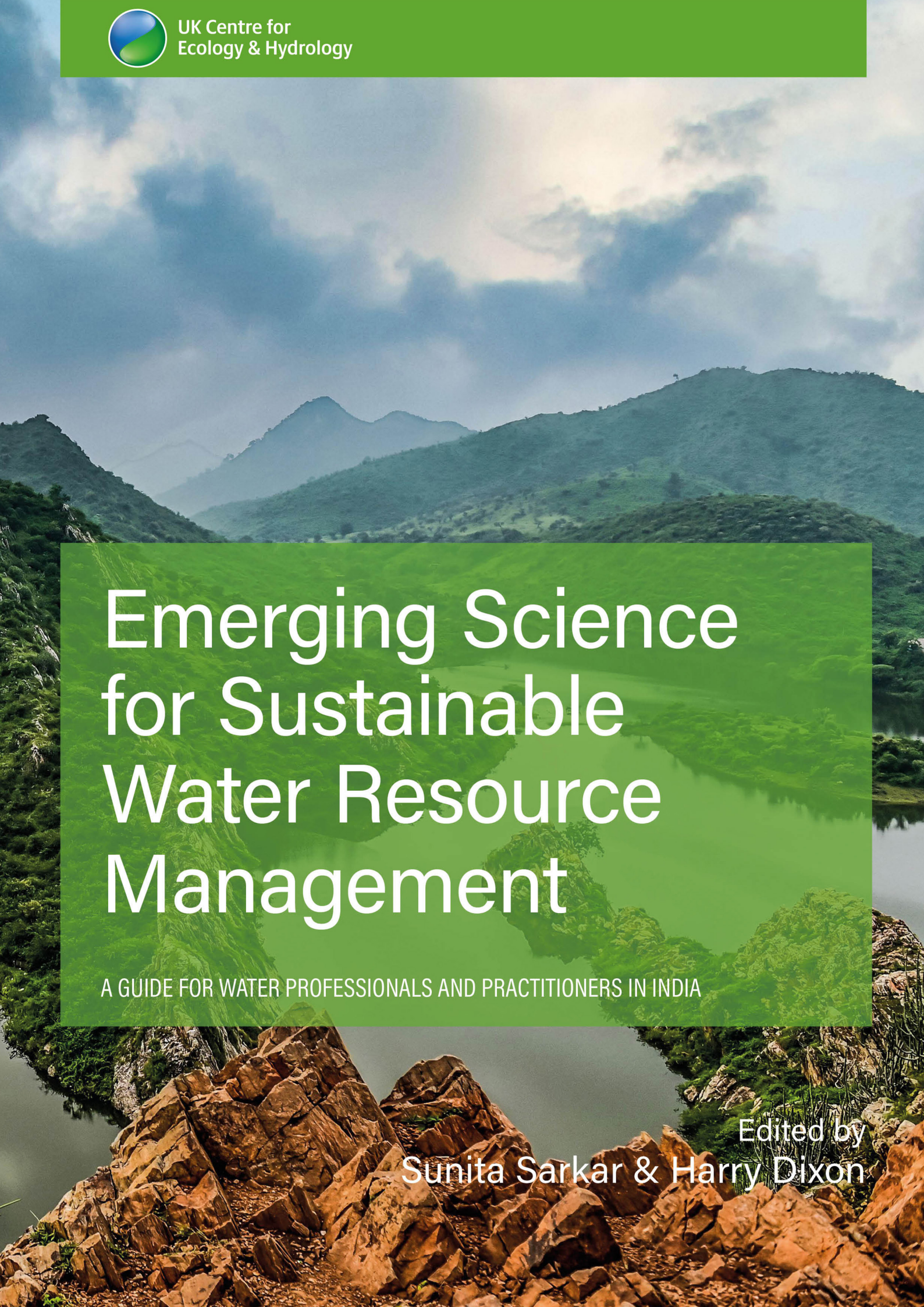
UK Centre for
Ecology & Hydrology
Emerging Science for Sustainable Water Resource Management
A GUIDE FOR WATER PROFESSIONALS AND PRACTITIONERS IN INDIA
Edited by
Sunita Sarkar & Harry Dixon

EMERGING SCIENCE FOR
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AND PRACTITIONERS IN INDIA

Dal Lake, Srinagar | Photo Credit srbh_graphy, Shutterstock

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Published by UK Centre for Ecology & Hydrology, Wallingford, United Kingdom

Editorial office: UKCEH, Benson Lane, Crowmarsh Gifford, Wallingford, OX10 8BB, UK

ISBN (Print): 978-1-906698-76-8 ISBN (eBook): 978-1-906698-77-5

A catalogue record for this book is available from the British Library.

This publication is an output of the 'Sustainable Use of Natural Resources to Improve Human Health and Support Economic Development' (**SUNRISE**) programme, and was made possible through the support of the Natural Environment Research Council (NERC).

The SUNRISE programme is funded by the Natural Environment Research Council (NERC) National Capability award

Suggested citation: Sarkar S & Dixon H (eds) 2021. *Emerging Science for Sustainable Water Resource Management: A Guide for Water Professionals and Practitioners in India.* UKCEH Wallingford 94pp.

Set in 10/14pt Acumin Pro
Printed and bound in the UK by Seacourt Ltd

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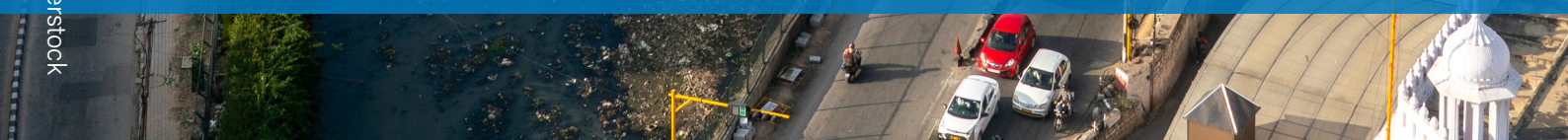
Aerial view, Bangalore Large Lake | Photo Credit PorqueNo Studios, Shutterstock

Urban Lake **RESTORATION**



URBAN LAKES SUPPORT A WIDE range of valued activities and services for urban citizens. They are often landscapes for recreation, groundwater recharge, fisheries, and a refuge for biodiversity (Figure 7.1). However, across the developing world, and especially in India, urban lakes have become pools of polluted water. Rapid urbanisation and population increases, without the construction of adequate wastewater treatment, is the major driver of this problem. This has greatly impacted the water quality and ecological health of urban freshwaters with consequent losses or restrictions on their use. New approaches are needed to successfully restore and sustain the valuable services lakes provide to urban citizens. We outline innovations in three areas that overcome common barriers or mistakes in restoration and can transform urban lake restoration programmes: (1) governance, (2) assessing ecological health and (3) decentralised wastewater treatment.

7.1 The need for new tools

Despite their potential value, urban lakes are often poorly managed and severely degraded. This is because they are, by their very nature, at the

Figure 7.1 Potential benefits of a healthy urban lake.

Innovative technical approaches and restructured governance can restore and protect our urban lakes for the benefit of citizens, and for local biodiversity.

LAURENCE CARVALHO
PRIYANKA JAMWAL
SHARACHCHANDRA LELE
ANNE DOBEL

"end-of-the-pipe", often receiving large volumes of wastewater (treated and untreated) and storm-water run-off produced in cities. One particularly severe example is Bellandur Lake in Bengaluru, which regularly caught fire and spewed foam because of the huge loads of untreated sewage effluent it received from several million people in the upstream catchment (Abraham 2018). Decomposition of this organic matter led to a loss of oxygen from the water-column and decline in fish and most other animal life. The high levels of decomposition and absence of oxygen also resulted in a huge production of the greenhouse gas methane, a flammable gas that was the likely cause of the fires on the lake surface (The Hindu 2019; Pickard et al 2021).

The severely degraded state of many urban lakes highlights that current approaches to managing water quality across cities have failed. Not only have city authorities failed to recognise the interconnectedness between urban catchments and lakes, but also the centralised wastewater treatment infrastructure is often highly inadequate, lagging behind rapidly growing populations and particularly ineffective during high rainfall periods, such as the monsoons (Jamwal et al 2015). In India, lake quality assessment schemes are not designed to evaluate the usability of lakes for the multiple benefits they provide, within a time-scale that is useful for lake managers. The governance of urban lakes is also fragmented between water supply and sewerage agencies, municipal wings that manage storm water, and pollution regulators that are generally focused on industrial, not domestic, wastewater.

New approaches, therefore, have to be multi-pronged, involving innovations in technology, civil society actions and institutions of governance. Given the high cost of centralised wastewater treatment, multiple decentralised treatment technologies need to be trialled. The effectiveness of such technological interventions on water quality and ecosystem health need to be monitored regularly and rapid feedback provided. This can be achieved through cheap multi-parameter and transparent monitoring mechanisms involving citizen groups and satellite earth observations, which can supplement conventional limited-parameter infrequent monitoring by environmental regulators. Finally, new governance regimes that are integrative, downwardly accountable, and nested into different scales of the problem are clearly required.

7.2 Integrated and democratic governance

Creating an institutional setup and processes that ensure integrated, decentralised and democratic governance of urban lakes is a critical step in lake restoration. Integration means coordination across the water supply and sewerage agency, the agency managing storm water drains, and the agency/agencies managing the lakes. As mentioned above, what happens to an urban lake is determined largely by what happens to storm-water and wastewater originating in its urbanised catchment, including upstream lakes. The current picture is often fragmented (**Figure 7.2a**), with individual lake rejuvenation plans simply diverting (untreated) wastewater downstream to the next lake. Wastewater treatment plants are set up at locations and scales that do not match the needs of the lake.

Integrated management requires catchment-level planning that recognises the inter-connections between lakes and subsequent approvals of individual lake restoration plans within this context (**Figure 7.2**). It also means that the multiple functions of lakes as storage of storm water and wastewater, as structures for groundwater recharge, as well as year-round habitats for biota, and as recreational spaces, need to be carefully considered. Decisions regarding the priority 'beneficial' uses must be taken collectively, transparently and with adequate scientific input. This will require municipalities to have custody of all lakes, the authority to direct the uses of the water, and the capacity to think holistically. However, large city bureaucracies face many competing interests and demands for resources. Consequently, urban lake management rarely receives the required attention.

In cities, the main users of lakes are often citizens living in the vicinity who use it as a green space. They are the most impacted by degraded lakes and so have the greatest incentive to ensure lakes get restored and remain so. One vision is to consider lakes as an urban green commons to be used and managed by (or at least to actively involve) local community groups (Nagendra 2016).

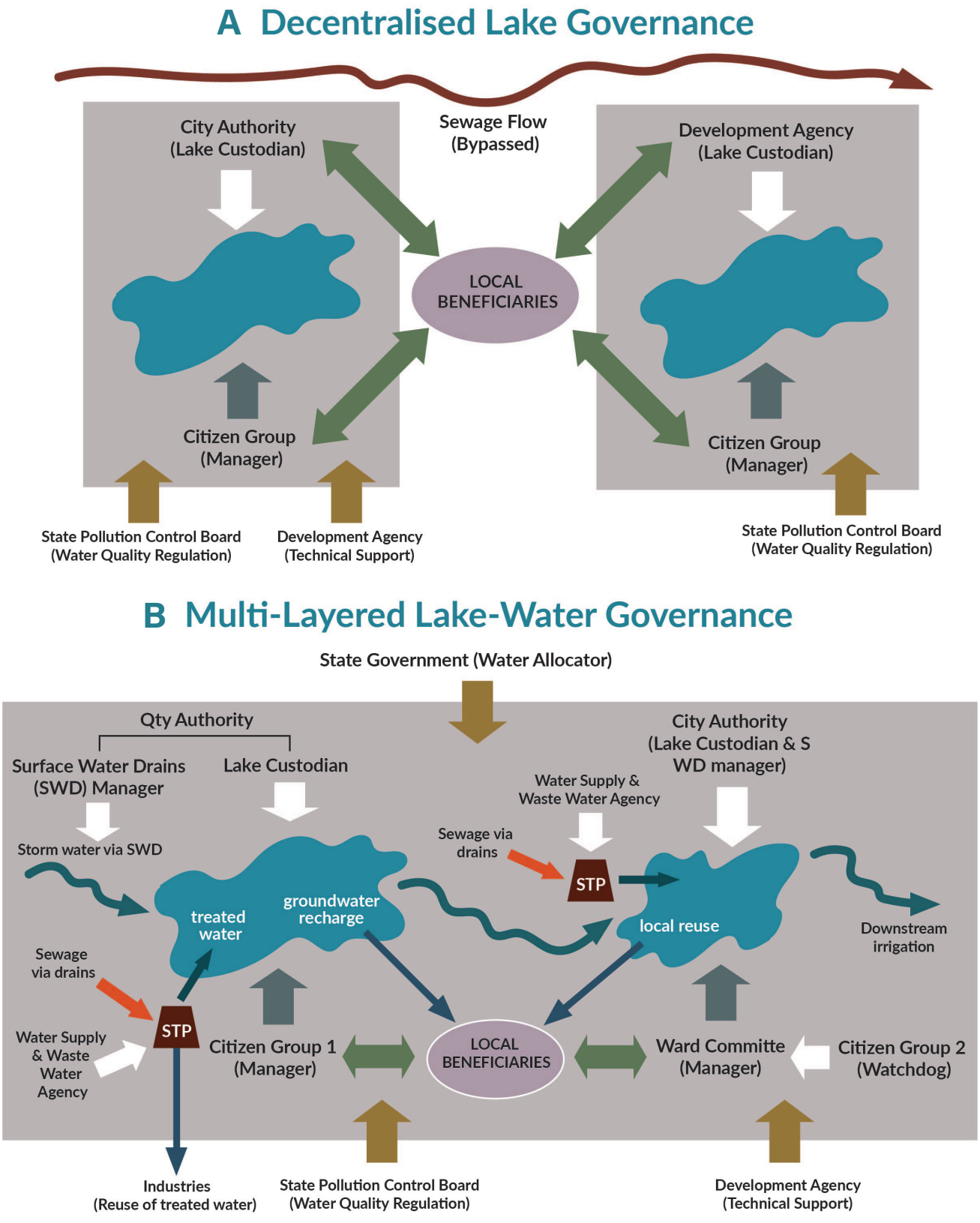


FIGURE 7.2 Models of Lake Governance (A) Narrow view where specific lakes are protected by bypassing sewage downstream, and (B) Broader view recognising need to treat sewage locally and not exacerbate the pollution problem downstream (modified from Lele & Bakshi Sengupta 2018).

The presence of strong citizens' movements for lake rejuvenation in many Indian cities supports this vision. In Bengaluru, local citizen groups have come forward to campaign for restoration and have volunteered to take over the management of their restored lake. The work of groups such as JalaPoshan , which manages Jakkur Lake, and MAPSAS which manages Kaikondrahalli lake in

Bengaluru, provide evidence that local citizens conducting day-to-day lake management and maintenance can deliver greater success, where more typical governance structures have failed (Biome Trust 2018; Nagendra 2016).

These citizens' groups encourage community engagement through recreational and educational activities. They conduct citizen science events to monitor the state of the lake and the biodiversity it supports and act as a check on any failures in sewage treatment or contamination of inflows (Ahluwalia 2018). Communities need to take a comprehensive view of their lake. They should not try to isolate it from sewage inputs and push the pollution problem downstream (**Figure 7.2a**). A better model would be to recognise that lakes are often connected and that it is better to treat pollution nearer the source, before it enters each lake (**Figure 7.2b**; Lele & Bakshi Sengupta 2018). The formal mechanism through which citizen groups entered into agreements with the municipality regarding operation and maintenance of restored lakes in Bengaluru needs to be institutionalised (see **Figure 7.2a** and **b**). However, citizen groups also have limitations, in particular the lack of representativeness. A potential solution is involving ward-level committees, which are statutory bodies mandated to manage urban water, to either directly manage lakes (**Figure 7.2b**) or monitor the functioning of citizen groups. The participation of local citizens (either through informal groups or ward committees) in day-to-day management of urban lakes has to be complemented by changes in the wider governance structure, to ensure integrated management and democratic governance. Democratic (and multi-layered) governance requires greater transparency, downward accountability and public input on planning and decision-making on lake restoration, wastewater treatment and water allocation, as well as lake water quality monitoring and the actions taken in response (**Figure 7.2b**). Democratic participatory governance can be transformative. However, if it is not comprehensive, then it too risks failing. For example, Jakkur lake faces an uncertain future with a proposal to divert all its treated water inflows into a power plant as cooling water (Joshi 2016). More democratic governance would likely lead to the consideration of a balance of interests through due process, and not just the interests of powerful stakeholders.

7.3 Monitoring water quality and ecological health

In India, the Central Pollution Control Board (CPCB) has developed the concept of designated best use: the use which demands highest water quality. Designated best uses include: drinking water, outdoor bathing, propagation of wildlife and fisheries, irrigation and industrial cooling . Defining the designated use of a water body is an essential precursor to setting appropriate water quality standards and restoration goals (Jamwal 2020). Most urban lakes are, however, far too polluted for drinking water or outdoor bathing to be an attainable use and, typically, they no longer serve as irrigation tanks for agriculture (Jayadev & Puttaih E.T. 2013). Standards set for wildlife, fisheries and industrial cooling are limited to a few chemical measures, and no standard exists for uses such as groundwater recharge and the widespread "secondary contact" recreation around, or on, the lake (e.g. walking, boating). In urban settings, it is important that all stakeholders agree to a more suitable set of standards to sustain the multiple uses of urban lakes.

Biological monitoring (such as use of invertebrates, plants and fish) to assess ecosystem health is now widely adopted (such as the European Water Framework Directive), as biological responses provide a more integrated assessment of a wide range of pressures (e.g. pollution, habitat destruction and invasive species) over weeks, months or years (Poikane et al 2015). The other advantage of biological monitoring is that the measures may be more visible and understood by the public and could also be the focus for training of citizen monitoring of lake health. This is important as the CPCB does not monitor many urban lakes and even if they are being monitored, there is no transparent process for choosing management actions if a lake fails its designated best-use standard.

Citizen monitoring and new platforms, such as lake dashboards, can overcome the capacity challenges in water quality monitoring that are typical across the world (Kirsche et al 2020) and provide transparency in enabling local communities to check compliance with restoration targets. Restoration targets should be defined based on the local conditions such as the quality of inflows,

seasonality, type of interventions etc. **Figure 7.3** provides an example of a potential citizen-led lake monitoring programme to check compliance with key uses of urban lakes.

7.4 Wastewater treatment solutions

In many cities, there is still a genuine need to increase capacity of primary and secondary wastewater treatment systems and ensure compliance checks on their discharges. Without sufficient treatment capacity, all other restoration actions are likely to fail. Capacity should also include tertiary treatment to remove (and ideally recover) nutrients. This is especially important in cities where treated effluent from STPs can be the primary source of water for urban lakes. Nutrients need to be removed, otherwise toxic algal blooms which are dangers to public and animal health are likely to persist (Carvalho et al 2013). On top of this, urban planning needs to consider decentralised wastewater treatment solutions to provide additional capacity (**Figure 7.4**). This could include separation and treatment of blackwater and greywater at source; for instance, innovative nature-based solutions in apartment blocks or constructed wetlands to treat effluent from polluting industries (Fowdar et al 2017). Decentralised solutions, such as SUDS and constructed wetlands, are also needed across cities to treat storm run-off and untreated effluent, particularly during the monsoon season. In-stream and in-lake solutions to further polish and manage symptoms of high organic or nutrient pollutant loads can also be adopted to help achieve target thresholds for the various uses of the lake (Jamwal, 2018; Jamwal et al 2020). In-lake solutions can include biomanipulation of fish and plant communities, floating vegetated islands, aeration and mixing in deep lakes, or even hydrogen peroxide application in polluted lakes if short-term restoration is needed for community events.

FIGURE 7.3 An example citizen-led lake monitoring programme. Photo credits: Laurence Carvalho.

7.5 Towards cleaner and healthier urban lakes

There is a need to transform the way urban lakes are managed, to ensure they can sustain the valuable services they provide to communities and businesses. Communities need to be at the centre of urban lake restoration and management through:

- Leading or co-developing governance of their lake.
- Agreeing targets for restoration.
- Monitoring progress and checking compliance through citizen monitoring.
- Supporting and promoting the integration of decentralised solutions into the urban landscape to augment city infrastructure.

This needs a conducive environment that encourages new governance structures, such as integrated city planning and environmental policies, as is being demonstrated in Bengaluru.

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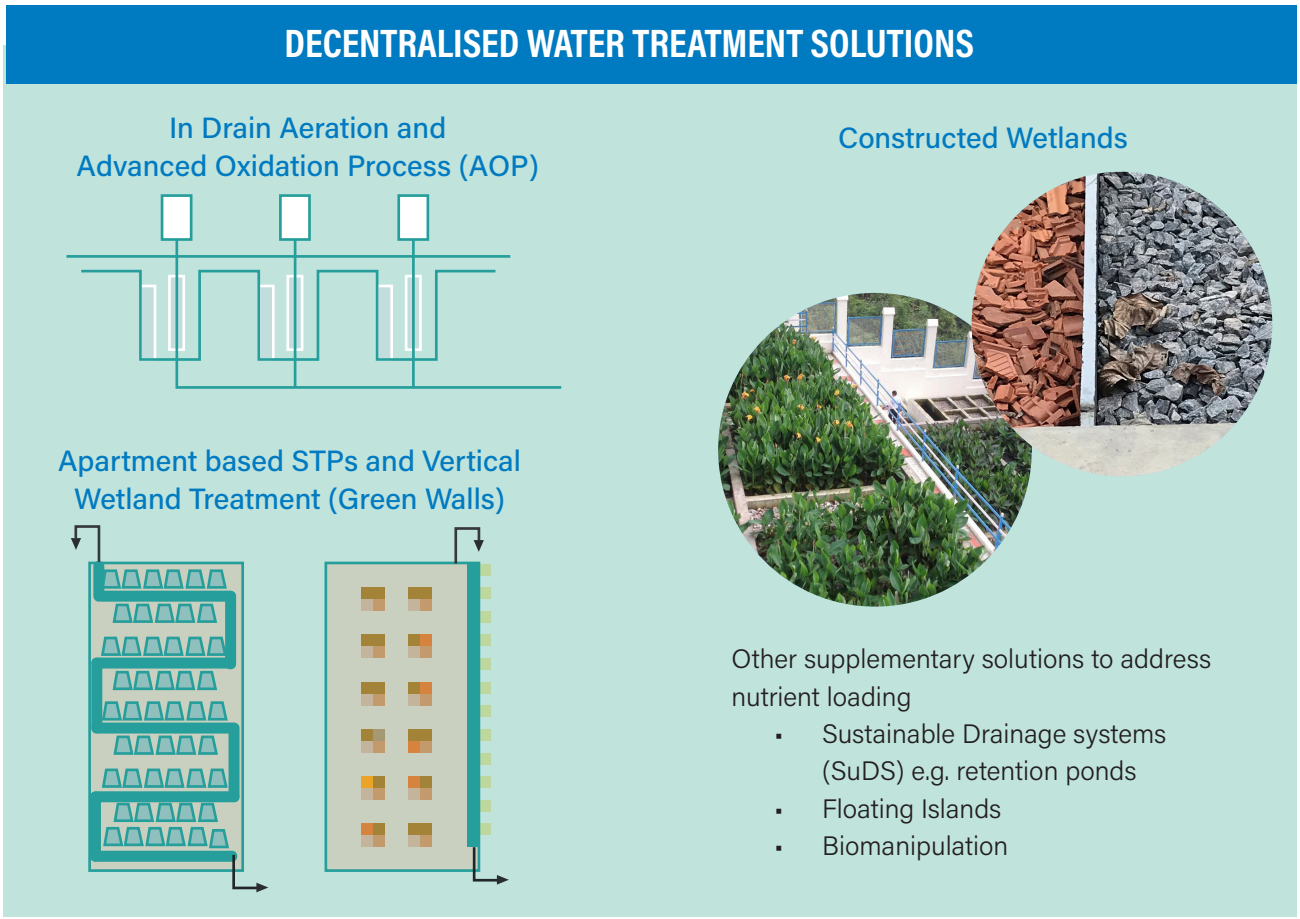

FIGURE 7.4 Challenges and solutions for decentralised wastewater treatment. Constructed wetland examples from (left) Himachal Pradesh (Credit: Re-bound Enviro-Tech) and (right) Sowl Kere, Bengaluru (Credit: ATREE).

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THE AUTHORS

Prof. Laurence Carvalho is a freshwater ecologist with expertise in the monitoring and management of freshwater quality and ecosystem health. He is currently a researcher at the UK Centre for Ecology & Hydrology.

Dr Priyanka Jamwal is an environmental scientist with expertise in the monitoring and management of water quality in rapidly urbanising catchments. She is also interested in understanding fate and transport of contaminants in hydrological systems. She is currently a Fellow at the Centre for Environment & Development, ATREE, Bengaluru, India

Dr Sharachchandra Lele is an interdisciplinary environmental scholar with expertise in forest and water governance for sustainable development. He is currently a Distinguished Fellow at the Centre for Environment & Development, ATREE, Bengaluru, India.

Anne Jo Dobel is a freshwater ecologist with expertise in phytoplankton taxonomy and biomass assessment for water quality. She is currently working as a researcher at the UK Centre for Ecology & Hydrology.