7 From *nallah* to *nadi*, stream to sewer to stream

Urban waterscape research in India and the United States

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The pure Walden water is mingled with the sacred water of the Ganges.
– Henry David Thoreau, *Walden*, 1854[1]

Comparative international water research is paradoxically ubiquitous and rare. Students read texts that are the product of comparative international experience. Water researchers and professionals travel to international conferences and field sites, and make use of that knowledge at least implicitly in their work. But these groups are unlikely to produce detailed comparisons of water case studies. It is through this paradox that this chapter seeks to contribute to the theme of liquescent materiality. Implicit comparisons operate widely in ways that presumably make a material difference in what is built, operated and experienced, though it may not be clear how. Flows of knowledge, experience and material transformation often remain implicit and indeterminate. Reflecting on this situation, one response would be to try to determine the logic and utility of rigorous international comparison. However, another response would be to let comparisons flow as they will and to develop narrative historical-geographic accounts of how they arise and where they lead.

While recognising the value of making implicit comparisons explicit, this chapter follows the second approach. It compares the historical geography of urban stream degradation and restoration in my home city of Boston with my sojourning city of New Delhi. The scale is "urban", though, as we shall see, urban water is a complex spatial construct whose water supply regions extend far into regional metropolitan hinterlands, to sources far beneath the surface of the land to ever-deeper and declining aquifers, and far downstream to low-lying and degrading wetland, estuarine and coastal environments.

Each urban configuration is different, from its headwaters to the city limits and long plumes of downstream effluents. But they have common characteristics as well, from the early modern era of the 16th century to the present in what are now the countries of India and the United States. Many if not most cities were located along a water body – a stream, lake or coast – often at the crossing of a water body by a road or ferry. These water channels are called rivers or streams in the

United States and *nahrs*, *nadi*s and *nallahs* in northern India. Water bodies known as *nallahs* have had a fascinating history, both the channels themselves and their names. It is widely believed today that a *nallah* is most commonly a *gandah nullah* [sic] – that is, a large, dirty, stinking open sewer. Many if not most urban rivers in the United States were also regarded as foul sewers in the 19th and early 20th centuries, though they did not coin a general name for this phenomenon other than "open sewer". Instead, they acquired iconic images and place names, like "Bubbly Creek", which gave off anaerobic gases from putrefying slaughterhouse wastes discharged into the small Chicago River; the Cuyahoga River in Cleveland, Ohio, which actually caught fire from volatile industrial effluents floating on its surface; and the Love Canal in Niagara Falls, New York, whose toxic wastes contributed to cancers and birth defects.[2] Industrial pollution has compounded the age-old hazards of sanitary waste disposal in urban streams.

Thankfully, that downward trajectory is being confronted, and in some cases reversed, as sanitary wastes are sewered and treated, urban industries are relocated to exurban locations with intensive wastewater recycling facilities, and some measure of water quality regulations are enforced. Some of these adjustments have centuries-old precedents and have been adapted over time to address the changing dynamics of urbanisation and urbanism.[3] Others involve a rediscovery of the value of urban streams, which are redefined as "blue-green urban infrastructure".[4] In still other regions, problematic forms of "bourgeois environmentalism" strive to clean up urban waterscapes while displacing the poor residents on their banks and covering or landscaping the channel and its banks.[5]

My initial aim for this chapter was to document how waterscape designers are restoring degraded urban streams in India and the United States. As I researched the topic, various underlying historical questions arose. Before asking how to transform sewers back into streams, it seemed important to understand how and when *nallahs* came to be associated with pollution. The early definition of a *nallah* was simply a stream or rivulet. What happened? I then asked: how might comparative international water research contribute to an understanding of these processes of urban degradation and ultimately restoration?

It is interesting to compare urban waterscape histories in India and the United States for at least three reasons. The first is that these histories are sometimes connected with one another. Water systems in India have influenced those in the United States and vice versa. Even as independent cases, stream degradation in one country can inform historical trajectories in distant places. Similarly, river restoration efforts in one country can inspire or be adapted for cities in other parts of the world. I will offer examples of each of these processes in the next section. But this type of comparative urban water research between India and the United States remains rare.[6] Important exceptions include comparisons of rainwater harvesting, storm water management and legal applications of the public trust doctrine to urban water bodies.[7]

The geographical foci for this comparison are Boston and Delhi. The first section introduces these two places through paired images. I then review the record of previous comparative water research more systematically and critically. I retrace the evolution of the words *nallah* and drain, which converged in mid-19th-century sanitation movements in India and the United States.

In the United States, this movement was guided by Frederick Law Olmsted's urban sanitary improvement plan for the Back Bay Fens in Boston. Its visionary origin, early failure, adaptation and revival as an urban ecological restoration project offer a rare long-term urban design case study for comparison with recent design proposals for the Barapula Nallah in Delhi. Conversely, Barapula's urban history is many centuries longer, which puts the Boston urban design case study into a broader macro-historical perspective.

*Nallah*s east and west

I began this enquiry with a pair of images in mind. Plate 7.1 presents a highway on-ramp cutting through mature vegetation along the Back Bay Fens in Boston, Massachusetts. The Fens were designed by landscape architect Frederick Law Olmsted in the early 1880s to address urban flooding, sanitary waste disposal and real estate development along the tidal Charles River and its infamously polluted Muddy River tributary.[8] Much more will be said about this iconic case of urban landscape architecture, which is part of Boston's Emerald Necklace of parks that is studied by urban design students worldwide.

Plate 7.1 Back Bay Fens, Boston.
Source: Photograph © James L. Wescoat Jr.

Plate 7.2 presents a comparable view of the new on-ramp to the Barapula Nallah flyover in south Delhi, which runs alongside the Nizamuddin *Basti* (village) whose fame arises from the *dargah* (shrine) of the early 14th-century Sufi saint Hazrat Nizamuddin Awliya (d. 1325), which is a pilgrimage centre for Muslims and other spiritual groups from South Asia and beyond (Plate 7.2). Construction of the highway ramp in 2011 tore up the *nallah* bed and banks, and thereby created an opportunity for redesign. A kilometre downstream from Nizamuddin, the *nallah* passes under the Mughal-period Barapula (12-pier) Bridge, which gives the *nallah* its name, after which it issues into the Yamuna River, which has itself become a polluted channel.[9]

From these initial images, I moved to a second pair to show that initial impressions can be deceiving. Plate 7.3 shows brilliant green algae and aquatic weeds that choke stagnant parts of Boston's Back Bay Fens, and that are the product of nutrient runoff today. The highway deck shades out streambank vegetation (Plate 7.3). A tall variety of invasive reed (*Phragmites*) rings the water edge. Less visible are polluting culverts that drain runoff directly from street surfaces into the water. Nearby views include various forms of litter. Thus, while nicely vegetated from some vantage points, the Back Bay Fens still suffers from chronic environmental pollution.

Plate 7.2 Barapula Nallah, New Delhi.
Source: Photograph © James L. Wescoat Jr.

Plate 7.3 Pollution in Back Bay Fens, Boston.
Source: Photograph © James L. Wescoat Jr.

Plate 7.4 requires some imagination. It indicates that the now degraded Barapula Nallah was once lined with historic architecture and gardens, like the monumental tomb-garden of the Mughal nobleman Khankhanan Abdur Rahim on its northern bank (Plate 7.4).[10] Imagine the bare *nallah* bank as a garden terrace perhaps with a pavilion overlooking the low flow of summer followed by the swollen discharge of the monsoon. The Barapula Nallah has drained the entire Delhi watershed from Shahjahanabad in the north to the Qutb Minar and Mehrauli area in the south. It had substantial social and environmental value for centuries, and like the Muddy River in Boston, it might still be restored. This comparison might thus be called "a tale of two *nallah*s", with disturbing similarities and fascinating differences. However, I first want to situate these cases within the larger context of comparative water research.

The status of comparative international urban water research

Comparative water research between the United States and India has been limited at all scales of enquiry.[11] It should be noted that both countries have federal systems of government, which give states constitutional primacy over water issues, with the exception of navigation, interstate

Plate 7.4 Barapula Nallah, New Delhi.
Source: Photograph © James L. Wescoat Jr.

commerce and international water treaties. A large body of comparative international research has dealt with transboundary issues that involve multiple countries in both regions, but much less research has compared urban water systems.[12]

A second field of comparative study between India, the United States and other regions emanates from Karl Wittfogel's infamous theory of hydraulic societies, which linked state, society and irrigation agriculture in a book titled *Oriental Despotism: A Comparative Study of Total Power*. Theories of irrigation and society may be traced back to the 17th-century travel accounts of Francois Bernier and others, who reported that deteriorating canals in northern India could be attributed to the absence of private property, excessive taxation and oppression of peasants, an idea picked up by Marx and Engels in the notion of an Asiatic Mode of Production and subsequent authors who have been reviewed extensively.[13] Wittfogel argued that large-scale irrigation agriculture in arid environments gave rise to despotic regimes in Asia, the most recent example of which was the Soviet Union. These propositions provoked many comparative studies by other scholars to refute them.

Another related line of comparative irrigation histories shows how a standard of waste and efficiency, known as the "duty of water", diffused from its origins as a measure of steam engine

efficiency in late-18th-century England to colonial canal irrigation in 19th-century northern India, where it established the *maximum* area to be irrigated by one cubic foot per second of *public* canal water. From there it diffused to the western United States where, by contrast, it was reconceived as a way to establish the *minimum* standards of irrigation efficiency for *private* water rights appropriators.[14]

One would think that modern urban water conservation in the 20th century would also receive intensive scientific comparison, but that has not been the case.[15] A systematic bibliographic mapping project showed that urban water systems in India and the United States have rarely been examined through comparative research. Exceptions include urban rainwater harvesting and water utility benchmarking.[16] Another line of comparative international water research involves the public trust doctrine, which originated in disputes over the control of submerged lands.[17] Early cases involved rival claims of access to and control over the resources of tidal lands. However, a landmark US Supreme Court case in 1892 involving the urban waterfront of Chicago (*Illinois v. Illinois Central Railroad Co. v. Illinois*) established the state's inalienable trust responsibility over its submerged lands on behalf of the public.[18] This precedent was cited a century later in environmental law cases in South Asia, starting with M.C. *Mehta v. Kamal Nath* on the Beas River.[19] That case was followed by an urban land use case in Lucknow and a coastal urban access case in Karachi, Pakistan. Most recently, public trust cases involving urban water bodies have been decided in the cities of Jaipur and Lahore.[20] The Jaipur case is particularly relevant, as it involved private restoration of a public *nallah* in exchange for a long-term lease for land reclaimed from the Man Sagar lake bed. The Rajasthan High Court decided that this arrangement violated the public trust doctrine and that the fill lands and *nallah* treatment works must be removed, a decision that was later modified by the Supreme Court of India in 2014.[21] These cases in India extend the public trust doctrine in ways that have relevance for United States urban water, land use and environmental law.

Nala, *nallah*, *nullah* and drain

The word *nallah* is known across most of South Asia, but I know of no investigation of its etymology or evolving usage. It has several different transliterated spellings, three of them used in the 2014 Supreme Court case on Jaipur's Man Sagar lake restoration alone. This section briefly retraces the terminology of *nallahs* to ascertain when and how they acquired the connotation of sewers. A brief discussion follows at the end of this section for the word drain, which is used in both Indian and Euro-American contexts.

Nala is a Persian word meaning small stream, canal or ravine.[22] Some sources suggest that it is associated with the Hebrew word *nahal*, which is similar to a *wadi*, sometimes wet and sometimes dry, which is also the case in subtropical monsoon environments. A more metaphorical yet perhaps associated meaning is the lament of a *nal* as a flute, song or poem. However, the word is more commonly transliterated today as *nallah*. The word *nallah* does not appear in early Mughal texts such as the *Baburnama* or the *Akbarnama*, but Jahangir referred to *nallahs* about a half-dozen times in his memoirs. The word appeared more frequently in the Shah Nawaz Khan's *Maathir-ul-umara*, generally as a place name or general geographic term.[23] Interestingly, it is a key word in the late

Mughal treaty of 1739 between Muhammad Shah and Nader Shah of Iran when the Mughals were forced to cede territory up to the Indus and *Nala Sankara*. Late 18th-century dictionaries continued to define the *nallah* as a stream, small creek, rivulet or, sometimes, ravine.

If we look at common transliterations in English today, the word *nallah* and its variants (with a capital N) are place names, which is still the most common use, and they are secondarily general geographic terms. A Google NGram search indicates that "*nullah*" has been the most common (but least appropriate) transliteration historically, though *nallah* is increasingly used (Plate 7.5). Usage increased and peaked towards the end of the 19th century. These general uses of the word continue with an increase in the *nallah* transliteration. More directly significant for this investigation is the evolving negative connotations of the *nallah*, which begin to appear in the 1850s. For that, it is useful to examine the content of works cited in Plate 7.5. They reveal the following developments:

- 1850s: Early references to odour and filth involved *nallahs* in large cities like Madras and Calcutta (notably Tolly's Nallah), as well as in some hill stations.
- 1863–4: Medical reports recommended that open *nallahs* be converted to covered sewers. They cited health problems associated with monsoon wet and dry seasons.
- 1860s and 1870s: These decades witnessed the development of urban public health regulations. For instance, the Bengal Council Laws of 1864 stated, "The owner or occupier of any part of the bank of any nullah or water course shall keep it free from filth, dense vegetation or other obstruction". An 1872 report from the Sanitary Commissioner of the Central Provinces stated, "A well should not be constructed within 50 yards of a nala, tank, or pool containing stagnant water".[24]

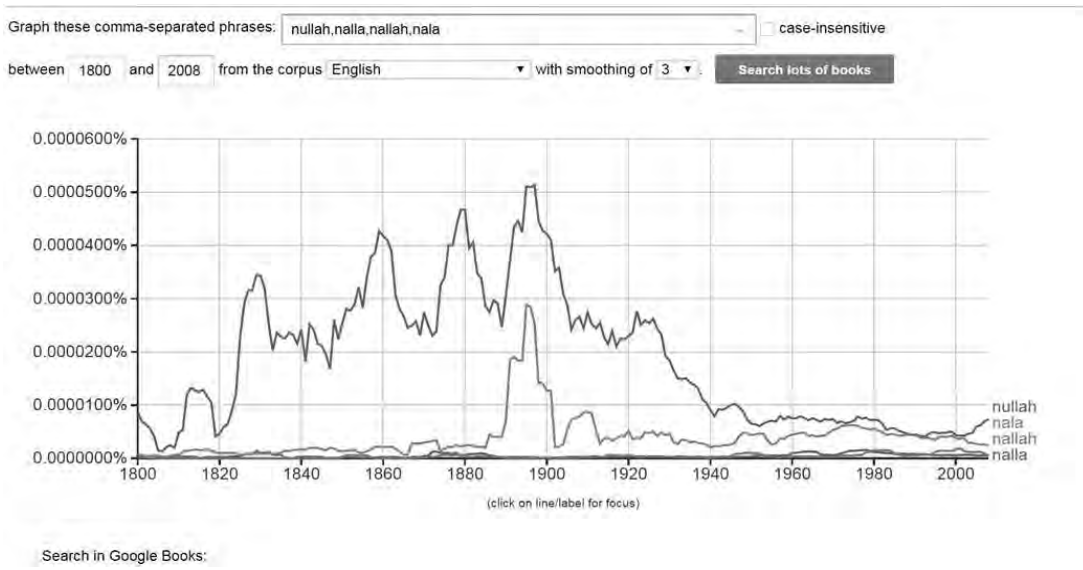

Plate 7.5 Frequency of different *nallah* transliterations over time.
Source: Google NGram Viewer http://books.google.com/ngrams, 17 February 2017

- 1876: Urdu histories and literature also refer to *nallahs*, a notable example of which is Shahjahan Begum's *Táj-ul Ikbál Tárikh*, which discusses the *nallahs*, sewers and larger water systems of Bhopal.[25]
- 1885: The shift in meaning is completed by an entry in volume five of *The Encyclopedic Dictionary*, in which the word "*nullah*" (the most frequent but not accurate transliteration) was defined as a sewer.[26]

It is interesting to observe that the negative shift in meaning associated with *nallahs* coincides with a marked decline of references in Plate 7.5. This trend may reflect a shift underway from public health planning to modern biomedical science, with the formation of the Indian Medical Service in 1896, as well as the increasingly negative connotations of urban stream-sewers.

From the late 19th century onwards, the word *nallah* also became increasingly translated as drain, a word that connotes storm and sanitary wastewater disposal in the English-speaking world as well.[27] The noun drain has an Old English etymology dating back about a millennium and has been associated with natural as well as the more common meaning of artificial channels.[28] Such channels were mentioned as draining urban as well as rural runoff as early as the mid-17th century. However, the association with sewage became strong in the compound word drain-pipe.

In summary, the shift towards negative connotations of urban streams in both regions occurred during the late 19th century, which was associated with urban sanitation movements in India and the United States. Sanitation was a common concern among many, if not most, countries during the second half of the 19th century, as poor water, sanitation and drainage were associated with the miasmic transmission of disease and losses particularly in military camps.[29] These sanitation movements have been subject to extensive critical research in recent years, in part for their impacts on cities and communities. Sanitation measures included ripping out aging housing, draining wetlands and widening transportation corridors to improve "ventilation", laying out distant suburban cantonments and reinforcing social policies of segregation.

The impact of poor sanitation on soldiers was a related driving force. Major reforms originated with the work of Florence Nightingale in the Crimean War that were extended to cantonment health in British India and military sanitation during the American Civil War, which involved landscape architect Frederick Law Olmsted, who radically transformed urban environments through urban parks and waterscape design across the United States.

From Walden Pond to the Muddy River and Back Bay Fens

During the 1860s, Frederick Law Olmsted played a prominent role on the United States Sanitary Commission, a non-governmental organisation influenced by English sanitation reformers Edwin Chadwick, Florence Nightingale and others. Olmsted had prior experience with landscape drainage design for Central Park and other projects, and he went on to incorporate grading and drainage works in most of his urban design projects, such as Boston's Back Bay Fens. Before proceeding to that case study, it is interesting to briefly set the stage with a dramatically different account of water purity in India and the United States.

I speak of Henry David Thoreau's *Walden*, his book on almost two years of simple living beside a small pond in Concord, Massachusetts, about 25 kilometres west of Boston. *Walden* has been

profoundly influential in the history of American social and environmental thought. In the winter of 1854, Thoreau wrote,

> Thus for sixteen days I saw from my window a hundred men at work like busy husbandmen, with teams and horses and apparently all the implements of [ice] farming [. . .] Thus, it appears that the sweltering inhabitants of Charleston and New Orleans, of Madras and Bombay and Calcutta, drink at my well. In the morning I bathe my intellect in the stupendous and cosmogonal philosophy of the Bhagvat-Geeta [sic], since whose composition years of the gods have elapsed, and in comparison with which our modern world and its literature seem puny and trivial; and I doubt if that philosophy is not to be referred to a previous state of existence, so remote is its sublimity from our conceptions [. . .] *The pure Walden water is mingled with the sacred water of the Ganges* [emphasis added].[30]

Thus, while Thoreau was attending to the micro-environmental economics of life at Walden Pond, he was reading Indian philosophical texts and marvelling at their wisdom. More than that, he imagined the *material* connections between Walden Pond and the thirsty cities of India and the American South, just as he critically contrasted the local harmonies of Walden with the dystopic corporate industrial life of urban Boston in the mid-19th century.

Like many leading figures of the time, Frederick Law Olmsted greatly admired Thoreau's courage and critical mind. As editor of *The Nation*, Olmsted published some of Thoreau's writings. However, in contrast with Thoreau, Olmsted sought to transform the heart and soul of American urban environments and lifeways. He attempted this in Boston through a project he called the Back Bay Fens, which drained the Muddy River, a small tributary of the Charles River.[31]

By the 1860s, the urban drainage situation in Boston had become a foul and dangerous mess. The city was growing rapidly, in part through massive filling of tidal wetlands along the Charles River to develop new real estate. This combination of land filling and impervious real estate development increased storm water runoff and flooding of the Muddy River and its floodplain. Initially, the new urban development discharged raw sanitary sewage into these urban streams (call them *gandah nallahs*!), some of which washed out into the river during low tide only to float back into the city at high tide. The people of Boston lived with these sewage flats for over 50 years before coming up with the idea for a partial solution in the 1870s that involved collaboration between Olmsted, the Parks Commission and the city sewer engineer.

Like most growing cities of this era in the United States, Boston created civic agencies, including a Parks Commission whose modest funding allowed it to purchase polluted flats along the lower Muddy River. The Parks Commission held a design competition that Olmsted refused to enter or jury, as he felt the results would not address underlying water problems. When the competition failed to bear fruit, the Park Commission hired Olmsted to prepare a plan, and he entirely reframed the project as one of urban sanitary improvement.[32] Olmsted objected strenuously to calling the project a park, as it lacked the main visual, social and functional qualities of a park. He tried many names, concluding with Back Bay Fens, to describe what today would be called blue-green urban infrastructure.

The Back Bay Fens improvement project put limits on further filling and wetland encroachment. It used raised *bunds*, curved water channels and gentle side slopes to reduce bank erosion from wave action as well as flooding. It included tide gates to regulate drainage and vegetation tolerant of fluctuating brackish flows. The Back Bay Fens design was so successful that it drew elite residential neighbourhood development and major institutions to its banks, including the Boston Museum of Fine Arts, built in the 1890s.

But there were also some failures to adapt the design to its changing context. In 1910, only two decades after construction, the Charles River was dammed downstream, transforming the brackish tidal river into a freshwater reservoir, which undercut all of the hydrologic assumptions of the Back Bay Fens project design, and its tide gate became obsolete. Perhaps for that reason it came to be operated and seen more in aesthetic than urban ecological terms. The first Curator of Indian and Islamic Art in the United States, Ananda K. Coomaraswamy, working in the Boston Museum of Fine Arts on the banks of the Fens, wrote an extraordinary series of essays later compiled under the title *Yakshas: Essays in the Water Cosmology*.[33] These essays discussed Indian water symbols and deities, such as *makaras* (mythic water creatures), *nagas* (serpent kings) and *tirthas* (sacred sites on waterways), as well as folk gods or *yakshas*. Coomaraswamy greatly admired Thoreau's writings and often went to Walden Pond. However, his archives do not refer once to the Back Bay Fens urban water project just outside his office.

The Fens condition worsened over time as it was used as a dump for subway excavation debris, new athletic fields and miscellaneous encroachments from rose gardens to war memorials. Invasive species began to choke its banks, and urban flooding increased in magnitude and severity. Notwithstanding a series of master plans from the 1970s to the present, the Fens became an under-maintained urban park, famous in name if not in eco-hydrologic functions.[34]

However, flood damage in the 1990s prompted a combination of federal and local intervention in a new Muddy River Restoration Project, funded by the US Army Corps of Engineers with an expert public Maintenance and Management Oversight Committee (MMOC).[35] The MMOC has five guiding objectives: 1) mitigation of flood hazards, 2) improvement of water quality, 3) enhancement of aquatic habitat, 4) rehabilitation of landscape and historic resources and 5) implementation of best management practices. Phase I consists of daylighting a buried reach of the Muddy River stream-sewer to reconnect Olmsted's Fenway with the Riverway park upstream. Phase II focuses on ecological restoration but remains unfunded to date. It will involve dredging accumulated sediments to increase storm water storage and also manage the dominant *Phragmites* vegetation along the Fens' margins. Olmsted's vision from 130 years ago is thus being renewed in ways that bear comparison with the Barapula Nallah in Delhi.

From Back Bay to the Barapula Nallah design workshop

Amazingly, a photograph of the Back Bay Fens during its initial construction in the 1890s looks strikingly similar in visual terms to an historical photograph of the Barapula Nallah just downstream of the Nizamuddin area in south Delhi about a decade earlier (Plates 7.6 and 7.7). I have

Plate 7.6 Back Bay Fens, Boston, ca. 1896. Digitised lantern slide. Source: Photograph © Frances Loeb Library, Graduate School of Design, Harvard University, Cambridge, MA, USA, GSD4109di, American Memory Project. Artwork in public domain

Plate 7.7 W. Caney, general view of the Bara Pula [Barapula] Bridge, Delhi, 1875. Source: Photograph © The British Library Board, London, Shelfmark: Photo 1003/(865)

not found references to the *nallah* in Sultanate or early Mughal texts, though its significance as a boundary between Nizamuddin (then called Ghiyaspur) and the late-13th-century riverfront capital of Kilokri to the south must have been significant. The siting of Kilokri palace to the south and Ghiyaspur settlement to the north constitutes an important framing of the nallah's significance in south Delhi. The Mughal Barapula bridge and subsequent funerary complexes in the 16th and 17th centuries helped defined the riparian landscape, but few textual references to it survive. In the early 18th century, the Barapula Nallah was mentioned as a place name just south of Shahjahanabad.[36] Alexander Cunningham's archaeological survey of Delhi also recorded the *nallah* and monuments near it in 1874.[37]

The next type of reference to the Barapula Nallah occurred in late-19th-century colonial public health surveys, coinciding with similar surveys in Euro-American cities undergoing sanitary reform along the lines mentioned in Boston earlier. These were not detailed documents of the sort prepared for the Tolly's Nallah in Calcutta in the late-19th century, when the colonial government was still headquartered there.[38] Modern sewerage and wastewater treatment proposals for New Delhi's *nallahs* were elaborated later, after the shift of the new capital there in 1912.[39] These engineering treatments continued with episodic civic attention through the 20th century leading to periodic desilting, bank stabilisation and channel engineering for hydraulic efficiency. Planning at the turn of the 21st century included slum eviction and transportation infrastructure to provide access to the 2010 Commonwealth Games.

I have travelled across and along the *nallahs* of Delhi for several decades now, and these experiences have involved a mixture of historical interest, sensory affront and imagining the prospects for restoration design. Years ago, there were large squatter settlements along the *nallahs* upstream and downstream of the Nizamuddin area. Many of these *jhuggi jhopris* (temporary accommodations) were forcibly evicted. Their displacement was alternately lauded and criticised as the growing "bourgeois environmentalism" of New Delhi.[40] More recently, designers like Morphogenesis and Oasis Design have proposed restoring the *nallahs* to *nadis* (streams) that can serve as blue-green infrastructure for the city.[41] Several improvement projects have been built over *nallahs*, a notable example of which is Delhi Haat, an outdoor regional craft and restaurant emporium in the western part of the city. More commonly, *nallahs* have been buried in sewers and covered by new urban development on bridge decks. The lower Barapula Nallah in south Delhi, however, remains an open drain.

The Aga Khan Trust for Culture (AKTC) has prepared and undertaken restoration design proposals for this reach of the Barapula Nallah.[42] The AKTC has led an expansive programme of urban revitalisation in the Nizamuddin area for over two decades.[43] The first phase of its work focused on the restoration of the Humayun's tomb gardens, which was a gift from the Aga Khan IV to India on the 50th anniversary of independence in 1997. That work was completed in 2003 and followed by an expanded programme of conservation that includes 1) socio-economic development in the Nizamuddin *basti* (urban village), 2) architectural conservation at Humayun's Tomb and 3) development of the Sundar Nursery as an urban environmental park. The Nizamuddin *basti* programme involved improvements in housing, schools, sewers, plantings and health facilities along the *nallah*. AKTC removed truckloads of silt and solid waste from the *nallah* bed. They

mapped and rebuilt local sewer lines. However, the 2010 Commonwealth Games highway flyover alignment followed the *nallah*, which involved massive construction activity in the channel (see Plate 7.2). Landscape architect Muhammad Shaheer prepared a *nallah* improvement plan for the AKTC, and the construction of terraces and plantings began in 2016 with substantial clean up in 2018.

Commonwealth Games construction activities in the lower reaches of the Barapula Nallah led to urban scale investigations.[44] The Aga Khan Program for Islamic Architecture at the Massachusetts Institute of Technology was fortunate to be able to work with AKTC on a design workshop to identify potential improvements in the Barapula Nallah. AKTC planner Shveta Mathur posed four guiding questions:

1 Can you develop a large-scale watershed perspective on the Barapula Nallah?
2 Can you develop proposals to enhance riparian landforms and ecosystems?
3 Can you link these watershed and riparian proposals with local socio-economic needs that would benefit the Nizamuddin community?
4 Can you link these socio-environmental proposals with cultural landscape heritage conservation for the Nizamuddin area?

This section of the chapter briefly reports on the design workshop's response to this suite of questions.

At the watershed scale, the first finding was that the Barapula Nallah drained the entire Delhi Ridge and Plains from Shahjahanabad to Mehrauli (Plate 7.8). Its headwaters served fortresses and Sufi shrines, including the Chishti progression from the shrine of Qutbuddin Bakhtiar Kaki to those of Nasiruddin Chiragh Delhi and ultimately Nizamuddin Awliya.[45] Along the way, the Kushak Nallah subwatershed and its tributaries passed through Sultanate water structures from the Hauz Shamsi to Hauz Rani, Satpula sluiceway and Chiragh Delhi Sufi shrine village. Although heavily modified, it is still possible to discern the urban watershed drainage and to some extent its hydrology. Comparatively, we notice similar uncertainties about the urban watershed in Boston, which also has aggravated urban runoff, flooding and stream pollution. Without a watershed analysis, however, it is not possible to understand or manage the hydrology of an urban water system, let alone its local streams, tanks and wells.

Urban water problems express themselves most vividly in polluted stream channels. A large portion of Delhi's raw sewage flows into various reaches of the Barapula Nallah. It comes from the vast sewage networks that drain the city, not always into interceptor sewers as required by design standards and regulations, but as raw sewage discharged into stream channels. Olmsted addressed similar issues in the problematic lower reaches of the Muddy River. As in Delhi, his design combined interceptor sewers for sanitary wastewater with the Back Bay Fens landscape for storm water storage. As mentioned earlier, however, Olmsted's sewer systems were quickly superseded by the damming of the Charles River and by a combined sewer pumping system to an outfall in Boston Harbour.

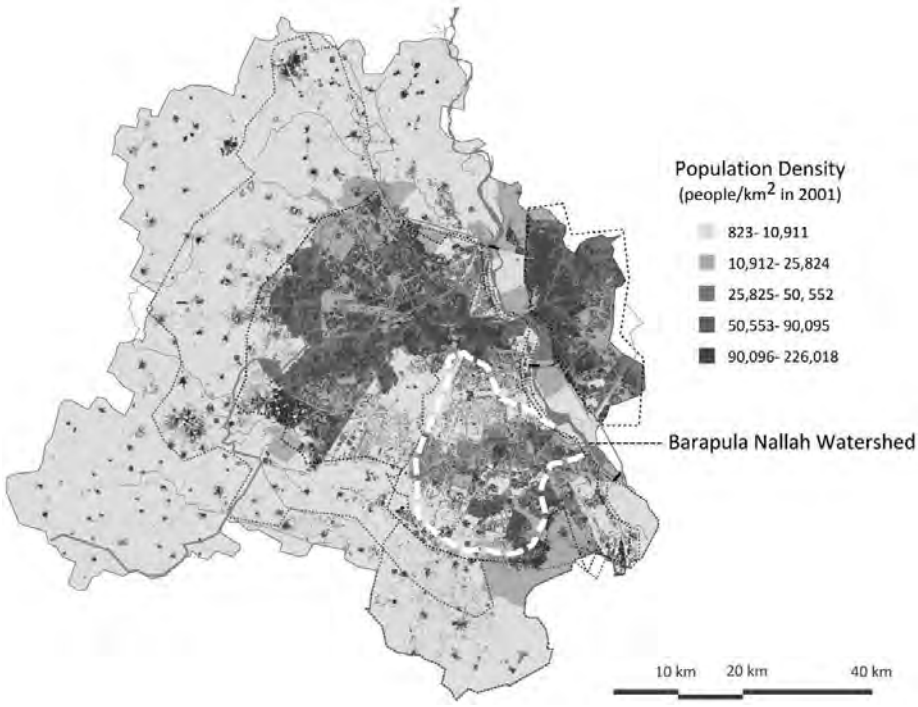

Plate 7.8 Watershed scale studies relevant for the Barapula Nallah stream restoration, 2012.
Source: Photograph © MIT Aga Khan Program Design Workshop, Celina Balderas-Guzman designer, James Wescoat instructor

Delhi also has plans to build or repair its interceptor sewers, the most fully documented of which are for the Najafgarh Drain in the northern part of the city.[46] Some green wastewater engineering design alternatives have also been proposed in south Delhi. They include constructed wetlands along the banks and bed of the *nallah* and in-channel treatment through lagoon and reedbed systems.[47] Our workshop also examined lagoon alternatives, which may be promising in the Nizamuddin reach. If the open sewer can be transformed back into a stream, through a combination of pollution prevention, interceptor sewers and in-channel treatment, landscape site design proposals have good prospects for success. Site design on a polluted channel could perhaps serve as a catalyst for cleaning up the root causes of channel degradation, but that is unlikely. More commonly, stream restoration precedes and helps support new site design improvements, investments and community benefits.

Sites selected for local design studies along the Barapula Nallah are interesting to compare with those along the Muddy River in Boston. The latter include large open spaces, like Jamaica Pond,

which have not developed along the Barapula Nallah corridor. Both case studies have elegant historical bridges and bridge proposals. Barapula design proposals include redesigned bridges and bridge abutment areas along the banks of the *nallah*. Two small pedestrian bridges connect the Nizamuddin Basti with an adjacent neighbourhood and a community graveyard across the *nallah* (Plates 7.9 and 7.10). The graveyard bridge is known as the Shab-i Barat Bridge, named after an annual festival that involves an evening procession across the illuminated bridge. In addition to an improved bridge, the workshop designers proposed a small tea stall on one side and graveyard entry garden on the other. The Barapula Bridge itself was selected for conservation design and community improvements on both sides of the *nallah*. At the larger neighbourhood scale, an area of the *nallah* near Nizamuddin Railway station received an urban design proposal for a civic water and environmental science centre to conduct field experiments and training. A fourth proposal would reconnect the Khankhanan Abdur Rahim tomb-garden with the *nallah* waterfront. These site design scale proposals addressed socio-economic and cultural dimensions of the *nallah*, as well as ecological design proposals at the reach scale, and socio-hydrologic planning concepts at the urban watershed scale.

Plate 7.9 Children playing in Shab-i Barat Nallah bridge area, 2012.
Source: Photograph © MIT Aga Khan Program Design Workshop photograph, James Wescoat instructor

Plate 7.10 Site design proposal for Shab-i Barat bridge area, 2012.
Source: Photograph © MIT Aga Khan Program Design Workshop, Jheng Jie designer, James Wescoat instructor

Conclusion

Cities around the world have historically despoiled, and now seek to restore, their urban streams. They have turned their streams into sewers, *nallahs* and drains. I have shown in this chapter how the words *nallah* and drain came to connote sewers by the mid-19th century. In the case of *nallahs*, the deterioration of meaning as well as material conditions led to the point where the word only connotes a *gandah nallah* (filthy sewer) at present. Drains have maintained a wider range of meanings related to storm water as well as sanitary wastewater, and the reclamation of urban drains in the United States is at this point moving well ahead of *nallah* restoration in India.[48]

However, another conclusion from this study is the value of thinking on longer historical time scales than those conventionally involved in modern environmental planning and design. That lesson was borne out not only in the language of *nallahs* and drains but also in the antecedent histories of urban streams, which proved to be significant in explaining the siting of Nizamuddin in relation to its nearby water benefits. A related lesson is to think at multiple scales, from the watershed to the steam reach and local sites. In principle, the scaling of water enquiry can go in either direction from site to watershed or watershed to site. In this study, we found that over long time scales larger watershed functions must be addressed before reach and site design proposals can be fulfilled. It is possible to do site design without reach or watershed interventions, but not

in a way that will satisfy basic socio-hydrologic, eco-hydrologic or experiential requirements. The watershed scale was also found to be crucial for flood mitigation in Boston, and for storm water drainage and water pollution abatement in both cities.

The reach scale was found to be a crucial nexus for pollution control, water quality treatment and landscape corridor design. Without effective interceptor sewers, in-channel water treatment and riparian landscape design, there can be little meaningful environmental design at the site scale. Many *nallah*s and urban streams remain noxious sewers. In-channel treatment has a long way to go to be effective in Boston for storm water management and nutrient control, and in Delhi for sanitary wastewater treatment. Should these watershed and reach conditions be fulfilled, the people-centred aims of site design can also be achieved. Neither case study has fulfilled these preconditions to date. In fact, the lesson from Boston was that initial design success in the Back Bay Fens was undermined within 20 years by modification of initial conditions and assumptions, followed by 50 years of unfulfilled plans that are only now being addressed. This is a sobering example for water and environmental planners in Delhi.

Another interesting comparison is that the Back Bay Fens project established an historic landscape design within an urban area that had no precedents but that became an attraction upon completion. By comparison the Barapula Nallah was the main attractor for the siting of historic places from Sufi shrines to Mughal tomb gardens and bridges. Upstream reaches in both urban streams have important historical sites, from the Arnold Arboretum in Boston to Chiragh Delhi on the Kushak Nallah. Boston has linked these sites with greenways, and Delhi proposes to do so. Both systems have upstream water impoundments and controls. In Boston, Jamaica and Ware Ponds have inlet and outlet weirs, which are analogous to those of the Satpula and Hauz Khas water complexes in Delhi. Delhi has larger Sultanate-period masonry water control structures than one finds at the metropolitan water system scale in Boston, which encourages bold urban water design thinking in Boston at the site scale as well. With new urban hydrologic models and technologies, it is possible to reconnect these individual watershed processes, reaches, structures and communities.

Although profoundly different in many ways, it is productive to compare these two urban streams. The Barapula Nallah and its tributaries have a far deeper, almost millennium-long, medieval heritage of urban water architecture. The cities of Delhi have reframed these water resources and heritage values many times, and in many ways, which may also be anticipated in Boston. The two streams have more closely comparable histories in the 19th century, when the flow of sanitation planning and policy was international in extent. Olmsted's dramatic reframing of the Muddy River stands out as a premier example of urban sanitation improvement, notwithstanding its mixed performance over time. As criticisms of 19th sanitation programmes are absorbed in new approaches to 21st century urban water planning, their potential for shaping new approaches to environmental health problems in both cities has enormous promise. At present, both urban streams have stimulating proposals for restoration that emphasise various combinations of grey and blue-green infrastructure. This chapter shows that such proposals can be informed and inspired by comparative historical-geographic enquiry.

Notes

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1 Henry David Thoreau, *Walden, or A Life in the Woods*, Boston: Ticknor & Fields, 1854, p. 225.

2 Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England*, Amherst: University of Massachusetts Press, 1994, who charted widespread examples of urban stream exploitation in the region of the US considered here.

3 Urbanisation refers to processes of urban spatial and physical development, as compared with urbanism which refers more to the culture of cities.

4 Ramboll Foundation, Liveable Cities Lab, 'Enhancing Blue-Green and Social Performance in High Density Urban Environments', 2016. Published online as 'Strengthening Blue-Green Infrastructure in our Cities', https://issuu.com/ramboll/docs/blue-green_infrastructure_lcl_20160, accessed on 19 June 2017.

5 Amita Baviskar, 'Cows, Cars and Cycle-Rickshaws: Bourgeois Environmentalism and the Battle for Delhi's Streets', in Amita Baviskar and Raka Ray (eds.), *Elite and Everyman: The Cultural Politics of the Indian Middle Classes*, New Delhi: Routledge, 2011, pp. 391–418; Gautam Bhan, '"This Is No Longer the City I Once Knew": Evictions, the Urban Poor and the Right to the City in Millennial Delhi', Environment and Urbanization, vol. 21, no. 1, 2009, pp. 127–42; The Displacement Research and Action Network, *India Displacement Research*, http://displacement.mit.edu/delhi-1//, accessed on 19 June 2017.

6 James L. Wescoat Jr., 'Searching for Comparative International Water Research: Urban and Rural Water Conservation Research in India and the United States', *Water Alternatives*, vol. 7, no. 1, 2014, pp. 199–219.

7 James L. Wescoat Jr., 'Submerged Landscapes: The Public Trust in Urban Environmental Design, from Chicago to Karachi and Back Again', *Vermont Journal of Environmental Law*, vol. 10, July 2009, pp. 435–75.

8 Cynthia Zaitzevsky, *Frederick Law Olmsted and the Boston Park System*, Cambridge: Belknap Press, 1992. A song titled *Dirty Water*, named after the Muddy River, had the refrain, "Well, I love that dirty water / Oh, Boston you're my home" (The Standells, 1966), www.lyricsmode.com/lyrics/s/standells/dirty_water.html, accessed on 19 June 2017.

9 Bharat Lal Seth and Suresh Babu, *Sewage Canal: How to Clean the Yamuna*, New Delhi: Centre for Science and Environment, 2007.

10 John Seyller, *Workshop and Patron in Mughal India: The Freer Ramayana and Other Illustrated Manuscripts of 'Abd al-Rahim*, Seattle: University of Washington Press, 2008.

11 Other overviews include James L. Wescoat Jr., 'Comparative International Water Research', *Journal of Contemporary Water Research & Education*, no. 142, 2009, pp. 61–6.

12 Such as comparisons between the Indus or Ganges and other large or international rivers, for example the Mekong, the Colorado, Mississippi and the Nile. See, for example, Neda A. Zawahri, 'International Rivers and National Security: The Euphrates, Ganges-Brahmaputra, Indus, Tigris, and Yarmouk Rivers',

Natural Resources Forum, vol. 32, no. 4, 2008, pp. 280–9. Integrated river basin development has been exported internationally, emanating from the Tennessee Valley Authority (TVA) in the United States, to the Damodar Valley in India in the 1940s. For a superb historical treatment see Daniel Klingensmith, *"One Valley and a Thousand": Dams, Nationalism and Development*, New Delhi, Oxford University Press, 2007. More could be done to compare the multi-decadal interstate tribunals in India with interstate compacts in the United States. The fields of comparative law and comparative politics are more developed than other water-related subdisciplines, which, along with international funding to address large-scale development issues, helps account for research in those fields.

13 Jessica Teisch, *Engineering Nature: Water, Development, and the Global Spread of American Environmental Expertise*, Durham: University of North Carolina Press, 2011; James L. Wescoat Jr., 'Wittfogel East and West: Changing Perspectives on Water Development in South Asia and the US, 1670–2000', in Alexander B. Murphy and Douglas L. Johnson (eds.), *Cultural Encounters with the Environment: Enduring and Evolving Geographic Themes*, Lanham: Rowman & Littlefield, 2000, pp. 109–32; James L. Wescoat Jr., 'Water Rights in South Asia and the United States: Comparative Perspectives, 1873–1996', in John F. Richards (ed.), *Land, Property, and the Environment*, Oakland: Institute for Contemporary Studies Press, 2001, pp. 298–337; James L. Wescoat Jr., 'Water Policy and Cultural Exchange: Transferring Lessons From around the World to the Western United States', in Douglas Kenney (ed.), *Search of Sustainable Water Management: International Lessons for the American West and Beyond*, Cheltenham: Edward Elgar Publishing, 2005, pp. 1–24.

14 David Gilmartin, 'Water and Waste: Nature, Productivity and Colonialism in the Indus Basin', *Economic and Political Weekly*, vol. 38, no. 48, 2003, pp. 5057–65; James L. Wescoat Jr., 'Reconstructing the Duty of Water: A Study of Emergent Norms in Socio-Hydrology', *Hydrology and Earth Systems Science*, vol. 17, no. 12, December 2013, pp. 4759–68.

15 Wescoat, 'Searching for Comparative International Water Research'.

16 Water utilities benchmarking is carried out by the American Water Works Association, the International Water Association, the Asian Development Bank and others.

17 Wescoat, 'Submerged Landscapes'.

18 *Illinois Central Railroad v. Illinois*, 146 U.S. 387, 1892.

19 M.C. *Mehta v. Kamal Nath and Others*, 1 SCC 388. Supreme Court of India, 1997.

20 Jaipur lake bed case, *Prof. K.P. Sharma v. State of Rajasthan and Ors.*, consolidated, Rajasthan High Court decision, http://hcraj.nic.in/Jalmahal.pdf, accessed on 19 June 2017.

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24 Government of India, *Abstract of the Proceedings of the Sanitary Commissioner with the Government of India, during the Year 1872*, Calcutta: Office of Superintendent of Government Printing, 1873.

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27 *Oxford English Dictionary* online, citing Verney L. Cameron, *Across Africa*, 'The Main Drain of the Country Is the Walé nullah', *London: G. Philip & Son, 1*885, p. 511.

28 This section draws on the *Oxford English Dictionary* online for "drain" as a noun and verb, accessed on 16 May 2015.

29 Paul Duffy, *The Sanitarians: A History of American Public Health*, Urbana: University of Illinois Press, 1992; Mark Harrison, *Public Health in British India: Anglo-Indian Preventive Medicine 1859–1914*, Cambridge: Cambridge University Press, 1994.
30 Thoreau, *Walden*, p. 222.
31 Zaitzevsky, *Frederick Law Olmsted*.
32 Frederick Law Olmsted, 'Tenth Annual Report, Boston Park Commissioners, Report on Back Bay', in *The Papers of Frederick Law Olmsted: The Early Boston Years, 1882–1890*, Vol. 8, Baltimore: Johns Hopkins University Press, 2014, pp. 228–31.
33 Ananda K. Coomaraswamy, *Yakshas: Essays in the Water Cosmology, New Edition*, ed. Paul Schroeder, New Delhi: Oxford University Press, 1993.
34 Anne Spirn has argued that landscape preservationists in the 1990s missed the mark by seeking to restore Olmsted's scenery rather than address urban social and environmental functions in the way Olmsted did. Anne W. Spirn, 'Constructing Nature: The Legacy of Frederick Law Olmsted', in William Cronin (ed.), *Uncommon Ground: Rethinking the Human Place in Nature*, New York: W.W. Norton, 1995, pp. 91–113.
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38 The Punjab Public Administration report for 1896–97 mentions expenditure for a *pucca* (masonry) well along the Delhi-Mathura Road near the Barapula nallah. Government of India, *Report on the Administration of the Punjab and Its Dependencies for 1896–97*, Lahore: Punjab Government Press, 1897, p. 180.
39 Commonwealth Shipping Committee, *Report*, vol. 20, London: H.M. Stationery Office, 1913, p. xlii.
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41 Akash Hingorani, 'Master Plan of South Delhi Greenway: Sustainable Urban Life', *LA! Journal of Landscape Architecture*, vol. 27, issue 1, 2010, pp. 37–45; and Pradeep Sachdeva for his work on Dilli Haat and other *nallah* improvement proposals, www.psda.in/, accessed on 19 June 2017.
42 Earlier studies of the Barapula Nallah include Pallavi Kalia Mande's thesis at the TVB School of Habitat Studies in Delhi. Landscape architect Muhammad Shaheer has prepared plans for improving the *nallah* in the Nizamuddin *basti* reach as part of the AKTC's urban renewal initiative.
43 See AKTC Annual Reports, www.nizamuddinrenewal.org, accessed on 19 June 2017.
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45 James L. Wescoat Jr., 'Watershed Architecture in Sultanate and Mughal Delhi: An Historical Geography of the Barapula Nallah & Its Tributaries', *Marg*, special issue on Water Architecture (Mumbai: Marg, 2016), pp. 84–95.
46 Department of Delhi Jal Board, *Laying of Interceptor Sewer along Najafgarh, Supplementary and Shahdara Drain for Abatement of Pollution in River Yamuna Revised Detailed Feasibility Report*, New Delhi: Department of Delhi Jal Board, 2008. I am not aware of comparable engineering documents to date for the Barapula Nallah or its tributaries.
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these technologies is substantial. See US Environmental Protection Agency, *Report to Congress: Municipal Wastewater Lagoon Study*, Washington, DC: US Environmental Protection Agency and the Office of Municipal Pollution Control, 1987. That report includes discussion of advanced pond and lagoon treatment technologies, such as those pioneered by Dr. Bailey Green of Oswald Green Technologies, www.oswaldgreentech.com/, accessed on 19 June 2017.

48 An important exception is the Osho Ashram's restored *nallah* in the city of Pune.

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