International rivers as border infrastructures: En/forcing borders in South Asia

Kimberley Anh Thomas

Department of Geography and Urban Studies, Temple University, 308 Gladfelter Hall, 1115 Polett Walk, Philadelphia, PA, 19122, USA

ABSTRACT

Rivers have long been convenient yet troublesome borders. Inherently itinerant, rivers routinely defy cartographic depictions of borders as static, territorially bounded formations. Such dynamism poses material and conceptual challenges to state regulatory activities, resulting in increasingly heterodox attempts to fix waterbodies through various securitizing mechanisms. I examine the dialectical relationship between rivers and borders through the concept of the river-border complex. I ask how the Ganges River shapes the form and function of the Indo-Bangladeshi border and how, in turn, bordering practices in India regulate flows along the river, which comprises 129 km of India's border with Bangladesh. Drawing on archival records, in-person interviews, and river data, I find that the border and efforts to secure it mediate many flows along the river. The study corroborates previous work within critical border studies that securitizing cross-border flows has the perverse effect of generating greater insecurity in adjoining countries. Crucially, historical analysis of sediment, information, and human flows reveals how international rivers also determine patterns and processes of circulation and thereby warrant reconceptualization as border infrastructures, rather than as merely being subject to them.

1. Introduction

For centuries, states have employed landscape features to serve as political partitions. Rivers, mountain ranges, coastlines, deserts, canyons, and waterfalls present environments that are inhospitable, treacherous, and difficult to traverse. Such environments create barriers to movement that nominally help demarcate territory and separate populations of humans and non-humans alike (*e.g.* Hipfl et al. 2002; Marcu, 2009). While border agencies instrumentalize ruggedness, vegetation, isolation, and other forms of physical deterrence (Boyce et al. 2019), borderland terrains do not always align with diverse and conflicting state agendas (*e.g.* those aimed at fostering tourism and commerce while discouraging immigration). They may also introduce challenges for authorities endeavoring to survey, monitor, fortify, or enforce harsh borderscapes (Nevins & Dunn, 2008; Sundberg, 2011). Much critical border scholarship has emphasized such activities to redefine the border as process or practice (Newman, 2006, Parker & Vaughan-Williams, 2009), but there has been insufficient attention to the materialities by which "the border comes to be a process" (Demetriou & Dimova, 2018, p. 2).

Accordingly, theorization of the nature of borders has much to gain from an examination of borders based on landscape features. Recognizing that nature is a multi-valent concept with diverse and contradictory meanings (Castree, 2014), this analysis examines the nature of borders as both the character of borders and the physical environments they occupy. Critical border scholars have been thoroughly interrogating the first meaning of border natures: how borders function and with what effects (see Laine, 2016; Newman, 2011, pp. 33–47; Paasi, 1998). Considerably less attention, however, has been accorded to the socio-natural landscapes across which borders are established (Krause, 2016; Ramutsindela, 2015), indicating a problematic tendency to marginalize the environmental dimensions of borders (Sidaway, 2019). While there is growing interest in the impacts of bordering practices on ecological systems, especially with respect to wildlife (Lasky et al. 2011; Linnell et al. 2016; Wadewitz, 2012, pp. 1–36), there has been limited engagement with the ways in which environments in turn shape borders (see Fall, 2005, Sundberg, 2011, and Alvarez, 2019 as important exceptions). I will demonstrate that borders and transboundary environments are dialectically entwined and thus necessitate more integrated treatment. This work also highlights how borders and transboundary environments are deployed in security discourses and play important roles in mediating circulation at and across borders. I therefore

synthesize critical border studies, infrastructure studies, and security studies to clarify the relationship between natural borders and state-making.

This work pivots on three central questions: States rely heavily on landscape features as "natural" borders, but how do they overcome these borders' inherent recalcitrance? How do attempts to correct, enforce, or reinforce natural borders affect flows across and along them? What becomes of natural borders thus modified?

The analysis centers on the Indo-Bangladeshi border, the fifth longest land border in the world and an important site of border security innovation. I focus on the Ganges River, which was a primary influence on the demarcation of the Indo-Bangladeshi border and comprises 129 km of the 4096 km-long boundary. The river is a conduit for a wide array of material and non-material flows, which I trace to illustrate the dialectical, processual relationship between rivers and borders.

Such concerns engage and extend ongoing debates among critical border studies and security scholars about how and where borders materialize and with what effects (*e.g.* Amoore et al. 2008; Deleixhe et al. 2019; Paasi, 1998). Specifically, the paper advances an argument about the vital yet underappreciated roles that environmental features and dynamics play in border practices. Methodologically, it also speaks to calls within political geography to transcend notions of the earth as a neutral backdrop for political activity and instead recognize the environment as an active participant in political life (Bakker, 2012; Clark, 2013; Dalby, 2007; Grundy-Warr et al. 2015). Alex Loftus's (2020) reflections on the productive engagement of political geography and political ecology are germane, as he emphasizes the importance of careful attention and site-based study to defetishize conceptions of the state, echoing the practice of "following the thing" to uncover the socio-ecological relations of commodity production (Christophers, 2011; Cook, 2004). Bringing the environment to life in political geography likewise requires patient, even granular attention to the political agency of socio-natural actors like forests (Peluso & Vandergeest, 2011), carbon (Mitchell, 2011), fisheries (Sneddon & Fox, 2012), and water (Linton & Budds, 2014). I focus here on silt, river data, and people to rethink the co-produced categories of international rivers and borders.

Foregrounding the environment this way parallels the figure-ground shift in infrastructure studies known as "infrastructural inversion," which recenters taken-for-granted backgrounds as formal objects of study (Bowker, 1994). The "study [of] boring things" (Star, 1999, p. 377) like pipes, wires, cell towers, and drainage ditches is central to understanding how uneven power relations are inscribed in systems that otherwise appear as dry, technical matters of service delivery and system maintenance (Anand et al. 2018). Infrastructure studies has often relegated environmental systems as secondary to the built structures and administrative practices that facilitate the circulation of people, goods, and services. However, as with political geography, that is quickly changing with growing awareness that, if infrastructure constitutes the substrate or background for networked services (Star & Ruhleder, 1996), then biotic and abiotic structures provide the substrate for infrastructural systems; thus, the "environment is the infrastructure of infrastructure" (Hetherington, 2019, p. 6). Recent work takes this further, asserting that nature itself serves as infrastructure (Carse, 2012). From this perspective, an aquifer becomes infrastructural to luxury housing development in Costa Rica (Ballestero, 2019) and oyster beds promise coastal protection from storm surge in New York City (Wakefield, 2020), for example.

Security studies likewise assumes background conditions that demand scrutiny. Of interest here is the relationship between stability and politics implied by securitization. Securitization entails the elevation of an issue to that of a national security concern, an ontological shift accompanied by the issue's removal from the space of ordinary politics to one in which state actors may undertake drastic but unacceptably undemocratic measures to neutralize the threat by any means (Balzacq, 2005; Trombetta, 2008). Norms of deliberation, debate, participation, and transparency are suspended for securitized subjects ranging from

'climate refugees' (Baldwin et al. 2014) to water (Fischhendler, 2015). The stage for 'normal politics' is thus one presumed to be stable but vulnerable to threats, and security issues are ushered into a separate realm of governance (Williams, 2003) akin to Agamben's (2005) "state of exception" where authorities can exercise greater autonomy and maneuver unhampered by due political and juridical process. Security, however, is a relational term co-produced and defined by its opposite: insecurity (Mehta et al. 2019). As such, to sequester security issues within extrajudicial spaces and handle them outside of conventional politics is to ignore how securitization engenders the insecurity and instability it purports to address (Thomas & Warner, 2019).

The paper illustrates how these concerns (borders, infrastructure, and securitization) impinge upon and intersect with one another to produce particular socio-natural forms and outcomes. First, it provides an overview of the ways that states enroll environments in demarcating and maintaining national boundaries, as well as the surprises that spring from such efforts. The second section examines the historical foundations of the Ganges River as a transboundary environment and highlights contingencies that contradict the notion of "natural" borders as self-evident. The subsequent section details the ways that river flows are subject to securitization and bordering practices while simultaneously driving new border technologies. Finally, the paper reviews the infrastructural traits of circulation, breakdown, and labor intensiveness to argue that international rivers themselves constitute border infrastructures.

2. The "natural" border

During early state formation in 17th century Europe, elements like mountains and rivers were understood to be products of divine nature, thus aligning political boundaries with such features helped legitimize monarchical rule (Amilhat Szary, 2014, pp. 31–54). Topological features lend borders an appearance of being pre-given and immutable that makes them less subject to being questioned as arbitrary, a type of "geometric destiny" that conflates nature and politics (Fall, 2010). Perceptions of "natural" borders as preferable to those deemed "artificial" persisted through the first half of the 20th century (Van Houtum, 2005). While the notion of natural borders has been contested for decades and is now widely regarded as outdated (see Fall, 2011), the practice of employing landscape features as borders remains robust (Popelka & Smith, 2020). Today, rivers alone constitute 150 international borders, comprising fully one third the length of all state boundaries (Donaldson, 2011). However, even for putatively "arcifinious frontiers," physical geography is rarely sufficient to maintain separation between polities, as natural borders pose all manner of governance challenges (Alvarez, 2019, p. 18).

This unruliness can be partly attributed to the fact that borders regularly flout their cartographically assigned positions, appearing at passport agencies, security checkpoints, offshore detention facilities, and even within visa holders (Balibar, 2002; Johnson et al. 2011; Weber, 2006). Critical border studies challenges popular notions of borders as fixed, static features by highlighting the ways that borders are quite mobile (Amilhat Szary & Giraut, 2015). However, borders are mobile in another sense in that many landscape features used to demarcate borders are themselves mobile. Border mobility is perhaps most pronounced with rivers, which can rapidly and dramatically shift course based on factors such as flow velocity and sedimentation rates (Donaldson, 2011). For example, the Ganges River along the India-Bangladesh border has exhibited significant and asymmetrical morphological change since 1973 due to high erosion and reduced accretion (Hossain et al. 2013). Waterways offer conspicuous examples of the ways that landscapes can stymie attempts to fix and reinforce borders.

I examine natural borders through an analysis of the Ganges River and Indo-Bangladeshi border that draws on interview transcripts, historical records, policy reports, and news media. In 2014, I conducted 65 semi-structured interviews with Bangladeshi residents in water-

dependent occupations, met with Bangladeshi government officials and legal scholars, and obtained Partition-era materials from the India Office of the British Library. During that time and since, I surveyed Internet-based policy reports and media coverage of Indian border security. Together, these materials form the empirical basis for an analysis that integrates international rivers and state borders as mutually constitutive, a conceptual orientation encapsulated by the *river-border complex* (Thomas, 2017a). This integrated approach towards rivers and borders helps "recover the environment as a site of bordering" (Ramutsindela, 2015, p. 135) and reveals the ways that borders transform their environments and how, in turn, natural borders compel successive waves of innovation in border maintenance and regulation.

The analysis is inflected by a "critical historical perspective" (Biggs et al. 2009) that underscores the political and economic contingencies that attended historical border formation and maintenance. "For borders have a history" (Balibar, 2002, p. 77), and this history permeates contemporary thought regarding not only the institutions of borders, but the various functions they assume over time (Müller, 2013). British colonial records chronicle the tortuous negotiations over the Bengal border designation and unsettle perceptions of rivers as natural boundaries. Crucially, they also document the historical precursors to contemporary disputes regarding cross-border flows of water, silt, and people that directly inform border security measures. Examination of the relationship between borders and transboundary environments thus begins by revisiting how the Ganges River became an international watercourse and national boundary.

3. The India-Bangladesh border

Interstate conflicts over the Ganges River have persisted for so long that it is easy to forget that the watercourse did not become an international river, nor part of a border for that matter, until 1947. It is necessary to excavate the logics that created these conditions in order to understand the historical contingencies that continue to reverberate in and through the Ganges river border. Stated otherwise, it is important to "[discuss] how empire and imperialism might be 'brought back in' so that we can take account of their historical legacies, and continuing influence, in shaping, sustaining, and restructuring national borders" (O'Dowd, 2010, p. 1033). Despite the fact that much has been and continues to be written about the Partition of British India and the indelible imprint of British imperialism on South Asia, existing analyses provide limited insight into the ways environmental concerns figured into the original designation and ongoing functioning of regional borders.

The incalculable offenses wrought by the Partition of British India have spawned generations of analysis and critique. Curiously, even across the immense variability within and between history, political science, literature, and other relevant fields, there is a striking commonality in how diverse scholars have narrated the Bengal border demarcation. Namely, the view that borders were delineated to create independent states solely based on religious grounds has enjoyed rare consensus (*e.g.* Feldman, 2003; van Schendel, 2009; Metcalf & Metcalf, 2012; Abraham, 2014). Islam (1990:19–20) succinctly captured this position by stating, "When in 1947 East Pakistan (presently Bangladesh) was carved out of the Bengal and Assam provinces of undivided India, religion was the sole determinant of demarcation of the boundary, and physical-geographical considerations could hardly be of any significance." The assertion that the Bengal border was drawn along communal lines prevailed uncontested until a recently declassified British government memorandum came to light 70 years after Partition (Thomas, 2017a).

Uncontested does not mean unexamined. The anomalous assignment of Muslim-majority areas to India and non-Muslim-majority areas to Pakistan has long been a source of consternation, especially regarding the riverine section of the border (Fig. 1, Crow et al. 1995; van Schendel, 2009). If religion was in fact "the sole determinant of demarcation of the
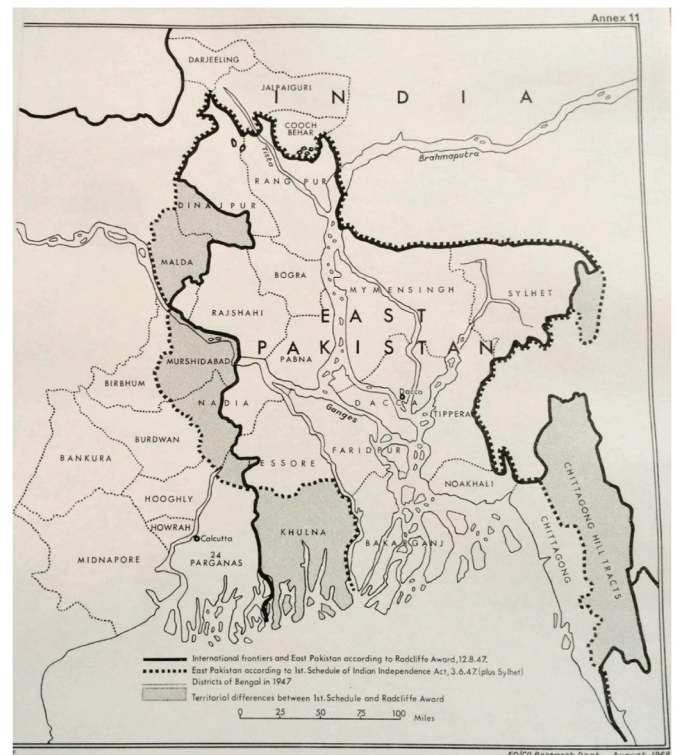

Fig. 1. Map of Bengal indicating the border based on religious demographics (dashed line) versus the Radcliffe Line that serves as the present-day border (solid line). The shaded areas indicate adversely assigned regions (i.e., Muslim-majority areas to India and vice-versa). Image: British Library India Office (BLIO, 1969).

boundary," then how does one make sense of the allocation of Muslim-majority Murshidabad to India, for example? Certainly, Sir Cyril Radcliffe and the two Boundary Commissions he helmed designated the new state borders with remarkable haste, taking a breathless five weeks to draw up both the Bengal border in the East and the Punjab border in the West. The puzzling territorial assignments in Bengal might have been interpreted as regrettable but understandable outcomes of working in an unfamiliar context (Radcliffe had never previously visited India) and under an impossibly short timeframe had their consequences not proved so monumental (Chatterji, 1999; Thomas, 2017b). Indeed, when Radcliffe allocated Muslim-based Murshidabad to Hindu-dominated India, he conferred to India unfettered control of the Ganges River along its entire length, from Uttarakhand to the Bay of Bengal (via the Hooghly River in West Bengal). This eventually enabled India to divert river water to Calcutta/Kolkata during the dry season, with deleterious impacts on the socio-ecology of western Bangladesh (see below).[1]

The British Research Department memorandum noted above puts the speculation to rest, explaining the rationale behind the border determination in straightforward, almost surgical terms:

"Murshidabad district was awarded to India. The total population was 1,640,530, of whom 927, 747 were Muslim and only 684, 987 were Hindu. Radcliffe awarded this district (despite its Muslim majority) to West Bengal so that it could control the rivers on which the life of Calcutta as a city and port depended. The award was therefore in India's favor." (BLIO, 1969:12).

As Anne-Laure Amilhat Szary (2014:37) has observed, "The natural border that seemed to have been created by God in an indefinite past

---

[1] I will use Calcutta when referring to the colonial and Partition eras to maintain consistency with the records from those periods and will use Kolkata when referring to present day.

does in fact have a historicity." With respect to the riverine section of the Bengal border, there was no question as to its creator, but historical inquiry into its delineation proves illuminating nonetheless. The British government document settles the question regarding the adverse assignment of Murshidabad to India, but it is also instrumental for highlighting the transformation of a domestic watercourse into an international one. From here, we turn our attention squarely to the concept of international rivers and how rethinking this ostensibly straightforward category becomes foundational, first for understanding the dialectical relationship between rivers and borders, and eventually for conceptualizing international rivers *as* border infrastructures rather than merely being subject to them.

4. Bordering river flows

"… movement, instead of being subsequent to geography, *is* geography" (Steinberg, 2013:157, quoted in Grundy-Warr et al. 2015:94)

Scholars of all persuasions have long relied on straightforward, commonsense notions of international rivers as watercourses that traverse national borders or, alternatively, as those shared by two or more countries (Thomas, 2017a). Yet, such simple definitions belie tremendous complexity underpinning the form, function, and governance of international rivers. By portraying international rivers as an unproblematic fact, such definitions also leave unattended crucial questions about what processes produce, sustain, and shape such waterbodies. The most fundamental among these processes, as the account of the Radcliffe Line illustrates, are the establishment of the borders that form international rivers, as well as the enrollment of rivers in bordering schemes.

International waterbodies would not exist without state borders, and in many cases comprise such borders, yet the two are rarely considered conjointly. Fortunately, there are exceptions. Geographers have drawn crucial attention to the ways that the apparently unquestionable division offered by a river in fact reveals a gap between legal theory and practice (Garcia-Alvarez & Puente-Lozano, 2017) and raises a multitude of administrative challenges due to the complexities of water and sediment flows (Donaldson, 2011). However, this scholarship perpetuates the notion of international rivers and state borders as distinct phenomena. It becomes helpful then, if not necessary, to rethink international rivers as synergistic, multi-faceted, and ongoing interactions between rivers and borders—or, as *river-border complexes*. These are defined as, "the network[s] of individual agents, discrete events and ongoing activities that interact to structure socio-natural dynamics in transboundary river contexts" (Thomas, 2017a, p. 49).

The river-border complex captures one expression of the hydrosocial cycle, or the "socio-natural process by which water and society make and remake each other over space and time," (Linton & Budds, 2014, p. 170), by delineating the iterative coproduction of international rivers and borders. As I detail below, both water flows and *non-water flows* along international rivers are as bound to borders and bordering processes (*e.g.*, customs, policing, monitoring) as they are to the channels along which they are conveyed. Meanwhile, international river flows shape the form and function of borders by resisting the fixity that state actors attempt to impose on them and compelling structural responses in turn (Alvarez, 2019; Sundberg, 2011).

Reconceptualizing international rivers as composites of hydrological and bordering processes is to be attentive to the ways that borders operate within and upon international rivers, to recognize that the border acts on all flows along the international river, even in cases where the river is not coterminous with the border. This mode of examination is consistent with two key observations from critical border studies. I introduced the first of these above, which is that borders, while used to regulate mobility, are themselves increasingly mobile. A second and related point is that state power is consolidated in part through the control of flows along and across borders: "No longer strictly a matter of disciplinary practices that stop, prohibit, enclose, delimit or proscribe,

the work of the contemporary border is conducted in and through movement itself" (Johnson et al. 2011, p. 64, emphasis added). While articulated in the context of human movement, this observation is equally germane to the policing of non-human movements (see below). Focusing on the ways that borders filter, mediate, and constrain human and non-human movements also conjures the large and growing body of scholarship on infrastructure.

Infrastructures are physical networks that facilitate and direct flows. Thus, they are material in that they are "matter that enable the movement of other matter" (Larkin, 2013, p. 329), but they are also defined by their social relations, as infrastructures necessarily emerge through social arrangements and processes (Star & Ruhleder, 1996). To take a relevant example, the material form of a border wall derives from a particular application of cement, sand, and rebar. But it becomes a wall through social practices of language and labor, while its function as a barrier emanates as much from its physical properties as from the concepts and meanings that people ascribe to it. States therefore rely on both the phenomenology and semiotics of infrastructures to bring borders to life and effect their desired patterns of circulation across bordered spaces.

Transboundary and boundary-forming rivers present a striking puzzle for thinking through cross-border mobility because they facilitate and structure a multiplicity of water flows and non-water flows. That they fundamentally operate as circulatory networks forms the grounds for my argument that international rivers function as border infrastructure. Such thinking extends Ashley Carse's (2012) notion of "nature as infrastructure," whereby nature is managed to provide services for economic activity and development. However, just as "no feature of the landscape is, of itself, a boundary" (Ingold, 1993, p. 156), neither does nature automatically function as infrastructure. Indeed, "making nature do its nature thing" requires work (Wakefield, 2020, p. 13). In New York City, the planned rehabilitation of oyster beds to dampen wave energy and mitigate flood damage has entailed considerable physical and political effort, at significant cost and with uncertain outcomes (*ibid*). Statist visions for international rivers to function as borders *and* to mediate mobility at, across, and along them, in other words to perform as border infrastructure, requires even greater industriousness—a process informed and facilitated by the securitization of river flows.

5. Non-water flows

The specific composition of non-water flows borne by a river depends on the physical and social features unique to that watercourse but includes entities both tangible (fish, sediment, people, pollution) and intangible (capital, information, energy). Like all rivers, the Ganges River is replete with non-water flows, such as abundant kinetic energy that has long made the river a target for hydropower development, pollution from the daily discharge of 500 million liters of industrial waste and 3.5 billion liters of untreated sewage (Chaudary, 2015), and diverse fauna, including 140 fish species, 90 amphibian species, and 5 species of freshwater cetaceans. Kinetic energy, pollution, and wildlife comprise just a subset of the non-water flows of the Ganges river network, each of which is significant for the socio-ecology of the region (Lafaye de Micheaux et al., 2018). I will elaborate on sediment, information, and people to illustrate how the river-border complex acts upon securitized transboundary flows and how such flows, in turn, compel new technologies for regulating circulation.

5.1. Sediment

Together with the Brahmaputra, the Ganges has the highest sediment load of any river basin in the world, transporting up to two billion tons of sediment per year (Hossain & Sakai, 2008). These fertile sediments are foundational to agrarian economies that support the basin's 400 million residents, but they also pose significant challenges.

The British government memorandum quoted previously hinted at,

but did not elaborate, how and why "the life of Calcutta as a city and port depended" on the Ganges and Hooghly Rivers (BLIO, 1969). The Hooghly River had once been the main distributary of the Ganges River (via the Bhagirathi), but approximately 500 years ago, the Ganges shifted away from the Hooghly and assumed a southeasterly course to the Bay of Bengal via the Padma River, which it has maintained to present day. As a result, the Hooghly was converted into a spill channel that only conveys water from the Ganges during high flow conditions (Begum, 1987). Nearly 200 years later and with full knowledge of this morphological change, the British constructed Calcutta port at the mouth of the Hooghly River despite the river's inconsistent volume and treacherous seaward approach (Begum, 1987). The irregularity and reduction in river flow supplying Calcutta has spawned centuries of navigational challenges all along the Hooghly River, chiefly due to progressive siltation of the riverbed.

Colonial administrative records, including the India and Bengal Despatches and Revenue Department logs, dating from at least the early 19th century indicate that navigational hazards, including shifting sand bars and drying rivers, confounded engineers, merchants, and military officials alike. These vested interests submitted dozens of proposals to mitigate such hazards, variously petitioning the government for authorization and funds to dredge channels, construct canals, relocate Calcutta port, erect barrages, build river training structures and even avoid the river altogether by building a railway link between Calcutta and the coast (Crow et al. 1995; Thomas, 2017a).

While none of the proposals were successful, they established a narrative that the Hooghly was deteriorating and that such decline was connected to the upstream rivers, especially the Bhagirathi, that linked the Hooghly to the Ganges (Crow et al., 1995). The proposed projects contributed to a consensus that the navigability of the Hooghly could be recovered by augmenting flows from the Ganges into the Bhagirathi during the dry season, thereby 'flushing' silt from the shipping channels. As the most important commercial and cultural center of the colony, Calcutta's welfare was of utmost importance to the British Raj, and later to the nascent state of India following Partition. The perceived long-term viability of the port city was intimately tied, therefore, to the riverine sediments choking the Hooghly. Accordingly, India proceeded with plans to develop a 2.25 km-long barrage to divert 40,000 cubic feet per second of water during the dry season from the Ganges into the Bhagirathi-Hooghly, with Pakistan only learning indirectly of the project through Indian newspapers in 1950 (Crow et al. 1995). The strategic placement of the barrage should come as no surprise: the town of Farakka in Murshidabad District, the Muslim-majority district awarded to India where the Hooghly bifurcates from the Ganges.

Addressing Parliament in 1967, the Indian Deputy Minister of External Affairs rationalized the barrage as the only viable response to the siltation problem:

"a galaxy of engineers … has unanimously asserted that the construction of a barrage with the objective of supplying additional water into the Bhagirathi-Hooghly system, was the only measure by which the alarming rate of deterioration of the Hooghly approaches to the port of Calcutta could be arrested. *This project is of national importance to India* and will not be detrimental to Pakistan." (Government of India (GoI), 1967).

In the midst of ongoing dispute, an Indian delegate reiterated this sentiment at Secretary level talks in Islamabad, stating, "… the uninterrupted flow of Ganga waters through the Bhagirathi-Hooghli is crucially important for the saving from extinction the Calcutta Port whose importance to the economy of India is too well known to need elaboration." (Government of India (GoI), 1970a, Government of India (GoI), 1970b). Indian officials securitized riverine silts by framing them as a matter of national concern, thereby justifying the extraordinary act of unilaterally constructing the Farakka Barrage despite vehement opposition from Pakistan.

Two decades of conflict followed the commissioning of the barrage in 1975, which had immediate, large-scale, and deleterious effects on the industry, food production, transportation and communication systems, and ecology of Bangladesh (Adel, 2001). In 1996, the two countries finally brokered a 30-year treaty that regulates dry season water sharing at Farakka. However, discord over the barrage persists to this day due to ongoing water crises in Bangladesh and the negligible degree to which the diversion has alleviated the Hooghly's navigational woes (Thomas, 2017b). Water retention in India during the dry season has been implicated in fishery declines, household water insecurity, and the loss of navigable channels in Bangladesh (Kawser & Samad, 2015). Pointing to the low river levels, a young Bangladeshi boatman lamented, "You can see that the river is not full to the brim now. But in India, they have more than enough water. Big ships can navigate their portion [of the Ganges river system], but we are operating small boats."

Many residents in southwestern Bangladesh similarly link their livelihood precarity to upstream water practices in India, often coupled with the assumption that the Farakka Barrage has addressed water problems on the other side of the border. However, the future of Kolkata's status as a regional economic hub continues to hang in the balance, while hydrological conditions upstream of the barrage have become more hazardous (Lafaye de Micheaux et al. 2018). Despite diverting water from the Ganges for the express purpose of maintaining the navigability of the port, the Ganges' high siltation rates have necessitated the annual dredging of twenty million cubic meters of silt at a cost of more than 3 billion USD and prompted mass layoffs at Kolkata's main port complex (Kolkata Port Trust, 2018; Saha et al. 2012). Meanwhile, the barrage has inadvertently altered the flow regime and sedimentation dynamics upstream. Such shifts have augmented the risk of extreme flooding and erosion in the Indian state of Bihar (Thakur et al. 2012), driving some officials to petition for its removal (Chari, 2016).

The 1947 designation of the border along and around water channels in Bengal continues to influence the regulation of water and non-water flows throughout the river-border complex. River-borne sediments, meanwhile, demonstrate their own agential capacity. Katie Meehan (2014) documents how water infrastructure in Mexico helps consolidate state power, but she also illustrates how everyday objects like buckets can limit the reach of the state. Here, too, sediments frustrate and circumscribe the Indian state's goals, spurring infrastructural and administrative responses with far-reaching impacts.

5.2. Information

The Ganges flows for 2240 km across India before culminating its overland journey in Bangladesh and is subject to innumerable withdrawals, diversions, and additions along its route. The river's water is diverted along more than 30,000 km of major and minor canals to irrigate approximately 4.1 million ha of land in the Indian states of Uttarakhand, Uttar Pradesh and Bihar (Food and Agriculture Organization of the United Nations (FAO), 2011). Additionally, the Ganges receives seasonal inputs of glacial meltwater and monsoon precipitation, with the latter making an important contribution to annual flooding in the lower reaches of the river (Mirza, 2011). These inputs and withdrawals constitute tangible modifications that are monitored and recorded (albeit inconsistently, see Nishat & Faisal, 2000; Sadoff et al. 2013), thus comprising a valuable flow of information along the watercourse.

Alterations to the river's volume and composition can have significant impacts on the quantity and quality of water that reaches lower riparians, which is why formal data sharing mechanisms are common and prominent features of river basin organizations and legal agreements (Sadoff et al. 2013; Wouters, 2013). The 1996 Ganges water treaty between India and Bangladesh mandates that a bilateral Joint Committee record river flow volume on either side of the border. Article-VI of the agreement states that the "Joint Committee shall submit to the two Governments all data collected by it and shall also submit a

yearly report to both the Governments" (Government of Bangladesh (GoB), 1996). Data sharing in reality, however, is a vastly more complicated proposition.

First, hydrological data shared between the two governments are exempt from public access, thereby preventing any non-state actors (*e.g.* researchers, civil society, media) from evaluating the strengths and weaknesses of joint river governance (Chowdhury, 2014; Surie & Prasai, 2015). Secondly, India is only legally bound to disclose information about river volume at a single point (Farakka Barrage), thus enabling India to withhold data about the myriad flows in the remainder of the basin, as well as any information about the other 53 transboundary rivers shared with Bangladesh. Expressed another way:

"Bangladesh cannot even ask what amount of water is being shared. After flowing through West Bengal and Bihar, whatever amount is left, (the residual flow) enters Bangladesh. Then India says that it is distributed honestly." (Professor Asif Nazrul quoted in Chowdhury, 2014, p. 7).

Indeed, retention of river data is paradigmatic in India where hydrological information for the Himalayan rivers is regarded as a national security issue, creating what some have characterized as a regime of secrecy (Price, 2014; Surie, 2014). Samer Alatout (2014) has documented analogous dynamics on the Jordan River whereby water became a "territorial object" that could be put to the service of national security. This operationalization of water could not occur, he argues, without the river first having been rendered as a border. Once established as borders, any flow along an international river, material or non-material, may be securitized, at which point it may be removed from the public political sphere and subject to exceptional measures.

India's suppression of hydrological data contributes to conspiracy theories and distrust among its neighbors (Price, 2014), and serves as another form of deprivation, less conspicuous than that of water but consequential nonetheless (Chowdhury, 2020). One reporter noted, "Bangladesh and India share 54 cross-boundary rivers but Dhaka hardly has any data from the other country on these rivers" (Zaman, 2014). Observers also implicate India's reticence in exacerbating downstream flood damages, as the absence of adequate warning about river conditions hampers Bangladesh's preparation and response (Khadka, 2013). Perceptions of India's "unilateral" water management are thus tied to its institutionalized lack of transparency, aggravating concerns that Bangladesh is neither adequately informed nor consulted about the use of rivers that inevitably affect it (Surie & Prasai, 2015). The Indo-Bangladeshi border mediates the flow of river data, such that valuable information is intercepted and retained within India, thereby accentuating disparities between the two states.

Border security practices elsewhere likewise instrumentalize information by coupling exhaustive data collection with their subsequent retention and suppression. Asylum seekers in Australia's offshore detention centers, for instance, are subject to "invasive" and "mundane" data collection, but information is closely guarded, such that unauthorized disclosure of refugee data carries the risk of 2–5 years of imprisonment per the 2015 Border Force Act (Heemsbergen & Daly, 2017). While such draconian measures are hallmarks of contemporary border security in many states, India's practices exemplify securitization, as its exceptional defiance of an international agreement is underpinned by its treatment of river data as a matter of national security.

5.3. People

In the years following Partition, several million people relocated from one side of the Bengal border to the other. However, given the substantial number of Hindus who remained in East Bengal and the many Muslims who stayed in West Bengal, Partition was an incomplete division that left important connections (religion, culture, identification, kinship) across the border intact (Cons & Sanyal, 2013; Feldman, 2003). Livelihood strategies were among the most difficult facets of life to reconcile with the new borders, as the new states sought to internalize economic relations (van Schendel, 2005). As a result, the routes and channels that had long connected jute producers with Calcutta markets, peasant homesteads with sharecroppers' plots, creditors with debtors, tenants with landlords, and fishermen with fishing grounds were abruptly blocked. Moreover, previously quotidian movements between such groups and sites were criminalized, so that anyone caught transiting the new border was vulnerable to detention, harassment, beatings, confiscated property, and sometimes death (Chatterji, 1999).

In Punjab, Majed Akhter (2019) argues that Partition was not a single event but is an ongoing exercise in state-making facilitated by hydraulic development. There are striking parallels with Bengal, where the act of bordering East Pakistan was not accomplished with border demarcation in 1947 but has been a cornerstone in India's efforts to curb flows of Bengali immigrants, Hindu and Muslim alike, since the turn of the millennium (Jamwal, 2004). In 1986, the central Indian government announced plans to fence the Indo-Bangladeshi border, but the idea did not gain traction with the provincial leadership of West Bengal (India) until the rise of the 'global war on terror' (Jones, 2012). In this recent bordering campaign (ostensibly intended to repress a burgeoning culture of terrorism), East Bengalis (Bangladeshis) have not only been discursively and legislatively constructed as smugglers and illegal immigrants, but also as "irrational, pre-modern, violent, and potentially evil terrorists" (Jones, 2012, p. 72).

Negative characterizations of Bangladeshis empower the Indian Border Security Force (BSF) to operate with impunity. The BSF's shoot-on-sight policy has resulted in the deaths of several hundred civilians from both countries, many of whom were caught transporting cattle from predominantly Hindu India (where beef consumption is strongly discouraged and cow slaughter has been banned in several states) to Muslim-majority Bangladesh (where cows are prized for their meat and hides; Sattar, 2012, Ghosh, 2014). The extrajudicial killing of unarmed civilians persists despite clamorous protest and several highly publicized deaths (Abrar, 2020; Sattar, 2012). India pledged to implement "non-lethal strategies" as an act of goodwill and to assuage protesters, but it emerged that alternatives were never enacted; a high-ranking Indian government official was quoted saying, "There is nothing like a non-lethal strategy. What is paramount is that our border needs to be protected" (Singh, 2015).

Against this backdrop, residents of the Bangladeshi border town of Rajshahi reported that their occupational fishing and boating activities along the river are significantly circumscribed by their fears of abduction, detention, and brutality by the BSF. A Hindu fisherman said to me, "If we go closer to the Indian border, BSF will catch us and send us to jail. That's why we remain cautious not to cross the border." This type of self-governance attends what Isin calls the "neurotic citizen," who "… is incited to make social and cultural investments to eliminate various dangers by calibrating its conduct on the basis of anxieties and insecurities rather than rationalities" (Isin, 2004 quoted in Salter, 2008, p. 373). However, even when one is willing to sacrifice livelihood opportunities, conscious efforts to avoid particular fishing grounds or boat launches are challenging because the river (and by extension the border, in this case) can dramatically and rapidly change course (Hossain et al. 2013). As another Bangladeshi fisherman explained:

"The river is changing its course frequently. The river is swinging from India to Bangladesh and Bangladesh to India. When the river shifts to India, fishermen have to go near the border to catch fish. Then, the BSF abducts Bangladeshi fishermen."

India recently inaugurated a new border control technology that should eliminate such ambiguities (Indian Ministry of Home Affairs (MHA), 2019). Since 2003, the Indian government has been constructing an 8-ft tall, double-walled barbed wire fence along 3400 km of its border with Bangladesh. Although the border fence, when complete, will constitute the longest barrier in the world, the Indian government is dissatisfied that the land barrier leaves 930 km of riverine border unfenced (Z News, 2015). Unfenced but not defenseless, the BSF patrols rivers and other waterbodies with speed boats, floating outposts, and a

proprietary "laser wall" technology that sounds alarms when a web of laser beams is disturbed (Z News, 2015). However, even this degree of futuristic border security has been deemed insufficient, prompting the Modi government to construct a "smart fence" equipped with five sensors ("radar, electro optics, unattended ground sensors, OFC based sensors and mini aerostat") that can distinguish between [unauthorized] boats and "ambient noise" like animals (Gurung, 2018). However, water and sediments undermine such efforts to fix the border, as floods, longer monsoon seasons, and shifting rivers delay construction and elevate costs (Chakravarty, 2018, The Economic Times (TEI), 2019).

Meanwhile, the securitization of people's mobility continues to "create and sustain fearful populations—both the subjects and the publics of enforcement—through the (geo)politics of fear" (Mountz, 2015, p. 186). Rajshahi fishermen continue to drift into Indian territorial waters, from which they are captured and tortured (Dulal, 2020), and 2020 marked the border's deadliest year in a decade despite fresh promises from the BSF Director General and High Commissioner of India to eliminate border killings (Rashid, 2020).

The diversion of water, retention of data, exclusion of certain populations (Bangladeshis), and criminalization of people and their everyday activities produce and perpetuate stratification between the two states. Moreover, the BSF's indiscriminate use of force contradicts India's purported concern for security, calling to mind the question: *what* is being secured, *where*, and *for whom*? (see O'Lear, 2018). Tracing the trajectories and fates of water, sediment, information, and people in Eastern Bengal reveals that state actors have not only securitized the Indo-Bangladeshi border, but also the manifold flows that comprise the Ganges River. River flows rarely align with official border imaginaries, however, thereby compelling ever more elaborate technologies aimed at disciplining these uncooperative entities—responses that reproduce rather than dissipate conditions of insecurity, in both countries.

6. En/forcing the border

The practices and technologies by which borders work to produce socio-spatial difference are legion. For instance, the act of granting or denying someone access into a country—a decision ultimately rendered by a human authority—involves such variegated methods as remote sensing, drones, detention centers, radio frequency identification, and biometric sensors, to name just a few (Amoore, 2009; Mountz, 2011; Salter, 2008). However, while high-profile counterterrorism and anti-immigrant campaigns have provided the general mobilizing thrust behind the expansion and diversification of bordering activities, many of the proximal imperatives for border innovation are distinctly more banal. This is not to imply that such drivers are inconsequential. Family reunification under the Netherlands' antagonistic border policy, for example, has resulted in "measures to detect "fake marriages", raise the minimum age for foreign spouses, establish income requirements for partners, and introduce language requirements" (Nicholls, 2016, p. 47). It is these less sensational, yet deeply consequential, drivers of innovation and improvisation in border enforcement on which this paper focuses. I pay particular attention to the problems that arise from "natural" borders as impetuses for the development of novel technologies.

Despite the many critiques that have been levelled against the idea of natural borders, rivers have been an enduring site of border-making and control. Responding to Ramutsindela's (2015:135) question "what do border studies stand to gain from engaging nature-related issues?", the present work asserts that we can further deepen our understanding of borders by examining how international rivers operate under and upon border systems. As this study demonstrates, focusing on international rivers can advance theorization of borders by expanding our understanding of where and how they operate. For instance, during his deliberations on the placement of the Bengal border during Partition, Cyril Radcliffe sought out "satisfactory natural boundaries" that might facilitate territorial assignments between India and Pakistan (BLIO, 1947:2). Although this deviated from the Crown's mandate to assign territory

according to religious demographics, the Ganges River and its distributaries figured prominently in the resultant Bengal Boundary Commission award. Rather than a discrete event, Partition is better understood as an ongoing process of state-making punctuated by bordering campaigns aimed at fixing and securing borders. Environments enrolled as borders often stymie such campaigns, however. Notably, international rivers have created unique challenges for Indian authorities and continue to compel new river management and border security technologies. Tracing river flows and attempts to discipline them illustrates the dialectical relationship between rivers and borders, and thereby helps to satisfy demand for additional theorization of border processes (see Parker & Vaughan-Williams, 2009; Ramutsindela, 2015).

This study thus brings literatures on national borders, infrastructure, and security into dialogue through an examination of three questions, to which I now return. First, states rely heavily on landscape features as "natural" borders, but how do they overcome these borders' inherent recalcitrance?

The notion that "borders make the nation" (Ludden, 2003, p. 1064) prevails in India, where the seeds to establish territorial boundaries predated independence by over three decades. Itty Abraham (2014:61) dates India's imperative for unambiguous territorial control back to the Paris Peace Conference in 1919: "To accommodate Indian diversity, national self-determination had to mean the freedom of the Indian *state*, which could only be defined in territorial terms." However, that objective has proved elusive. During Partition in 1947, the Bengal Boundary Commission defied its mandate to delineate the territories of India and Pakistan along religious lines, instead configuring the border to sustain the hydrological connectivity of Calcutta port with its hinterland. This transformed the Ganges River into an international watercourse and established the river as a segment of the border itself. As a dynamic waterway, the river has not provided optimal demarcation between states. India constructed large-scale infrastructure to commandeer river flows and will the river to cooperate with its territorial aspirations, but the water and sediment that so strongly define the river regularly frustrate state authorities' efforts to establish a firm boundary and maintain the navigable channels on which Kolkata relies. Unauthorized movements of people have likewise precipitated ever more inventive approaches to border security, as "bodies challenge and subvert state control of territory" even as they are vulnerable to the violence of border practices (Smith et al. 2015, p. 258). Therefore, states do not necessarily overcome the challenges of bordered landscape features so much as they struggle with them—and each is remade in the process.

I also asked, how do attempts to correct, enforce, or reinforce "natural" borders affect flows across and along them? Employing the concept of the *river-border complex*, the analysis regards international rivers and borders as mutually constitutive, which complements Weber's (2006:24) suggestion that "… borders are becoming malleable and fluid." This certainly applies to South Asia, where the Indo-Bangladeshi border does not constitute a fixed, passive interface between territories but is effected at multiple points along the river, mediating both water and non-water flows throughout the Ganges network. For example, the Farakka Barrage lies just upstream of the Indo-Bangladeshi border and diverts critical dry season water away from Bangladesh toward Kolkata. Moreover, hydrological data are collected throughout the basin, but in an atmosphere where "transboundary water management and cooperation have been highly nationalistic, technocratic and zealously securitized" (Surie & Prasai, 2015, p. 2), such information is retained within India's borders, in direct contravention of international legal principles and much to the frustration of its riparian neighbors. Conversely, rhetoric about Bangladesh as an incubator for Muslim fundamentalists and potential terrorists has stimulated fresh investments in securing and militarizing the riverine portions of the border, thereby excluding millions of people from traditionally held access to family members and economic opportunities. The indiscriminate use of deadly force by the BSF places Indians and Bangladeshis at equal risk (Jamwal, 2004). Examining these cases in tandem through the lens of the river-border

complex reveals that bordering practices dramatically alter water and non-water flows, resulting in greater insecurity in both countries.

Finally, what becomes of the "natural" border thus modified by barrages and smart fences? Here, I turn to infrastructure studies, from which I extrapolate the characteristics of circulation, failure, and maintenance and apply them toward infrastructure and international rivers alike.

First, infrastructure refers to the physical systems that facilitate circulation and exchange across space (Larkin, 2013). As securitized entities, international rivers likewise mediate material and non-material flows across and along borders. However, infrastructures do not always cooperate with planners' intentions, making failure and disruption the norm rather than the exception (Graham, 2010, Schwenkel, 2015). For the Ganges River, the conveyance of people, fish, water, and commercial goods along the watercourse is subject to, yet often defiant of, border imaginaries.

Infrastructure exists along a spectrum of visibility, ranging from the unseen (think buried power lines and subterranean pipes) to the monumental (the Hoover Dam, for instance) (Larkin, 2013). Regardless of where a given infrastructure sits on this continuum, it is always at its most visible when it malfunctions, when it fails to perform as intended or expected (Edwards et al. 2009). In the case of the Ganges, the river-border comes into full view when it fails to curtail incidental or intentional incursions of fishermen and cattle smugglers, traders and travelers. If the river performed its job, as the logic of the natural border goes, then people would not suffer such injustices as abduction, interrogation, and "undesirable death" (Abrar, 2020).

Vulnerability to breakdown and failure highlights another immanent quality of infrastructure: it requires continuous inputs of labor. Infrastructures are not standalone objects but rather "articulated components" (Star & Ruhleder, 1996, p. 111) within a complex web of relations. Infrastructures are brought into existence and sustained through amalgamations of environment-derived materials, human ingenuity, and labor. This applies equally to "nature as infrastructure:"

> "As infrastructure, nature is irreducible to a non-human world already 'out there.' It must, in its proponents' terms, be built, invested in, made functional, and managed. This is an active and inherently political process. As nature *becomes* infrastructure through work, human politics and values are inscribed on the landscape" (Carse, 2012, p. 540).

Borders, likewise, are not pre-given entities but must be conceived of and asserted. Once established, they must be continually reasserted, as they "are perpetually open to question" (Agnew, 2008, p. 176). In this light, it becomes possible to recognize the Ganges River as border infrastructure, whose function as a border requires constant maintenance due to the dynamism of its constitutive flows. Moreover, as the river thwarts state border imaginaries, and as various river flows become securitized over time, the international river as border infrastructure also demands improvisation and innovation. International rivers are thus "malleable infrastructures" that persist over time while assuming new functions as political imperatives dictate (Cousins, 2019). Such technologies as diversions, laser walls, and floating fences are brought online to mediate river flows, sometimes only to be later rejected or abandoned. Thus, while the international river functions as a border infrastructure, it alone is insufficient to the task of regulating circulation to meet the simultaneous, evolving, and at times contradictory demands of states and capital. Rather than a natural entity, the border must therefore be iteratively en/forced, as the project of bordering flows is always partial and incomplete.

The conceit of the natural border as superior, real, pre-given, or legitimate has long been discredited, yet many political systems continue to subscribe to it and appear likely to do so for the foreseeable future. I advance the notion of 'international rivers as border infrastructures' to highlight the inconvenient truths that the river-border,

typical of any networked system, is uncooperative and subject to breakdown. Contending with disruption and failure should account not just for whatever services the river-border may provision, but also the costs, which are surely the bodily, psychological, livelihood, and economic securities the border is presumably intended to protect.

7. Conclusions

The past decade has witnessed growing calls for political geographers to directly engage the environment as an object of inquiry, rather than subordinate it to the status of a passive stage upon which politics unfold. This demand attends broad awareness of the impact of environmental concerns on political processes and greater appreciation for the environment as a political actor. Within political geography, there has been parallel interest among critical border scholars to address the environmental dimensions of borders and bordering processes. However, scholarship to date has tended to adopt a unidirectional orientation by focusing on the ways that borders impact environmental issues like animal migration and sensitive habitats. While important, such work reinforces nature-society binaries that miss important dynamics in which environments themselves impinge upon and structure border practices.

This study addresses this lacuna through an examination of the Ganges River and Indo-Bangladeshi border. It traces the fates of three river flows (silt, river data, and people) to illustrate how river dynamics are securitized, as well as how they inform border functions and security technologies. In so doing, it builds on existing scholarship that challenges the "natural" border as pre-given or superior to so-called "artificial" borders. However, it also disrupts problematic nature-society dichotomies by establishing international rivers and borders as mutually constitutive and dialectically intertwined. Rather than viewing borders and transboundary environments as distinct, this work highlights how they behave more akin to socio-natural hybrids.

Finally, I draw on infrastructure studies to theorize how transboundary environments function as borders. I elaborate three key characteristics of infrastructures (circulation, failure, maintenance) and apply them to international rivers. This approach reworks prevailing conceptions of transboundary environments as simply being subject to border infrastructures (*e.g.* walls, surveillance towers, chemical defoliants). By highlighting how transboundary watercourses are made to mediate flows across and along borders, it advances the argument that international rivers themselves function as border infrastructure.

Declarations of competing interest

None.

References

Abraham, I. (2014). *How India became territorial: Foreign policy, diaspora, geopolitics*. Palo Alto: Stanford University Press.

Abrar, C. R. (2020). Killings at the Bangladesh-India border. *The Daily Star*. Dhaka https://www.thedailystar.net/opinion/human-rights/news/killings-the-bangladesh-india-border-1855045.

Adel, M. M. (2001). Effect on water resources from upstream water diversion in the Ganges Basin. *Journal of Environmental Quality, 30*, 356–368.

Agamben, G. (2005). *State of exception*. Chicago: Chicago University Press.

Agnew, J. (2008). Borders on the mind: Re-framing border thinking. *Ethics & Global Politics, 1*(4), 175–191. https://doi.org/10.3402/egp.v1i4.1892

Akhter, M. (2019). Adjudicating infrastructure: Treaties, territories, hydropolitics. *Environment and Planning E: Nature and Space, 48*(19), 19. https://doi.org/10.1177/2514848619864913, 251484861986491.

Alatout, S. (2014). From river to border. In D. L. Kleinman, & K. Moore (Eds.), *Routledge handbook of science, technology, and society* (pp. 307–331). Abingdon: Routledge.

Alvarez, C. J. (2019). *Border land, border water*. Austin: University of Texas Press.

Amilhat Szary, A. L. (2014). *Natures of borders: From historical to prospective epistemologies*. In M. Ramutsindela (Ed.). Newcastle upon Tyne: Cartographies of Nature.

Amilhat Szary, A. L., & Giraut, F. (2015). Borderities: The politics of contemporary mobile borders. In A. L. Amilhat Szary, F. Giraut, & Gira (Eds.), *Borderities and the politics of contemporary mobile borders* (pp. 1–19).

Amoore, L. (2009). Algorithmic war: Everyday geographies of the war on terror. *Antipode, 41*(1), 49–69. https://doi.org/10.1111/j.1467-8330.2008.00655.x

Amoore, L., Marmura, S., & Salter, M. (2008). Smart borders and mobilities: Spaces, zones, enclosures. *Surveillance and Society, 5*(2), 96–101.

Anand, N., Gupta, A., & Appel, H. (2018). *The promise of infrastructure*. Durham: Duke University Press.

Bakker, K. (2012). Water: Political, biopolitical, material. *Social Studies of Science, 42*(4), 616–623. https://doi.org/10.1177/0306312712441396

Baldwin, A., Methmann, C., & Rothe, D. (2014). Securitizing "climate refugees": The futurology of climate-induced migration. *Critical Studies on Security, 2*(2), 121–130. https://doi.org/10.1080/21624887.2014.943570

Balibar, E. (2002). *Politics and the other scene*. London: Verso.

Ballestero, A. (2019). The underground as infrastructure? In K. Hetherington (Ed.), *Infrastructure, environment, and life in the anthropocene* (pp. 17–44). Durham: Duke University Press.

Balzacq, T. (2005). The three faces of securitization: Political agency, audience and context. *European Journal of International Relations, 11*(2), 171–201. https://doi.org/10.1177/1354066105052960

Begum, K. (1987). *Tension over the Farakka barrage: A techno-political tangle in south Asia*. Stuttgart: Steiner Verlag Wiesbaden GMBH.

Biggs, D., Miller, F., Hoanh, C. T., & Molle, F. (2009). The delta machine: Water management in the Vietnamese mekong delta in historical and contemporary perspectives. In F. Molle, T. Foran, & M. Kakonen (Eds.), *Contested waterscapes in the mekong region hydropower, livelihoods and governance* (pp. 203–225). London: Earthscan.

Bowker, G. C. (1994). *Science on the run: Information management and industrial geophysics at schlumberger, 1920–1940*. Cambridge: MIT Press.

Boyce, G. A., Chambers, S. N., & Launius, S. (2019). Bodily inertia and the weaponization of the sonoran desert in US boundary enforcement: A GIS modeling of migration routes through Arizona's altar valley. *Journal on Migration and Human Security, 7*(1), 23–35. https://doi.org/10.1177/2331502419825610

British Library India Office (BLIO). (1947). *Report of the bengal boundary commission*. Legislative Department No. F 68/47-R. 17 August 1947. L.D. 48.

British Library India Office (BLIO). (1969). The origins of the frontier between India and East Pakistan. *Research Department Memorandum Annex, 10*. MSS Eur D 768 . (Accessed 19 February 1969).

Carse, A. (2012). Nature as infrastructure: Making and managing the Panama Canal watershed. *Social Studies of Science, 42*(4), 539–563.

Castree, N. (2014). *Making sense of nature*. Abingdon: Routledge.

Chakravarty, I. (2018). On the fence: Fluid and ever changing, the Indo-Bangladesh border defies the idea of a neat boundary. *The Scrolls*. https://scroll.in/article/865586/on-the-fence-fluid-and-ever-changing-the-indo-bangladesh-border-defies-the-idea-of-a-neat-boundary.

Chari, M. (2016). Over 50 years ago, Bengal's chief engineer predicted that the Farakka dam would flood Bihar. *The Scrolls*. https://scroll.in/article/815066/over-50-years-ago-bengals-chief-engineer-predicted-that-the-farakka-dam-would-flood-bihar.

Chatterji, J. (1999). The fashioning of a frontier: The Radcliffe line and bengal's border landscape, 1947-52. *Modern Asian Studies, 33*(1), 185–242.

Chaudary, A. (2015). *India spending $956 million on waste plants along Ganges*. New Delhi: Bloombery Business. retrieved 18 March 2015, from http://www.bloomberg.com/news/articles/2015-02-26/india-spending-956-million-on-waste-plants-along-ganges, 26, 2.

Chowdhury, P. P. (2014). Divided by borders, united by rivers. *Dhaka Tribune, 10*. March: 7.

Chowdhury, S. I. (2020). India shares no info on barrage gates opening. *New Age Bangladesh*. https://www.newagebd.net/article/108679/india-shares-no-info-on-barrage-gates-opening.

Christophers, B. (2011). Follow the thing: Money. *Environment and Planning D: Society and Space, 29*(6), 1068–1084. https://doi.org/10.1068/d8410

Clark, N. (2013). Geoengineering and geologic politics. *Environment & Planning A, 45*(12), 2825–2832. https://doi.org/10.1068/a45646

Cons, J., & Sanyal, R. (2013). Geographies at the margins: Borders in south Asia - an introduction. *Political Geography, 35*(C), 5–13. https://doi.org/10.1016/j.polgeo.2013.06.001s

Cook, I. (2004). Follow the thing: Papaya. *Antipode, 36*(4), 642–664.

Cousins, J. J. (2019). Malleable infrastructures: Crisis and the engineering of political ecologies in Southern California. *ENE Nature and Space*, 1–23. https://doi.org/10.1177/2514848619893208

Crow, B., Lindquist, A., & Wilson, D. (1995). *Sharing the Ganges: The politics and technology of river development*. New Delhi: Sage Publications.

Dalby, S. (2007). Anthropocene geopolitics: Globalisation, empire, environment and critique. *Geography Compass, 1*(1), 103–118. https://doi.org/10.1111/j.1749-8198.2007.00007.x

Deleixhe, M., Dembinska, M., & Danero Iglesias, J. (2019). Securitized borderlands. *Journal of borderlands studies, 34*(5), 639–647. https://doi.org/10.1080/08865655.2018.1445547

Demetriou, O., & Dimova, R. (2018). Introduction: Theorizing material and non-material mediations on the border. In O. Demetriou, & R. Dimova (Eds.), *The political materialities of borders* (pp. 1–15). Manchester: Manchester University Press.

Donaldson, J. W. (2011). Paradox of the moving boundary: Legal heredity of river accretion and avulsion. *Water Alternatives, 4*(2), 155–170.

Dulal, A. A. (2020). 4 Bangladeshi fishermen picked up, tortured by BSF in Rajshahi. *The Dhaka tribune*. https://www.dhakatribune.com/bangladesh/2020/10/22/4-bangladeshi-fishermen-picked-up-tortured-by-bsf-in-rajshahi.

Edwards, P. N., Bowker, G. C., Jackson, S. J., & Williams, R. (2009). Introduction: An agenda for infrastructure studies. *Journal of the Association for Information Systems, 10*(5), 364–374.

Fall, J. (2005). *Drawing the line: Nature, hybridity and politics in transboundary spaces*. Aldershot: Ashgate.

Fall, J. J. (2010). Artificial states? On the enduring geographical myth of natural borders. *Political Geography, 29*(3), 140–147. https://doi.org/10.1016/j.polgeo.2010.02.007

Fall, J. J. (2011). Natural resources and transnational governance. In D. Wastl-Walter (Ed.), *Ashgate Research companion to border studies* (pp. 627–641). Surrey: Ashgate Publishing Limited.

Feldman, S. (2003). Bengali state and nation making: Partition and displacement revisited. *International Social Science Journal, 55*(175), 111–121.

Food and Agriculture Organization of the United Nations, & FAO. (2011). Ganges-Brahmaputra-Meghna river basin. *Water Report 37. AQUASTAT website*. http://www.fao.org/nr/water/aquastat/basins/gbm/index.stm.

Garcia-Alvarez, J., & Puente-Lozano, P. (2017). A controversial natural border: The making of the Spanish-Portuguese boundary along the Minho River (1855-1866). *Geoforum, 79*, 5–16. https://doi.org/10.1016/j.geoforum.2016.11.015

Ghosh, P. (2014). *Cattle smuggling: A dangerous, illegal and highly profitable trade between India and Bangladesh*. New York: International Business Times. http://www.ibtimes.com/cattle-smuggling-dangerous-illegal-highly-profitable-trade-between-india-bangladesh-1553155.

Government of Bangladesh, & GoB. (1996). *Treaty between the government of the people's republic of Bangladesh and the government of the republic of India on sharing of the ganga/ganges waters at Farakka* (Dhaka).

Government of India, & GoI. (1967). *Shri surendra pal singh's statement in rajya sabha on Farakka barrage project. External publicity division. Ministry of external Affairs*. New Delhi: Government of India.

Government of India, & GoI. (1970a). Shri V. V. Chari's statement. *At Islamabad talks on eastern rivers. External publicity division. Ministry of external Affairs*. New Delhi: Government of India.

Government of India, & GoI. (1970b). *Estimates committee 124th report: Farakka barrage project*. New Delhi: Ministry of Irrigation and Power (Government of India).

Graham, S. (Ed.). (2010). *Disrupted cities: When infrastructure fails*. London: Routledge.

Grundy-Warr, C., Sithirith, M., & Li, Y. M. (2015). Volumes, fluidity and flows: Rethinking the 'nature' of political geography. *Political Geography, 45*(C), 93–95. https://doi.org/10.1016/j.polgeo.2014.03.002

Gurung, S. K. (2018). *Smart fencing project along India-Bangladesh border hits rough weather*. New Delhi: The Economic Times. https://economictimes.indiatimes.com/news/defence/smart-fencing-project-along-india-bangladesh-border-hits-rough-weather/articleshow/65845957.cms?from=mdr.

Heemsbergen, L., & Daly, A. (2017). Leaking boats and borders: The virtu of surveilling Australia's refugee population. *Surveillance and Society, 15*(3/4), 389–396.

Hetherington, K. (Ed.). (2019). *Infrastructure, environment, and life in the anthropocene*. Durham: Duke University Press.

Hipfl, B., Bister, A., Strohmaier, P., & Busch, B. (2002). Shifting borders: Spatial constructions of identity in an Austrian/Slovenian border region. In U. Meinhoff (Ed.), *Living (with) borders: Identity discourses on east-west borders in Europe*. Hampshire: Ashgate.

Hossain, M. A., Gan, T. Y., & Baki, A. B. M. (2013). Assessing morphological changes of the Ganges River using satellite images. *Quaternary International, 304*(C), 142–155. https://doi.org/10.1016/j.quaint.2013.03.028

Hossain, M. Z., & Sakai, T. (2008). Severity of flood embankments in Bangladesh and its remedial approach. *Agricultural Engineering International, 10*, 1–11.

Indian Ministry of Home Affairs (MHA). (2019). *Shri Rajnath Singh to inaugurate BOLD–QIT project along international border in Dhubri, Assam tomorrow*. New Delhi: [Press Release. https://pib.gov.in/PressReleaseDetail.aspx?PRID=1567263.

Ingold, T. (1993). The temporality of the landscape. *World Archaeology, 25*(2), 152–174.

Isin, E. (2004). The neurotic citizen. *Citizenship Studies, 8*, 217–235.

Islam, N. (1990). Let the delta be a delta: An essay in dissent on the flood problem of Bangladesh. *The Journal of Social Studies, 48*, 18–41.

Jamwal, N. S. (2004). Border management: Dilemma of guarding the India-Bangladesh border. *Strategic Analysis, 28*(1), 5–36.

Johnson, C., Jones, R., Paasi, A., Amoore, L., Mountz, A., Salter, M., & Rumford, C. (2011). Interventions on rethinking 'the border' in border studies. *Political Geography, 30*(2), 61–69. https://doi.org/10.1016/j.polgeo.2011.01.002

Jones, R. (2012). *Border walls: Security and the war on terror in the United States, India, and Israel.* London: Zed Books.

Kawser, M. A., & Samad, M. A. (2015). Political history of Farakka Barrage and its effects on environment in Bangladesh. *Bandung: Journal of the Global South, 2*(16), 1–14. https://doi.org/10.1186/s40728-015-0027-5

Kolkata Port Trust. (2018). *Global tender for outsourcing the work of maintenance dredging in the shipping channel of kolkta dock system* [Bid Document]. Kolkata http://kolkat aporttrust.gov.in/showtndfile.php?tender_id=4248.

Krause, F. (2016). Rivers, borders, and the flows of the landscape. In A. Kannike, & M. Tasa (Eds.), *The dynamics of cultural borders* (pp. 24–45). Tartu: University of Tartu Press.

Lafaye de Micheaux, F., Mukherjee, J., & Kull, C. A. (2018). When hydrosociality encounters sediments: Transformed lives and livelihoods in the lower basin of the Ganges River. *Environment and Planning E: Nature and Space, 1*(4), 641–663. https://doi.org/10.1177/2514848618813768

Laine, J. P. (2016). The multiscalar production of borders. *Geopolitics, 21*(3), 465–482. https://doi.org/10.1080/14650045.2016.1195132

Larkin, B. (2013). The politics and poetics of infrastructure. *Annual Review of Anthropology, 42*(1), 327–343. https://doi.org/10.1146/annurev-anthro-092412-155522

Lasky, J. R., Jetz, W., & Keitt, T. H. (2011). Conservation biogeography of the US-Mexico border: A transcontinental risk assessment of barriers to animal dispersal. *Diversity and Distributions, 17*(4), 673–687. https://doi.org/10.1111/j.1472-4642.2011.00765.x

Linnell, J. D. C., Trouwborst, A., Boitani, L., Kaczensky, P., Huber, D., Reljic, S., et al. (2016). Border security fencing and wildlife: The end of the transboundary paradigm in eurasia? *PLoS Biology, 14*(6), 13. https://doi.org/10.1371/journal.pbio.1002483. e1002483.

Linton, J., & Budds, J. (2014). The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water. *Geoforum, 57*(C), 170–180. https://doi.org/10.1016/j.geoforum.2013.10.008

Loftus, A. (2020). Political ecology II: Whither the state? *Progress in Human Geography, 44* (1), 139–149. https://doi.org/10.1177/0309132518803421

Ludden, D. (2003). Maps in the mind and the mobility of Asia. *Journal of Asian Studies, 62* (4), 1057–1078.

Marcu, S. (2009). The geopolitics of the eastern border of the European union: The case of Romania-moldova-Ukraine. *Geopolitics, 14*(3), 409–432. https://doi.org/10.1080/14650040802693796

Meehan, K. M. (2014). Tool-power: Water infrastructure as wellsprings of state power. *Geoforum, 57*(C), 215–224. https://doi.org/10.1016/j.geoforum.2013.08.005

Mehta, L., Huff, A., & Allouche, J. (2019). The new politics and geographies of scarcity. *Geoforum, 101*, 222–230. https://doi.org/10.1016/j.geoforum.2018.10.027

Metcalf, B. D., & Metcalf, R. (2012). *A concise history of modern India* (3rd ed.). New York: Cambridge University Press.

Mirza, M. M. Q. (2011). Climate change, flooding in South Asia and implications. *Regional Environmental Change, 11*(S1), 95–107.

Mitchell, T. (2011). *Carbon democracy: Political power in the age of oil.* London: Verso.

Mountz, A. (2011). The enforcement archipelago: Detention, haunting, and asylum on islands. *Political Geography, 30*(3), 118–128. https://doi.org/10.1016/j.polgeo.2011.01.005

Mountz, A. (2015). In/visibility and the securitization of migration. *Cultural Politics, 11* (2), 184–200. https://doi.org/10.1215/17432197-2895747

Müller, A. (2013). Territorial borders as institutions. *European Societies, 15*(3), 353–372. https://doi.org/10.1080/14616696.2012.717633

Nevins, J., & Dunn, T. (2008). Barricading the border. *NACLA Report on the Americas, 41* (6), 21–25.

Newman, D. (2006). Borders and bordering: Towards an interdisciplinary dialogue. *European Journal Of Social Theory, 9*(2), 171–186.

Newman, D. (2011). Contemporary Research agendas in border studies: An overview. *Ashgate Research companion to border studies*. Surrey: Ashgate Publishing. https://doi.org/10.4324/9781315612782.ch2

Nicholls, W. J. (2016). Producing-resisting national borders in the United States, France and The Netherlands. *Political Geography, 51*(C), 43–52. https://doi.org/10.1016/j.polgeo.2015.12.001

Nishat, A., & Faisal, I. M. (2000). An assessment of the institutional mechanisms for water negotiations in the Ganges-Brahmaputra-Meghna system. *International Negotiation, 5*, 289–310.

O'Dowd, L. (2010). From a 'borderless world' to a 'world of borders': "bringing history back in. *Environment and Planning D: Society and Space, 28*(6), 1031–1050. https://doi.org/10.1068/d2009

O'Lear, S. (2018). *Environmental geopolitics*. Lanham: Rowman and Littlefield.

Paasi, A. (1998). Boundaries as social processes: Territoriality in the world of flows. *Geopolitics, 3*(1), 69–88. https://doi.org/10.1080/14650049808407608

Parker, N., & Vaughan-Williams, N. (2009). Lines in the sand? Towards an agenda for critical border studies. *Geopolitics, 14*(3), 582–587. https://doi.org/10.1080/14650040903081297

Peluso, N. L., & Vandergeest, P. (2011). Political ecologies of war and forests: Counterinsurgencies and the making of national natures. *Annals of the Association of American Geographers, 101*(3), 587–608.

Popelka, S., & Smith, L. (2020). Rivers as political borders: A new subnational geospatial dataset. *Water Policy*, 1–20. https://doi.org/10.2166/wp.2020.041

Price, G. (2014). *Attitudes to water in south Asia: Executive summary*. London: Chatham House.

Ramutsindela, M. (2015). Natured borders. *Geoforum, 61*(C), 135–137. https://doi.org/10.1016/j.geoforum.2015.03.007

Rashid, M. (2020). Bangladesh sees highest border killing in decade. *New Age*. https://www.newagebd.net/article/124734/bangladesh-sees-highest-border-killing-in-decade.

Sadoff, C. W., Harshadeep, N. R., Blackmore, D., Wu, X., O'Donnell, A., Jeuland, M., Lee, S., & Whittington, D. (2013). Ten fundamental questions for water resources development in the Ganges: Myths and realities. *Water Policy, 15*(S1), 147–164.

Saha, S., Basu, K., & Phadikar, A. (2012). *Politics and silt choke haldia. The telegraph*. https://www.telegraphindia.com/states/west-bengal/politics-and-silt-choke-haldia-trina mul-fishes-in-troubled-waters-private-operator-loses-lakhs/cid/386029.

Salter, M. B. (2008). When the exception becomes the rule: Borders, sovereignty, and citizenship. *Citizenship Studies, 12*(4), 365–380. https://doi.org/10.1080/13621020802184234

Sattar, M. (2012). Bangladesh-India border: "Wall of death. *Global Post*. http://www.globalpost.com/dispatch/news/regions/asia-pacific/india/111225/india-banglade sh-border.

van Schendel, W. (2005). *The bengal borderland: Beyond state and nation in south Asia*. London: Anthem Press.

van Schendel, W. (2009). *A history of Bangladesh*. Cambridge: Cambridge University Press.

Schwenkel, C. (2015). Spectacular infrastructure and its breakdown in socialist Vietnam. *American Ethnologist, 42*(3), 520–534. https://doi.org/10.1111/amet.12145

Sidaway, J. D. (2019). Decolonizing border studies? *Geopolitics, 24*(1), 270–275.

Singh, S. S. (2015). No non-lethal strategy on borders. *The Hindu*. http://www.thehindu.com/news/national/rajnath-visits-bangladeshborder/article7058004.ece.

Smith, S., Swanson, N. W., & Gökarıksel, B. (2015). Territory, bodies and borders. *Area, 48*(3), 258–261. https://doi.org/10.1111/area.12247

Sneddon, C., & Fox, C. (2012). Inland capture fisheries and large river systems: A political economy of mekong fisheries. *Journal of Agrarian Change, 12*(2), 279–299.

Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist, 43*(3), 377–391.

Star, S. L., & Ruhleder, K. (1996). *Steps toward an ecology of infrastructure: Design and access for large information spaces* (pp. 111–134). Information Systems Research a Journal of the Institute of Management Sciences.

Steinberg, P. E. (2013). Of other seas: Metaphors and materialities in maritime regions. *Atlantic Studies, 10*(2), 156e169.

Sundberg, J. (2011). Diabolic caminos in the desert and cat fights on the rio: A posthumanist political ecology of boundary enforcement in the United States–Mexico borderlands. *Annals of the Association of American Geographers, 101* (2), 318–336.

Surie, M. D. (2014). *Desecuritizing transboundary water in south Asia*. New Delhi: The Asia Foundation. http://asiafoundation.org/in-asia/2014/09/17/desecuritizing-transbo undary-water-in-south-asia/.

Surie, M. D., & Prasai, S. (2015). *Strengthening transparency and access to information on transboundary rivers in south Asia*. New Delhi: The Asia Foundation.

Thakur, P., Laha, C., & Aggarwal, S. P. (2012). River bank erosion hazard study of river Ganga, upstream of Farakka barrage using remote sensing and GIS. *Natural Hazards, 67*, 967–987.

The Economic Times, & TEI. (2019). *Smart fence' along riverine bangla border in Assam by july 2020: BSF DG*. https://economictimes.indiatimes.com/news/defence/smart-fenc e-along-riverine-bangla-border-in-assam-by-july-2020-bsf-dg/articleshow/73020 134.cms.

Thomas, K. (2017a). the river-border complex: A border-integrated approach to transboundary river governance illustrated by the Ganges river and Indo-Bangladeshi border. *Water International, 42*(1), 34–53.

Thomas, K. (2017b). The Ganges water treaty: 20 years of cooperation, on India's terms. *Water Policy, 19*(4), 724–740.

Thomas, K. A., & Warner, B. P. (2019). Weaponizing vulnerability to climate change. *Global Environmental Change, 57*, 101928. https://doi.org/10.1016/j.gloenvcha.2019.101928

Trombetta, M. J. (2008). *Environmental security and climate change: Analysing the Discourse, 21*(4), 585–602. https://doi.org/10.1080/09557570802452920

Van Houtum, H. (2005). The geopolitics of borders and boundaries. *Geopolitics, 10*(4), 672–679. https://doi.org/10.1080/14650040500318522

Wadewitz, L. (2012). Pacific borders. *The nature of borders*. Seattle: University of Washington Press.

Wakefield, S. (2020). Making nature into infrastructure: The construction of oysters as a risk management solution in New York City. *Environment and Planning E: Nature and Space, 3*(3), 761–785. https://doi.org/10.1177/2514848619887461

Weber, L. (2006). The shifting frontiers of migration control. In S. Pickering, & L. Weber (Eds.), *Borders, mobility and technologies of control* (pp. 21–43).

Wouters, P. (2013). *International law: Facilitating transboundary water cooperation*. Stockholm: Global Water Partnership.

Z News. (2015). *22.7 percent border with Bangladesh unfenced: Kiren Rijiju. Z News*. from http://zeenews.india.com/news/india/22-7-percent-border-with-bangladesh-unfen ced-kiren-rijiju_1560035.html.

Zaman, S. S. (2014). *Scanty teesta water hampers irrigation. Dhaka tribune 29 March*.