flood control measures within larger political and economic concerns by weaving together themes such as private property, drives to extend the commodity frontier, the ecological limits for maximising revenue collection and the troubled efforts to consolidate bourgeois landlordism.

PULSES OF MUSCLE AND FIN

As early as the 1980s – when environmental historians of South Asia were yet to evolve their ideas about river flooding as a geomorphological process – river ecologists the world over were already actively debating the notion of the 'flood pulse', arguing that flood intensity and flow variability, especially within large tropical river systems, were critical to forging a vast number of complex ecological interactions between floodplains, wetlands, swamps and estuarine zones. Seasonal floods or pulsing regimes in particular, it was pointed out, were crucial to connecting fluvial ecosystems and maintaining intricate biological webs. Rivers, in other words, were more than raging geological agents that sculpted landscapes through erosion and deposition.[43] And at the heart of such efforts to reconceptualise rivers as a biological pulse lay the significance of fish population dynamics and the fluvial contexts for sustaining aquatic diversity.

As pointed out earlier, British colonial efforts in deltaic eastern India through the course of the long nineteenth century were predominantly aimed at trying to harness the Gangetic river system as an economic resource – either

43. Wolfgang Junk, Peter B. Bayley and R.E. Sparks, 'The flood pulse concept in river-floodplain systems', in D.P. Dodge (ed.), *Proceedings of the International Large River Symposium* (Ottawa: Canadian Special Publications in Fisheries and Aquatic Sciences, 1989), pp. 110–27; J.R. Sedell, J.E. Ridley and F.J. Swanson, 'The river continuum concept: a basis for the expected ecosystem behaviour of very large rivers?', in Dodge, *Proceedings*, 49–55; K. Tockner, F. Malard and J.V. Ward, 'An extension of the flood pulse concept', *Hydrological Processes* **14** (2000): 2861–83; see also Brij Gopal, *Environmental Flows: An Introduction for Water Resources Managers* (New Delhi: National Institute of Ecology, 2013).

for navigation or for perennial irrigation.[44] Seasonal flooding, in this narrow economistic and technical perspective, consequently appeared essentially as a natural disaster event. Unsurprisingly, therefore, colonial authorities also remained woefully blinkered about the complex ecological webs between fish, flooding and their linkages with what Deb and Haque aptly describe as the social domain of 'fishantry' – marginal artisanal/small-scale fishers, who in contrast to the land-based peasantry critically depended upon variability in the river's flow.[45]

Gunnel Cederlof notes that early East India Company officials in eastern India, despite their otherwise careful and detailed documentation of social and economic realities on the ground, nonetheless overwhelmingly failed to acknowledge the dietary connection between river fish (protein) and rice cultivation (carbohydrates). Fishing even remained largely untaxed, and when a duty was finally imposed by the colonial authorities it was limited to the fish that was exported. Cederlof observes that,

> As one officer complained, when the land was under water people simply entered the fields and caught the fish. No revenue could be got from such activities. Thus, the daily fishing that sustained people never entered the revenue files.[46]

Even as fish were erased in the colonial revenue records, the reality of rivers as a biological force began to unsettle engineering narratives that pressed for dams, weirs and diversion structures such as *anicut*s (temporary bunds or embankments). Sometime in August 1867, the then secretary of state for India sent a despatch to the Madras Government calling attention to an uncharacteristic communication from the much celebrated colonial irrigation engineer, Sir Arthur Cotton (1803–1899).[47] The despatch flagged Cotton's fears about

44. See Elizabeth Whitcombe, *Agrarian Conditions in Northern India, Vol. 1: The United Provinces under British Rule (1800–1900)* (Berkeley: University of California Press, 1972; Ian Stone, *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Economy* (Cambridge: Cambridge University Press, 1985); Imran Ali, *The Punjab under Imperialism, 1885–1947* (Princeton: Princeton University Press, 1988); David Gilmartin, 'Scientific empire and imperial science: Colonialism and irrigation technology in the Indus basin', *Journal of Asian Studies* **53**, 4 (1994): 1127–49; David Gilmartin, *Blood and Water: The Indus River Basin in Modern History* (Berkeley: University of California Press, 2015); Rohan D'Souza, 'Water in British India: The making of a colonial hydrology', *History Compass* **4**, 4 (2006): 621–8; Daniel Klingensmith, *'One Valley and a Thousand': Dams, Nationalism and Development* (New Delhi: Oxford University Press, 2007); Daniel Haines, *Building the Empire, Building the Nation: Development, Legitimacy, and Hydro-Politics in Sind, 1919–1969* (Karachi: Oxford University Press, 2013).

45. A. Krishna Deb and C.E. Haque, '"Beyond the lens of peasantry": Theoretical basis of "fishantry" as a distinct social domain (part 1)', *International Journal of Social Science Research* **2**, 1 (2014): 77–101.

46. Gunnel Cederlof, *Founding an Empire on India's North Eastern Frontiers* (*1790–1840): Climate, Commerce, Polity* (New Delhi : Oxford University Press, 2014), p. 21.

47. Lady Hope, *General Sir Arthur Cotton: His Life and Work* (New Delhi: Asian Educational Services, 2005 [1900]), pp. 77–88.

the probable 'injury to the coast[al] fisheries' from the irrigation works that he had constructed on the Kaveri (1834–1836), the Godavari (1844–1846) and Krishna (1852–1857) rivers. On 27 March 1868, Surgeon-Major Francis Day (1829–1889), then inspector general of fisheries, was tasked to examine the impact of these *anicut*s or weirs on fisheries in the Madras Presidency, Orissa and Lower Bengal, British Burma, and at the end of 1869 the brief was even extended to the distant Andaman islands.[48]

Day's report, submitted to the Madras Government in 1873, made for arresting reading. While carefully detailing, just as Cotton had feared, how weirs, under-sluices and dams were indeed hindering fish migration and destroying several fish runs along the eastern coast, his conclusions, more significantly, challenged the reigning civil engineering orthodoxy about rivers.[49] Unlike the quest to classify rivers according to their irrigation potential, for Day flows needed to be recategorised according to what they offered for sustaining fish populations, breeding aquatic diversity and maintaining fish habitats. Reconceptualised thus, three types of rivers in British India and neighbouring Burma were described and assessed:

a) Emerging from hills with 'Alpine sources' – that is, snow-fed streams. These rivers which descend from the Himalayas with 'spasmodic' and torrential flows required their fish species to be equipped with adhesive suckers.

b) Emerging from hills but monsoon fed such as the Krishna, Godavari and rivers flowing from the Western Ghats and the Nilgiri ranges. These rivers with their relatively warmer waters and with flows subject to sudden rise and falls during the rains enabled a variety of fish to ascend and descend the hills for spawning.

c) The third comprised the huge river systems such as the Indus, Ganges, Brahmaputra and the Irrawaddy that coursed across the vast flood plains and were made of up of 'impetuous' currents during the monsoons that allowed fishing only at the 'edges'.[50]

Day's three types of rivers explained how the peculiarity of a flow regime could affect fish-breeding habits and shape their migratory patterns.[51] But at the heart of this new understanding about the meaning of river flows was the effort to emphasise how the monsoons were critical to energising a range of links between fish migration and breeding, and how fish movements to spawn and complete migratory journeys defined several ecological and fluvial rhythms for

48. Francis Day, 'Report on the fresh water fish and fisheries of India and Burma' (Calcutta: Office of the Superintendent of Government Printing, 1873), p. 1.

49. Ibid., 7–13.

50. Ibid., 5–6.

51. Ibid., 4–6.

the entire subcontinent.[52] From this perspective, floods played the role of a type of biological pulse in which a broth of soil, silt, vegetation, sediment, muscle, fin, ova and fish was flushed into innumerable channels, drainage lines, depressions, rice fields, tanks and capacious rivers systems. In a further enquiry in 1906 by K.G. Gupta, member of the Board of Revenue, Francis Day's notion of eastern India turning into a fish hatchery during the monsoons was further supplemented with an equally vivid description:

> During the rains, i.e. from July to September, a great part of the country [Bihar and Bengal], is under water, and may not be inappropriately regarded as one vast inland fishery, even the ricefields attracting swarms of fry and small fish. By a wise provision of Nature this is also the period when most of the fresh water species spawn.[53]

Several studies and enquiries followed in the early decades of the twentieth century as perspectives on fisheries and floods increasingly collided against a civil engineering narrative concerned with the need for perennial irrigation. T. Southwell, deputy director of fisheries for Bengal, Bihar and Orissa, for example, acknowledged even more forcefully in a report in 1915 that intricate and delicate linkages existed between the monsoons, fisheries and livelihoods:

> These fish occur in the rivers and their fry are extensively cultivated in tanks. They breed prolifically in the rivers during the rains, but they never breed in the tanks … We have noted that these fish breed during the rains. At that time the Province [Bihar and Bengal] may be said to be flooded. Consequently [a] tremendous number of [fish] eggs and young fish – probably the greater part of the total spawn in the rivers – escape into the paddy-fields … They are extensively caught by the poorer ryots [peasants] from the Nalas [drains], paddy fields and tanks.[54]

Clearly, the dynamic ecological web between the monsoons, rivers, wetlands, fish migratory routes, aquatic habitats and spawning grounds meant that much of eastern deltaic India was made up of soil and water admixtures rather than neatly separable into distinct domains of land and river flow.

But are rivers when grasped principally as a biological force impossible to harness for irrigation? Put differently, could a flood-dependent irrigation overcome the ecological challenges posed by the colonial bias for perennial irrigation, which required standardised and controlled flows?

The first considered and systematic reflections by a British engineer on 'inundation irrigation' in the Indian subcontinent was put forward by William Willcocks (1852–1932). Born in India and having survived the 'Indian Mutiny' of 1857, Willcocks worked his way up the Indian Irrigation Service

52. Ibid., 5–7.

53. K.G. Gupta, 'Results of enquiry into the fisheries of Bengal and into fishery matters' (Calcutta: Bengal Secretariat Book Depot, 1908), p. 5.

54. T. Southwell, 'Report on fishery investigations in Bengal and Bihar and Orissa with recommendations for future work' (Calcutta: Bengal Secretariat Book Depot, 1915), pp. 8–9.

and acquired a sizable reputation for his services in Egypt and Mesopotamia (modern-day Iraq).[55] In the twilight years of his career, however, in early March of 1930 he delivered four strikingly provocative lectures at Calcutta University. Despite a lifetime spent in espousing the ideals and virtues of modern or perennial canal irrigation, in these lectures Willcocks stoutly argued the opposite. In a drastic reassessment, he now claimed that a large network of 'overflow canals' had previously traversed the deltas of the Ganges and Damodar basins and irrigated almost 7 million acres of land. These overflow canals, furthermore, comprised a vast complex and vibrant network for enabling an inundation-based or flood-based irrigation strategy, which following British rule had been physically erased from the province of Bengal.

These broad and shallow inundation canals were specifically designed to tap the silt-laden crest waters of the flooding rivers. Willcocks also noted that for the cultivators, the 'rich red water of the river and the poor white water of the rainfall' needed to be combined for growing crops. Inundation irrigation, thus, meant that water had to be augmented with the fertilising properties of silt for agriculture to be kept sustainable in the delta:

> if your rice fields have been irrigated by rain water alone, they are weak and cry for irrigation in October with excessive and costly supplies of poor river water … If however you have irrigated your rice fields with rain and river water mixed together in the early months of the monsoon when the river water is rich and full of mud, you so strengthen the plants of rice that they resist the hard condition of an early failure of the monsoon in a way rice irrigated by rain water alone has no knowledge of. River water in the early months of the floods is gold.[56]

In these muddy waters, moreover, bobbed a multitude of fish eggs, which floated and drifted into an intricate fluvial mesh made up of subsidiary channels, drainage lines, tanks, depressions and rice fields. These eggs soon hatched into young fish and then voraciously fell upon and 'lived on' mosquito larvae, and thereby eliminated or diminished much of the potential malarial fevers in an otherwise moisture-saturated and waterlogged terrain. Overflow irrigation, moreover, helped the delta steadily build up by widely diffusing silt and depositing sediment across the alluvial fans. In sum, for Willcocks inundation irrigation was, in essence, an ecologically regenerative practice as it mimicked or extended rather than worked against the geomorphological and biological momentum that was brought on by variable flood pulses. Inundation irrigation

55. For Willcocks's experiences in Egypt, especially his bitter fight with Sir Murdoch Macdonald over records of the flow of the River Nile, see Herbert Addison, *Sun and Shadow at Aswan* (London: Chapman and Hall, 1959), pp. 69–78. For an autobiographical sketch, see William Willcocks, *Sixty Years in the East* (Edinburgh: W. Blackwood, 1935). See also Canay Ozden, 'The pontifex minimus: William Willcocks and engineering British colonialism', *Annals of Science* **71**, 2 (2014): 183– 205.

56. William Willcocks, *Ancient System of Irrigation in Bengal and Its Application to Modern Problems* (Delhi: B.R. Publications, 1984 [1930]), p. 32.

as an amplification of a deltaic flooding rhythm thus fertilised the rice fields, nourished the soils with fresh deposits of sediment and enabled vast fish populations to crisscross the fluvial breadth of the delta.

While Willcocks undoubtedly sought to radically revise the meaning and relationships between floods and irrigation in the Bengal delta in his lectures, his provocative formulations nonetheless largely retained the usual distinctions between soils and flows. That is, Willcocks held the view that deltaic flooding was overwhelmingly a fluvial phenomenon driven exclusively by the action of deltaic rivers. This familiar separation between land and water or soils and flows, however, has been recently compellingly unsettled by the geographer Kuntala Lahiri-Dutt and the environmental historian Gopa Samanta, who have explored the ecological and social worlds of the people inhabiting the *char* regions in the Ganges delta.[57] For Lahiri-Dutt and Samanta, the *chars* cannot be summed up as being an admixture of land and water. Rather, these ambiguous, uncertain and tentative ecological forms need to be grasped as 'hybrid environments' that 'destabilise' the simple land/water dichotomy and open up the possibility for understanding them as 'lived-in' landscapes that have been shaped by the cultures and material practices of the people inhabiting them.

> As pieces of accumulated sand and silt, floating on and rising above the water of the riverbeds, they [*chars*] are literally embedded in water, enmeshed into the riverine environments … [A] divide between land and water as two different elements belonging purely within the physical domain [has] robbed the chars of their histories, extracted them from their social contexts of human experience, and essentialized them.[58]

For Lahiri-Dutt and Samanta, the *char* dwellers, in fact, through a creative mix of 'risky' livelihood strategies such a subsistence agriculture, wage labour, livestock rearing, fishing, informal trading and mobility, have been able to craft possibilities for place-making in hybrid environments.[59]

Environmental histories that can conceptualise floods as biological pulses can consequently help us grasp how biological webs, livelihood strategies and a range of human material practices have done as much as they have been able to harness volatile deltaic environments.

CONCLUDING REMARKS

In this review essay I have discussed how three major frameworks have debated the notion of floods within environmental history writings on South Asia.

57. K. Kuntala Lahiri-Dutt and Gopa Samanta, *Dancing with the River: People and Life on the Chars of South Asia* (New Haven, CT: Yale University Press, 2013).
58. Ibid., pp. 7–8.
59. Ibid., pp. 135–207. See also Imtiaz Ahmed, *People of Many Rivers: Tales from the Riverbanks* (Dhaka: Dhaka University Press, 2015).

The initial understanding that floods were entirely a natural disaster event and therefore outside the pale of historical and sociological analysis has been substantially challenged. From the late 1990s onwards, studies have begun to explore how flooding proved critical to the shaping of several political, economic and social outcomes. In particular, these studies have been able to convincingly argue that British colonial efforts, such as instituting the Bengal Permanent Settlement Act of 1793 in eastern India, came unstuck not only because of the internal legal contradictions within the act but essentially because the act failed to contend with the ecological dynamism brought about by deltaic flooding. At heart, I argue that in such writings, floods were no longer viewed as natural disaster events. Rather, these studies or revisionist environmental histories have been able to develop the notion of the deltaic flood as a geomorphological process in which annual inundations were part of a larger process for building up the delta, and which therefore became critical to land formation in the region. Viewed as a geomorphological process, floods could no longer be simply treated as an ahistorical noisy environmental backdrop to the real drama of political economy but rather as a fluvial process that was central to how power and politics played out.

The third and final framework in which floods have been conceptualised as biological pulses helps us particularly open up for exploration fisheries, fish migration patterns, inundation irrigation and livelihood strategies, and the risky cultures of the people who inhabit the *diaras* and *chars*. At heart is the possibility of understanding flooding as but one element of a 'hybrid environment' – a contingent continuum between land and water. While viewing flooding as a biological pulse is still an incipient formulation, it nonetheless pushes environmental histories of South Asia to move beyond the usual hard binaries of treating land and water as distinct environmental domains. Instead, viewing deltaic flooding as biological pulses throws up the possibility for exploring the fluid and uncertain worlds of riverine communities and their intricate entanglement with fluvial biological webs.

In studies of the environmental history of South Asia, floods can thus no longer be made to squarely fall within the exclusive realm of disaster histories. If anything, floods in South Asia open up the urgency of exploring and debating the fate of hybrid environments amidst growing concerns about climate change, global warming and environmental politics in the epoch of the Anthropocene.[60]

60. While this essay was in press, three monographs published in in rapid succession focused on floods in South Asia as problems of environmental history. Unfortunately, their arguments and compelling claims could not be included in this review. Readers may want to look up: Debjani Bhattacharyya, *Empire and Ecology in the Bengal Delta: The Making of Calcutta* (United Kingdom: Cambridge University Press, 2018); Dilip da Cunha, *The Invention of Rivers: Alexander's Eye and Ganga's Descent* (Pennsylvania, United States: University of Pennsylvania Press, 2018); and Arupjyoti Saikia, *The Unquiet River: A Biography of the Brahmaputra* (New Delhi: Oxford University Press, 2019)