James L. Wescoat Jr.

WATERSCAPES AND WATER-CONSERVING DESIGN

In summer 2009, temperatures in Delhi soared to 40+ celsius with delayed monsoon rains and increasing power outages. As the city fast-tracked new Metro lines and other infrastructure for the 2010 Commonwealth Games, millions lacked reliable water services, and far too many still required safe water and sanitation of any kind. The River Yamuna and its *nullah* tributaries festered while infrastructure, earthworks, and parking structures unfolded in their beds.

And still "the stepwell is half-full," to adapt a metaphor, with advances in waterscape design within the wider environmental and cultural contexts of India. This essay appraises current challenges and innovations in the human-hydrological cycle, that is, in the joint relationships between hydrologic processes and human water uses, from rainwater harvesting to stormwater, irrigation, tank systems, river restoration, wastewater reuse, and coastal water management. Each section assesses what might yet be achieved through innovative landscape architectural design. The essay concludes with an expanded model for water-conserving design.

perhaps the cultural meanings of monsoon rainfall as expressed in music, painting and poetry...

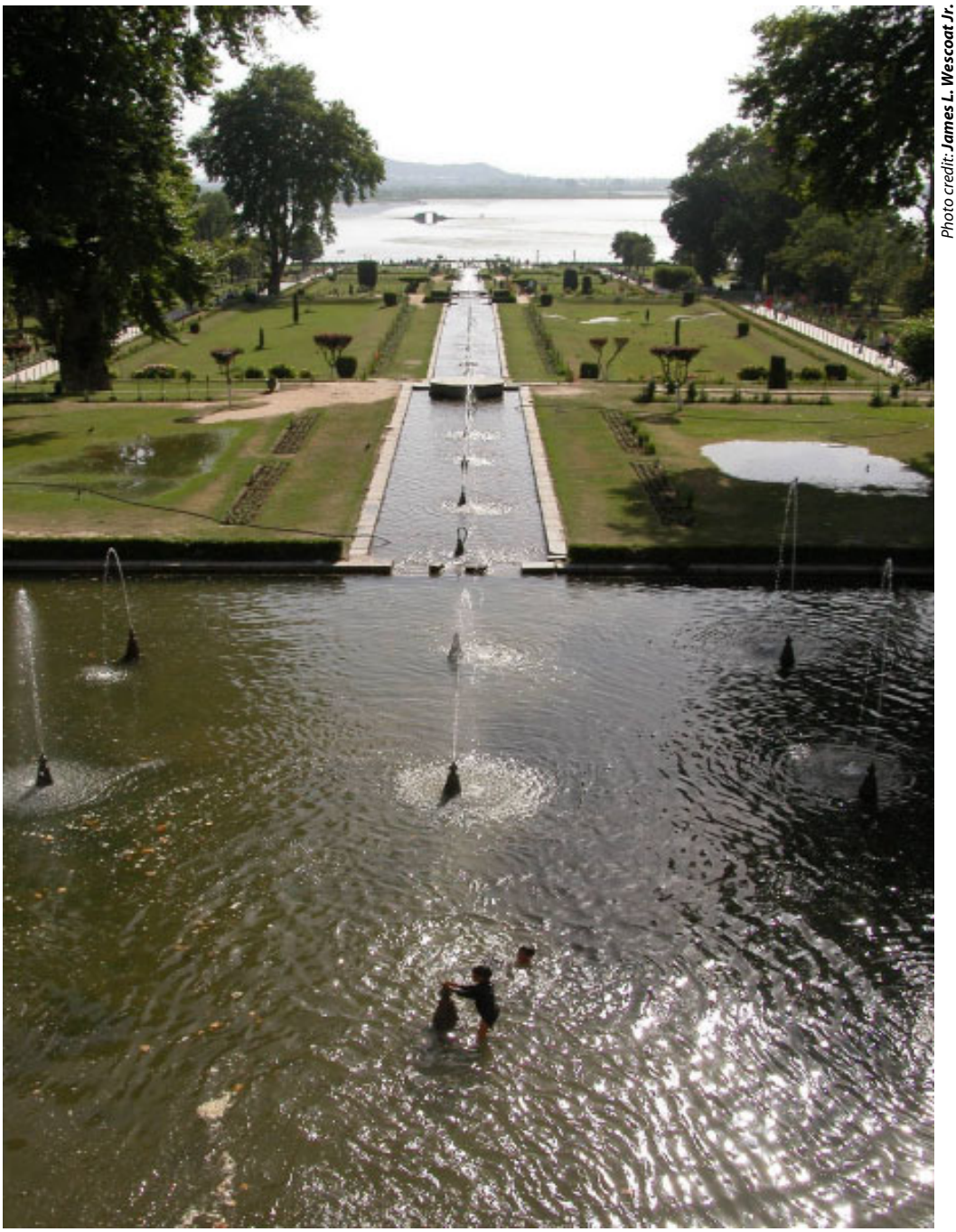


Photo credit: **James L. Wescoat Jr.**

...and enjoyed on tree swings, streets, and rooftops have played a role in India's leadership in rainwater harvesting

Precipitation, climate, and water harvesting

The turn of the 21st century has witnessed exciting diffusion of rainwater harvesting from rural catchments to suburban rooftops and urban regulations in South Asia and beyond, inspired in significant measure by work of the Centre for Science and Environment and other organizations in India. Perhaps the cultural meanings of monsoon rainfall as expressed in music, painting and poetry, and enjoyed on tree swings, streets, and rooftops have played a role in India's leadership in this field. Traditional rainwater harvesting technologies need to be further refined and integrated with modern water supply systems. Rainwater harvesting is also the beginning of a landscape design that focuses on the skies – on humidity, clouds, haze, fog, and dew. Snow and ice are a related design opportunity in mountain regions where, for example, Himalayan and Karakorum communities channel snowmelt from warm south-facing slopes to cool north-facing slopes to refreeze it for use in later summer months. Climate change remains the great frontier for waterscape design at all scales.

Infiltration, soil moisture, and urban drainage landscapes

Soil moisture provides vital support for vegetation and stormwater management, but it is largely mismanaged in urbanizing areas in ways that increase runoff, sedimentation, and parched soils. Stormwater regulations have driven creative site design for infiltration, drainage, and composting in many regions of the world. Landscape architecture may draw upon its agrarian roots to raise consciousness of soil moisture conservation to a level comparable with rainwater harvesting. The challenges in India are enormous as impervious and compacted surfaces expand in urbanizing regions. Drainage strategies for Saket neighbourhood in south Delhi, will be profoundly different from those for Shahjahanabad in North Delhi or Shahdara in East Delhi.

Evapotranspiration, irrigation efficiency, and the aesthetics of planting design

Economic growth increases water demand and scarcity, which must drive higher landscape irrigation efficiencies. Landscapes of late-20th century India continued to rely on flood irrigation methods and simple sprinkler irrigation controllers. Advances in irrigation science and technology have lowered micro-irrigation costs and enhanced controller technologies based on real-time precipitation, evapotranspiration, and soil moisture conditions zoned for different types of plantings. South Asia has produced some of the most innovative social research on irrigation. Opportunities to adapt advanced irrigation methods from Indian Council of Agricultural Research, Central Arid Zone Research Institute, and other Indian agricultural research centers abound. In a parallel vein, re-discovery of native flora and the aesthetics of naturalistic planting have enormous potential for water and landscape design, but they require greater public appreciation of deciduous and dormant as well as lush green foliage. Long-distance production and transport of exotic and overused ornamental species occur in India as elsewhere. These plantings suffer terribly when water shortages hit, raising important questions about the ethics of planting design. Naturalistic planting projects are underway in the Sundar Nursery project in Delhi through collaboration of the Central Public Works Department, the Archaeological Survey of India, and the Aga Khan Trust for Culture; and in the hyper-arid Rao Jodha desert garden design of naturalist and eco-botanist Pradip Krishen and the Mehrangarh Museum Trust.

FACING PAGE
Nishat Bagh, Srinagar, Kashmir, July 2009

what might "wise" landscape development look like, from the mountains to the sea, and how might it evolve over time?

Groundwater landscapes

Most cultures find deep water mysterious because it is less visible, more complex in its movement, and highly evocative when it emerges as springs. Sweet groundwater has relatively constant cool temperature and natural filtration. Landscape development places enormous pressure on these precious groundwater resources, lowering water tables, depleting renewable supplies, and altering aquifer structure and quality. Proliferation of "tubewell landscapes," has taken advantage of powerful pumping technologies in ways that jeopardize underregulated groundwater resources. How might such landscapes look if abandoned 5, 10 or 20 years hence? Research in other regions indicates that formerly irrigated landscapes do not revert to native vegetation without passing through long periods of weedy succession. Urban "stepwell landscapes," by comparison, have largely gone out of use. Although increasingly rediscovered and restored in architectural terms, their waters are less often used in ways that rural, irrigation and temple tanks have demonstrated over the course of centuries in areas of South India.

Riparian Runoff and Reuse: From *Nahr* to *Nullah* and Back Again

Equally severe are degrading trends in riverine landscapes of India. Increasing withdrawals for agricultural, urban, and industrial use are aggravated by concentrated pollution from these uses, which transforms transformed rivers into *nullahs* and lakes into dumps. To be sure, some waterscapes irrigated with partially-treated effluent enhance plant growth and reduce treatment costs. Water reuse has great potential, provided public health hazards associated with human contact and food consumption are incorporated in design. River depletion notwithstanding, flash flooding remains a dominant hazard in both monsoon and montane regions, which argues for greater emphasis on innovative floodplain landscape design in India. A key design question is how larger urban nullahs and lakes can be redesigned for enhanced human-hydrologies. Covering *nullahs* with mixed use development has worked in some places. IIT-Delhi has successfully experimented with a constructed reed-bed wetland treatment system in a *nullah* tributary. Restoration design needs to be scaled-up, scientifically monitored, and adapted for larger *nullahs* and river channels.

Estuarine and coastal waters

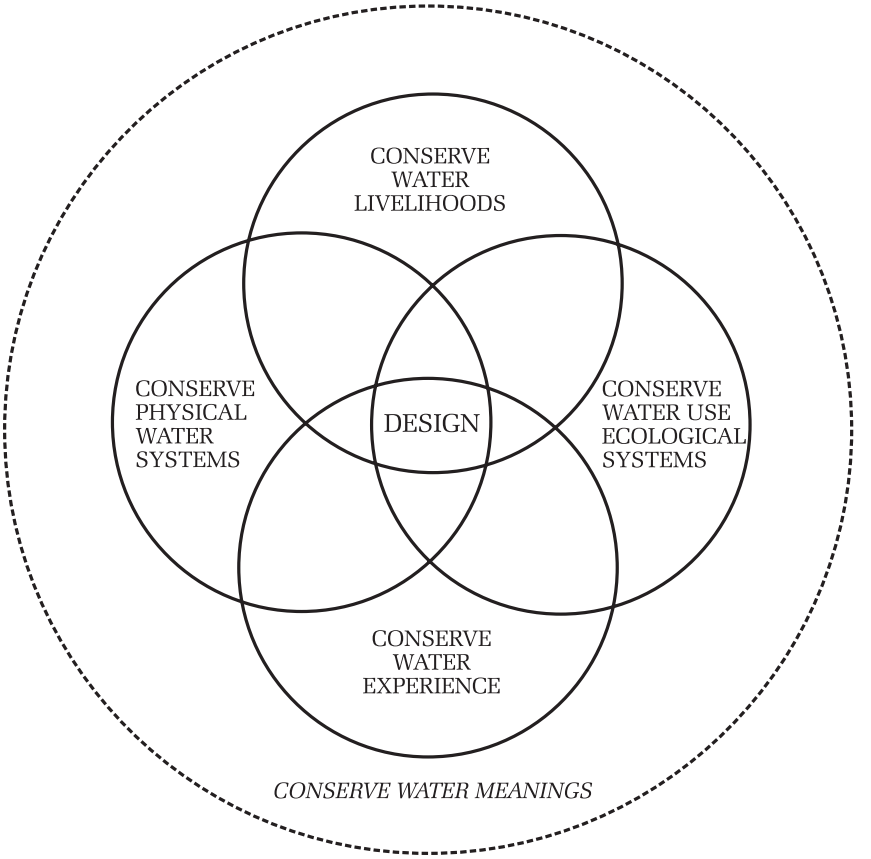
Only a fraction of river flows reach the sea, except during flood events. These downstream flows have enormous significance for the coastal estuaries and deltas of India. As in most regions of the world, India's coastal settlements face a host of hazards ranging from salt water intrusion, subsidence, and erosion to catastrophic cyclones and tsunamis. The landscape implications of long-term sea level rise have yet to be addressed except in especially vulnerable places like the Maldives. What might "wise" landscape development look like, from the mountains to the sea, and how might it evolve over time? How might each place express the wisdom of water-conserving design? The initial image in this essay of the Kashmir mountain catchment with its snow fields, springs, and Mughal gardens that discharge into Lake Dal, which is connected in turn with the River Jhelum, Indus, and Indian Ocean is one of many complex waterscapes that inspire efforts to answer these questions.

what lies at the center? ...it is "water-conserving design"

Water and Wisdom: Towards an Expanded Model of Water-Conserving Design

The issues surveyed above invite further reflection on the wisdom of waterscape design. Several recent books on water in India underscore the importance of wisdom in past and future water systems, from Anil Agarwal and Sunita Narain's Dying Wisdom to Ramaswamy Iyer's Towards Water Wisdom: Limits, Justice and Harmony. These works mark wider approaches in water-conservation to link efficiency, equity, and meaning. A simple model that may have relevance for addressing different types and aspects of water-conserving design is diagrammed here.

In any Venn diagram one wants to ask, what lies at the center? In this case, it is "water-conserving design," the integrative work of harmonizing human and hydrologic systems in ways that that strive for innovative and just landscapes across India, and around the world.



Acknowledgements

Deep thanks to the many colleagues in India who have shaped my understanding of water and landscapes. And, congratulations to this Journal's team on this 25th issue, and for the vision and energy that have produced the first "generation" of this publication within a fraction of the generational timescale.

Image and diagram courtesy the author.

James L. Wescoat Jr. is Professor, Aga Khan Program for Islamic Architecture, MIT. He is a well-known historian of Mughal garden designs in Islamic South Asia, an environmental researcher focusing on water management and policy and a preservationist. His research has concentrated on water systems in South Asia and the US from the site to river basin scales. For the greater part of his career, Wescoat has focused on small-scale historical waterworks of Mughal gardens and cities in India and Pakistan.
E-mail: **wescoat@mit.edu**