Cities that Work

IGC

POLICY PAPER

Urban water and sanitation systems: Managing infrastructure, institutions and access

Ignacio Banares-Sanchez, Mikey Blake,
Victoria Delbridge, Ed Glaeser, Yoshiki Wiskamp

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Executive summary

The proximity of firms and workers in dense urban centres enables the miracle of productivity. However, where people are close enough to share ideas and innovate, they are also close enough to spread disease. Nearly every major pandemic, from cholera to COVID-19, started and rapidly spread from cities.[1] The challenge for city leaders is to make density a source of health and prosperity, not vulnerability. That begins with clean water and safe sanitation.

Water-borne diseases such as cholera, schistosomiasis, typhoid and dysentery remain major public health challenges in low-income cities. Each year, children lose 443 million school days because of water-related illnesses,[2] and 13% of deaths among children under five can be attributed to inadequate water and sanitation provision.[3] A study from Lusaka, Zambia, shows that piped-water outages not only increase diarrhoeal disease and typhoid fever, but also reduce household financial transactions and shift girls' time-use towards household chores, likely at the expense of schooling.[4] Poor sanitation costs African countries an estimated 1-2.5% of annual GDP.[5] Clean water and sanitation are therefore not just public health interventions – they are economic investments in human capital and productivity.

Poor sanitation costs African countries an estimated 1-2.5% of annual GDP.

Evidence shows that the returns are high. For example, investments in clean drinking water and sanitation in Sri Lanka cut infant mortality tenfold.[6] Even simple, low-cost initiatives can have a widespread impact: washing hands with soap can reduce the risk of diseases by 42 to 47%.[7] Better access also frees time for education and work, particularly for women. In Tanzania, students were 12% more likely to attend school when they had access to water within a 15-minute walk.[8]

> **In India, a school sanitation programme increased girls' enrolment by one-third and increased academic performance by 25% for both boys and girls.[9]**

1 Department for International Development (DFID). (2013). Water and Sanitation Evidence Paper.

2 UNDP. (2006). Human Development Report: Beyond scarcity: Power, poverty and the global water crisis.

3 World Health Organization. (2019). Safer water, better health: 2019 update.

4 Ashraf, N., Glaeser, E., Holland, A., & Millett Steinberg, B. (2021). Water, health and wealth: the impact of piped water outages on disease prevalence and financial transactions in Zambia. *Economica*.

5 **https://www.worldbank.org/en/news/press-release/2012/04/16/inadequate-sanitation-costs-18-african-countries-around-us55-billion-each-year** (accessed: 18 January 2026)

6 WaterAid. (2008). Tackling the silent killer: The case for sanitation.

7 Curtis, V., & Cairncross, S. (2003). Effect of washing hands with soap on diarrhoea risks in the community: A systematic review. The Lancet Infectious Diseases, 3.

8 Marshall, J. (2002). Water in Africa: A resource for development. IRC International Water and Sanitation Centre.

9 UNICEF Regional Office for South Asia (2012). *WASH for School Children: State-of-the-art in Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.* UNICEF ROSA, Kathmandu.

In Cape Town, doubling the number of functioning public toilets was estimated to reduce sexual assaults by 30%.[10]

Recent evidence shows that increasing sewer access to 1% of households, results in a 6% increase in population density in that neighbourhood.

Sewers also improve our ability to tolerate the urban density needed for cities to become engines of economic growth. Recent evidence shows that increasing sewer access to 1% of households, results in a 6% increase in population density in that neighbourhood.[11] By improving proximity and access to jobs in the central business district, sewers have an effect similar to that of investing in new transit lines.[12]

Effective water and sanitation policy becomes even more important when considering growing environmental and climate risks. More than 80% of wastewater worldwide (reaching up to over 95% in some developing countries) is discharged directly into rivers, lakes, and seas, causing wide-scale environmental degradation, damaging local ecosystems, and contaminating ground and surface water.[13] Moreover, as seen in Pakistan in 2022, flooding can severely worsen sanitation conditions by damaging water and sanitation infrastructure, contaminating drinking water, and triggering disease outbreaks.[14] Widespread droughts, as we have seen with the 'Day Zero' crisis in Cape Town, necessitate better management of water resources.

While they are hugely expensive public investments, improvements to water and sanitation provide strong value for money.

> **For every dollar spent on water and sanitation, the amount returned in terms of increased national productivity, decreased time off work, and healthcare savings is between USD 2-4 for water and USD 5-9 for sanitation.[15]**

However, every dollar spent on water and sewerage infrastructure reduces the resources available for other high-impact interventions, such as vaccination campaigns, land titling programmes, or primary education. This underscores the need for rigorous cost-benefit analysis to guide public spending and ensure that resources are allocated where they generate the greatest social return. This paper sets out how cities can prioritise, finance, and deliver water, sanitation and hygiene (WASH) systems that turn urban density into a source of both health and economic growth.

10 Gonsalves, G. S., Kaplan, E. H., & Paltiel, A. D. (2015). Reducing sexual violence by increasing the supply of toilets in Khayelitsha, South Africa: A mathematical model. *PLOS ONE*, 10(4).

11 McCulloch, S. E., Schaelling, M. P., Turner, M., & Kitagawa, T. (2025). Sewers and urbanization in the developing world (Working Paper No. w33597). National Bureau of Economic Research.

12 Ibid.

13 United Nations World Water Assessment Programme. (2017). The United Nations World Water Development Report 2017: Wastewater: The untapped resource.

14 Government of Pakistan, World Bank, Asian Development Bank, & United Nations. (2022). Pakistan floods 2022: Post-disaster needs assessment.

15 World Health Organization. (2012). Global costs and benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage.

In this paper

This paper focuses on how city leaders can deliver clean water and sanitation efficiently, affordably, and at scale. It first explores how to **choose the right technologies** for different urban contexts, balancing cost, density, and long-term maintenance. It then considers **who should provide these services**, from public utilities to public–private partnerships and informal providers, and how governments can structure their involvement. The paper next examines **how to finance water and sanitation systems**, from major trunk infrastructure to household connections and ongoing maintenance, and how to **incentivise household uptake** through subsidies, fines, and microfinance. It also looks at how to **shape behaviour** through information campaigns and social norms, and how to **strengthen institutions, regulation, and contracting** to make these systems work sustainably. Together, these sections provide a roadmap for cities to turn water and sanitation investment into lasting health, productivity, and environmental gains.

Deciding between technologies for water and sanitation, and who provides them

.When providing water and sanitation to their citizens, policymakers must decide what type of **technology** to implement and what the level of **government involvement** in the construction, expansion, maintenance, and service delivery should be. Figure 1 below shows the choice governments face between the quality of the technology and the level of government involvement required in providing these services. The choice of which technology to adopt is highly contingent on municipal budgets, the state of urban development, and the time-horizon considered by policymakers.

Figure 1: WASH technologies and government involvement.

Source: authors' own elaboration. Technologies related to the provision of water in blue and sanitation in orange.

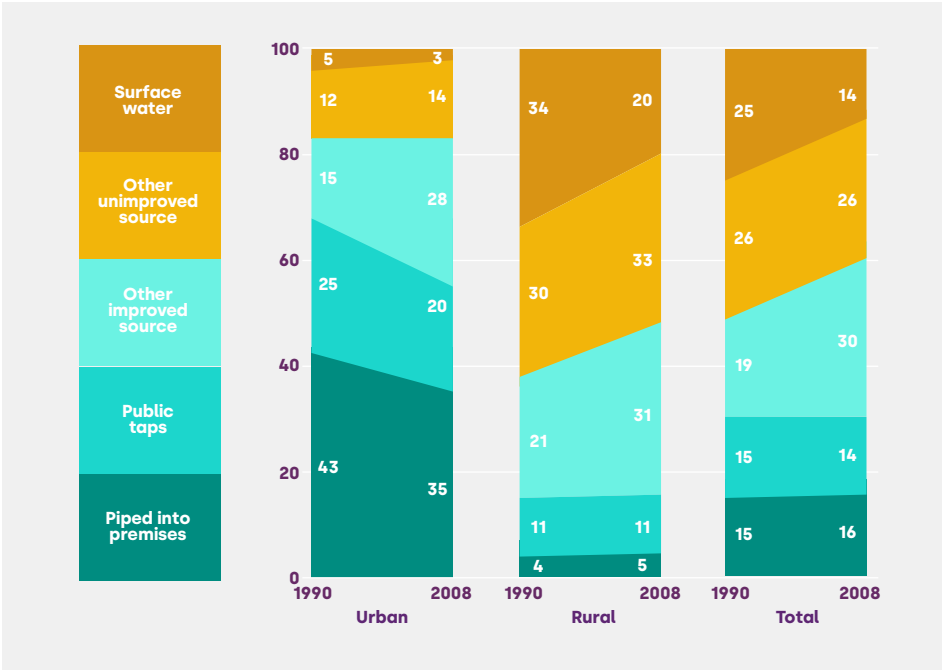
What to provide: choosing the "right" technology

Cities today have a range of technologies to draw on for delivering clean water and safe sanitation - and these technologies are constantly evolving. **Appendix 1** provides a detailed overview. On the **water side**, options range from large, centralised piped networks and treatment plants to decentralised systems such as boreholes, water kiosks, and small-scale purification units. On the **sanitation side**, cities use both networked sewers and a spectrum of on-site solutions, including septic tanks, pit latrines, and container-based toilets. Each system has distinct implications for cost, maintenance, and service quality.

No single technology is universally best: the right choice depends on a city's density, terrain, institutions, and capacity to maintain what it builds.

While urban areas offer significantly better water access than rural regions, public investment in piped infrastructure has struggled to keep pace with rapid urbanisation. Across sub-Saharan Africa, for example, the share of the population with access to piped water in urban areas declined between 1990 and 2008.[16] In many developing cities today, only 68% of the population is serviced by the official water utility.[17] Of these, just over half have access to individual piped water connections, while the rest rely on shared pipes. This disparity leaves many urban residents, particularly those in informal settlements, dependent on non-piped water sources, such as wells, boreholes, and surface water from canals, lakes, and rivers.

Figure 2: Water sources in sub-Saharan Africa from 1990 to 2008.



Source: World Health Organization (2011) "Drinking Water: Equity, safety and sustainability".

There are stark trade-offs between these technologies. While piped water is higher quality and often more cost-effective in the long term, it requires significant up-front investments and strong public institutions. In Dakar, for example, the costs of piped networks were estimated to

16 World Health Organization. (2011). Drinking water: Equity, safety and sustainability.

17 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

be five times higher than those of a faecal sludge management system using septic tanks.[18]

While non-piped sources can provide reliable access to water, they are often prone to contamination and are managed by a mix of formal and informal private sector operators, who typically charge higher prices per unit of water.

> **As a result, poorer residents in informal areas frequently face higher costs for water than wealthier city dwellers with formal piped connections, further exacerbating inequality in water access and quality.[19]**

For a full discussion of water technologies, see **Appendix 1**.

Sewerage systems reach only 16% of urban residents across sub-Saharan-Africa.

In the case of sanitation, the trade-offs policymakers face between quality and cost are even more stark. Here, too, waterborne piped sewerage systems deliver the most significant benefits, both in terms of public health and environmental impact. However, in many low-income cities, existing sewerage infrastructure is extremely limited and willingness to pay for sewerage services is low – both relative to piped water services and relative to the costs of sewerage infrastructure. For example, sewerage systems reach only 16% of urban residents across sub-Saharan-Africa.[20]

Waterborne sewerage systems may therefore be financially unfeasible for many low-income cities.

> **Instead, decentralised, private, on-site approaches to sanitation, such as ventilated pit latrines, can be five times less expensive to construct and still offer important public health benefits.[21]**

However, policymakers need to think carefully about the design and maintenance of such options, given they are susceptible to spreading diseases and water contamination, as well as safety and dignity concerns. For example, where safety and dignity is ignored in communal toilets, residents frequently resort to defecating at or near their home and improperly disposing of faecal matter. In fact, 8% of urban residents in sub-Saharan Africa[22] and 12% in urban India still defecate in the open, a problem that is particularly pronounced

18 Dodane, P., Mbéguéré, M., Sow, O., & Strande, L. (2012). Capital and operating costs of full-scale fecal sludge management and wastewater treatment systems in Dakar, Senegal. *Environmental Science & Technology.*

19 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

20 World Health Organization & United Nations Children's Fund. (2021). Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs.

21 Dodane, P. H., Mbéguéré, M., Sow, O., & Strande, L. (2012). Capital and operating costs of full-scale fecal sludge management and wastewater treatment systems in Dakar, Senegal. *Environmental Science & Technology*, 46(7), 3705–3711.

22 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

in crowded informal settlements.[23] For a full discussion of sanitation technologies, see **Appendix 1**.

Overall, the decision depends on thorough **cost-benefit analyses.** This will help weigh trade-offs between technological solutions and institutional approaches, considering maintenance, pricing, education, and the need and cost of future neighbourhood retrofitting - all of which are important factors, irrespective of the technological or institutional choices made. Such cost-benefit analyses are often highly specific to the country and context and need to be carried out on a case-by-case basis. A series of cost-benefit analyses by the World Bank exemplifies this:

- In the Philippines, flush toilets with septic tanks (but without sewerage connections) are the most cost-effective option in low-income areas.[24]

- In Indonesia, wet pit latrines achieve the most favourable economic performance, with a benefit-cost ratio of 3.2. However, pit latrines are not always a feasible solution, due to the high population density of many Indonesian cities. The benefit-cost ratio of decentralised wastewater treatment systems was found to be 1.7, making it a feasible option instead.[25]

- In Cambodia, high-cost sanitation options, like sewerage with treatment, perform poorly, with a benefit-cost ratio of 0.14 under full capacity use. On the other hand, wet pit latrines show a benefit-cost ratio of 2.3 to 2.9.[26]

- In Vietnam, the most favourable sanitation options were shown to be improved wet pit latrines, with a benefit-cost ratio of 8.6, which required less than one year to recover the value of the initial investment. Sewerage with improved off-site management of excreta had a benefit-cost ratio of 2.7, making it a feasible option if governments can achieve high household connection rates to the network system.[27]

23 **https://www.unicef.org/india/what-we-do/ending-open-defecation** (accessed: 18 January 2026)

24 Rodriguez, U. P., Hutton, G., Jamora, N., Ockelford, J., Harder, D., & Galing, E. K. (2011). The economic returns of sanitation interventions in the Philippines. *World Bank Water and Sanitation Program.*

25 World Bank Group. (2011). The economic returns of sanitation interventions in Indonesia. *Water and Sanitation Program Research Brief.* Washington, D.C.: World Bank Group.

26 World Bank. (2011). The economic returns of sanitation interventions in Cambodia.

27 World Bank Group. (2011). The economic returns of sanitation interventions in Vietnam. *Water and Sanitation Program Research Brief.* Washington, D.C.: World Bank Group.

Who provides: Public utilities, PPPs, and informal providers in urban water and sanitation

Natural monopolies arise in sectors like water and sanitation due to the high fixed costs and networked nature of infrastructure: once you lay the pipes, each new connection is cheaper. There is also a 'public goods' problem, in that everyone benefits when more people have clean water and sanitation – even those who do not pay for it.

To ensure full coverage, water and sanitation services will always require some level of public sector involvement.

This means that to ensure full coverage, water and sanitation services will always require some level of public sector involvement. A subsidised centralised provider is the most efficient way of delivering these services – expanding access while keeping costs down. The centralised delivery of water and sanitation could be done directly by a public utility or contracted to a private company through a public-private partnership (PPP).

In many instances, however, the high upfront costs of building the network infrastructure are prohibitive, particularly in informal settlements and other low-income areas. In these areas, service gaps are filled by alternative technological solutions, such as sachet or bottled water markets, wells and boreholes, or on-site sanitation facilities like pit latrines. This often requires a mix of private sector engagement, as well as contributions from informal providers.

Public utilities

Well-structured public utilities can perform efficiently, particularly when they have managerial autonomy and transparent regulation. Many African and Latin American utilities have improved performance through capacity-building and investment in non-revenue water reduction – in other words, fixing leaks and stopping water theft - which enables expanded service to under-served populations.[28] The Phnom Penh Water Supply Authority in Cambodia provides a good example of how government-run water and sanitation utilities can operate efficiently.

28 Baietti, A., Kingdom, W., & van Ginneken, M. (2010). Characteristics of well-performing public water utilities. *Water Supply and Sanitation Working Notes*, No. 9. Washington, D.C.: World Bank Group.

Case study 1: Phnom Penh Water Supply Authority[29]

The Phnom Penh Water Supply Authority reached near-universal access while maintaining financial sustainability. The service was expanded from 20% of the city in 1993 to over 90% by 2008, and included subsidised connections for low-income households. It achieved this by:

- Implementing tariff and billing reforms - introducing volumetric tariffs and requiring metered connections
- Reducing non-revenue water - improving leak detection, preventing illegal connections, and building community partnerships
- Modernising technology, training and operations
- Building strong governance and autonomy – this was enabled by political support and institutional reforms that allowed it to operate on commercial principles.

In fact, well-run public utilities in cities in developing countries share a lot of characteristics with efficient private providers, with the most successful ones being autonomous and commercially inclined but accountable to governments. However, successful public utilities are not the norm but the exception. Many of these utilities have found themselves in a pernicious cycle of weak performance, customers' low willingness to pay, insufficient maintenance funding, and the subsequent rapid depreciation of assets, made worse by political interference.[30]

29 **https://ppp.worldbank.org/public-private-partnership/sites/default/files/2024-08/PhnomPenh_ExemplaryWaterUtilityinAsia_EN.pdf** (accessed: 18 January 2026)

30 Baietti, A., Kingdom, W., & van Ginneken, M. (2010). Characteristics of well-performing public water utilities. *Water Supply and Sanitation Working Notes*, No. 9. Washington, D.C.: World Bank Group.

Public utilities also run the risk of being used as job creation programmes – where governments try to create jobs, inflating costs, rather than optimising for an affordable and efficient service for residents.

Moreover, it is rare to find a purely public utility. The private sector is often involved in some aspects - from funding, to construction and maintenance. In Mexico City, the handling of meter readings and billings is in the hands of private operators, while Bogotá's public water utility relies on private companies to operate its entire public network.[31] In both cases these PPPs involve shared responsibilities between private actors and government bodies.

Privatisation and PPPs

Informal water vendors and sanitation providers play a critical role in filling service gaps left by formal systems.

Privatisation and PPPs in water and sanitation have often improved operational efficiency, service coverage, and innovation across several cities in developing countries. For example, the privatisation of water services in Argentina during the 1990s resulted in an 8% overall reduction in child mortality, with the largest gains, a 26% decline, occurring in the poorest areas, largely due to decreases in deaths from infectious and parasitic waterborne diseases.[32]

However, while private operators may increase efficiency and service quality, there are also potential challenges. For example, in Argentina, as the tariff freeze was lifted following the 2001 economic crisis, a lack of regulation led to tariff increases well above inflation, resulting in significant public backlash.[33] In Cochabamba, Bolivia, tariff increases by the water company also exceeded what was needed for cost recovery.[34]

These experiences highlight that water and sanitation privatisation can lead to affordability issues and their success hinges on robust legal frameworks, transparent contracts, and the design of mechanisms that promote affordability for low-income households.[35] [36]

The IGC policy paper on PPPs and procurement provides more evidence on how to effectively design these arrangements.[37]

31 Marin, P. (2009). Public-private partnerships for urban water utilities: A review of experiences in developing countries. *Trends and Policy Options*, No. 8. Washington, D.C.: World Bank Group.

32 Galiani, S., Gertler, P., & Schargrodsky, E. (2005). Water for life: The impact of the privatization of water services on child mortality. *Journal of Political Economy*, 113(1), 83–120.

33 Marin, P. (2009). Public-private partnerships for urban water utilities: A review of experiences in developing countries. Trends and Policy Options, No. 8. Washington, D.C.: World Bank Group.

34 Ibid.

35 Ibid.

36 **https://ppp.worldbank.org/public-private-partnership/water-and-sanitation/water-sanitation-ppps** (accessed: 18 January 2026)

37 Collier, P., Glaeser, E., Manwaring, P., Wani, S., & Venables, T. (2023). Delivering urban development: PPPs and other procurement options for urban infrastructure and services. *IGC Policy Paper.*

Private and informal provision

In areas where centralised water and sanitation utilities are not feasible due to the high costs of building water or sewage networks (such as peri-urban regions and informal settlements), decentralised solutions can provide an effective alternative. These systems often rely on intermediate technologies, such as boreholes, community-managed water kiosks, or on-site sanitation facilities like pit latrines and composting ecological toilets. Implementing these solutions typically involves private stakeholders.

In many urban areas, especially informal settlements, this private participation comes from the informal sector. Informal water vendors and sanitation providers play a critical role in filling service gaps left by formal systems. For example, in Ghana, sachet water supplied by private vendors became the dominant source of drinking water in urban areas, with the share of households relying on it rising from 14% in 2010 to 51% by 2017.[38] These providers are often more flexible and responsive to local needs but can charge high prices and lack quality control. Their integration into formal systems could improve reliability and affordability while addressing public health concerns.

While requiring lower upfront investment, private and decentralised provision does not account for the 'public good' elements of water and sanitation, potentially leading to under-provision and subsequent health and environmental externalities.

Financing water and sanitation provision

> **The Organisation for Economic Co-operation and Development estimated that achieving universal access to water and sanitation by 2030 would require annual investments exceeding USD 1 trillion, equivalent to approximately 1.21% of global GDP in 2022.[39]**

There are three major aspects of WASH infrastructure which require financing: (i) large-scale trunk infrastructure, (ii) individual connections to the trunk infrastructure, and (iii) the ongoing operations, maintenance, and expansion of this infrastructure.

38 Moulds, S., Chan, A. C. H., Tetteh, J. D., Bixby, H., Owusu, G., Agyei-Mensah, S., et al. (2022). Sachet water in Ghana: A spatiotemporal analysis of the recent upward trend in consumption and its relationship with changing household characteristics, 2010–2017. PLoS ONE, 17(5), e0265167.

39 OECD. (2022). Financing a water secure future. *OECD Studies on Water.* OECD Publishing, Paris.

Financing initial capital investments in trunk infrastructure

The scale of up-front capital investments required to finance trunk infrastructure is one of the most intractable barriers to better quality water and sanitation. In the 1800s, Chicago's sanitation district cost approximately USD 1.1 billion to build, and New York's first aqueduct cost about USD 336 million, both expressed in 2011 US dollars.[40] Few low- and middle-income cities can fund such sums from their own budgets.

Because water and sanitation deliver large public benefits (reduced epidemics, cleaner rivers, higher land values) and extend across multiple jurisdictions, these investments almost always require large-scale national government funding. Several countries have established dedicated water funds or line ministries responsible for coordinating and sustaining long-term investment plans in the sector.

Grants and concessional loans from development partners play an equally important part in financing initial investments in low- and middle-income countries. Public health is a global issue; as the COVID-19 pandemic showed, a disease that starts in one place can spread anywhere. Thus, investments in local water and sanitation infrastructure can also be seen as a global public good.

Development assistance greatly alleviates the burden on lower-income countries to fund the initial capital injection. However, grants can reduce incentives for good financial management and operational efficiency. As such, aid transfers in the form of concessional loans with lower interest rates and more flexible repayment terms have become the most common source of finance for governments aiming to incentivise long-term financial sustainability. Multi-year budgeting, earmarked sector allocations, or legal guarantees can help crowd in donor investment.

For example, in 1996, the city of Salvador, Brazil, embarked on an eight-year programme of mass public investments to expand access to the sewerage system from 26% of the population to 80%. The programme cost $440m, $246m of which was funded by a concessional loan from the Inter-American Development Bank (IADB).[41] In Kampala, Dakar and Ouagadougou, a combination of donor grants and loans with low interest rates and long grace periods were used to fund piped water infrastructure.[42] The case study below shows Zambia's approach to financing water and sanitation.

40 Troesken, W. (2015). *The pox of liberty: How the Constitution left Americans rich, free, and prone to infection.* University of Chicago Press.

41 Hall, D., & Lobina, E. (2008). Sewerage works: Public investment in sewers saves lives. UNISON and Public Services International Research Unit.

42 Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). Providing water to poor people in African cities effectively: Lessons from utility reforms. World Bank.

Case study: water sector financing in Zambia[43]

The Zambian government has recognised the critical role of water and sanitation in national development and has taken steps to improve sector financing. Zambia's water sector funding sources include treasury allocations, tariffs, fees, grants, and concessional loans. While legislation such as the Water Supply and Sanitation Act (1997) and the Water Resources Management Act (2011) provided for trust fund mechanisms, these have yet to be fully operationalised.

To address financing challenges, the government launched the **Zambia Water Investment Programme (ZIP) 2022-2030**, aligning with the **Continental Africa Water Investment Programme (AIP)**. ZIP aims to mobilise USD 5.75 billion for water security investments and create 200,000 formal jobs by 2030. Key investment areas include urban and rural water supply, sanitation infrastructure, and climate-resilient systems.

Despite these efforts, Zambia faces ongoing challenges such as fragmented financing frameworks, outdated tariff guidelines, and limited private sector involvement. While budget allocations for WASH infrastructure have increased significantly – from **USD 16.6 million in 2022 to USD 70 million in 2024** – this still falls short of regional targets. The current allocation of **1.13%** of Zambia's 2025 National Budget is well below the **5%** recommended by the **UN Convention and Southern African Development Community regional protocols.**

Sustained investment, improved governance frameworks, and enhanced private sector engagement remain crucial to ensuring Zambia's water and sanitation goals are met.

Incentivising individual connections to the trunk infrastructure

> **In many countries, the benefits of large-scale infrastructural investments in piped water and sewerage systems have failed to materialise because poorer households are unwilling to pay for connections to the network.**

This is known as the 'last mile problem' – the inability to connect infrastructure with the final user.

In 1840s New York, the Croton Aqueduct brought clean water to the city, but poorer households were unwilling to pay connection fees, instead using often contaminated water from nearby wells and boreholes.44

43 Input for this case study was provided by Blessings D. Kapukanya at the Ministry of Water Development and Sanitation in Zambia.

44 Ashraf, N., Glaeser, E., & Ponzetto, G. (2016). Infrastructure, incentives, and institutions. *American Economic Review,* 106(5), 77–82.

New York's 1866 cholera epidemic occurred 25 years after the aqueduct was constructed, which suggests that the last-mile problem remained unsolved for a long time and challenged the effectiveness of the aqueduct in improving public health outcomes.

> **In Lusaka, Zambia, a 2005 survey showed that approximately 80% of inhabitants live in areas close to utility networks, but the majority are not actually connected to these.[45]**

Common approaches to incentivising household connections include offering connection subsidies or imposing fines on property owners who fail to connect. In contexts where governments cannot afford to subsidise connections, micro-loans or payment plans may serve as viable alternatives. The choice of policy instrument may depend on institutional capacity: strong executive institutions may support the effective implementation of subsidies, while strong judicial institutions may be better suited to enforcing penalties. In settings with limited institutional strength, a mixed approach combining subsidies and penalties could be the most effective strategy.[46]

Subsidies

Subsidies for water and sanitation services aim at partly covering installation, connection, or ongoing service costs, making these essential services more affordable for residents, particularly in informal or low-income settlements. These subsidies can be structured in various ways. They may target the demand side through fee reductions for residents, or the supply side by providing support to utility providers to help offset their costs.

✓ **Subsidies allow households to connect quickly and in a coordinated manner,** ensuring broad community adoption.

✓ **Price discrimination enables targeting of low-income households:** By tailoring subsidy levels to households' willingness and ability to pay, support can be directed toward those most in need of water and sanitation upgrades, ensuring effective use of available funds.[47] Willingness-to-pay elicitation exercises can effectively identify those most in need of subsidies and determine the required subsidy.[48]

✗ **Inhibits cost-recovery:** Large and untargeted subsidies may keep prices for piped water and sewage unsustainably low in low-income communities, inhibiting cost recovery and resulting in a limited budget for operations and maintenance.

45 Ibid.

46 Ibid.

47 Johnson, T., & Lipscomb, M. (2022). Pricing people into the market: Targeting through price discrimination. Working Paper.

48 Berry, J., Fischer, G., & Guiteras, R. (2020). Eliciting and utilizing willingness to pay: Evidence from field trials in Northern Ghana. *Journal of Political Economy*, 128(4), 1436–147

✗ **Risk of subsidy traps:** Low-quality infrastructure can create a cycle of dependency on government subsidies, known as a *subsidy trap*.[49] Subsidising poor-quality systems can lock governments into a cycle of breakdowns and bailouts. Instead of upgrading infrastructure, authorities keep patching it with public money. To avoid this trap, every subsidy should come with an **exit strategy** – a clear timeline or trigger for phasing out support once systems improve.[50]

Subsidised last-mile connections typically require an additional allocation of public funds. However, in some cases governments recover some of the expenditure later via user fees, targeted particularly at richer households, as discussed in a later section.

Fines

> **In many developed economies, fines and legal penalties played a crucial role in increasing the connection rates of buildings to the main water and sanitation network.**

For example, 19th century New York's last mile problem was solved by implementing fines on property owners who refused to connect to the main network.[51] The fines were typically levied on large property owners by an independent health agency, which made it more politically palatable and effective.

This may be less applicable in many low-income countries, particularly in informal settlements where land often lacks formal ownership and inhabitants may be too poor to afford connections, or indeed the fines levied on them to connect. However, informal property agreements, receipts, or other forms of evidence showing that someone occupies or uses a piece of land, could serve as a basis for administering fines, at least in the short term.[52]

Moreover, fines can be used to punish illegal activities, such as unauthorised connections to water and sanitation networks or the improper disposal of sewage by households and firms.

✓ **Signal desirable actions:** Fines directly penalise socially undesirable behaviours, clearly signalling which actions are discouraged. This explicit penalty can serve as an effective tool to drive behavioural change.

✓ **Additional revenue stream:** Fines can provide an additional source of revenue to support infrastructure operations and maintenance,

49 McRae, S. (2015). Infrastructure quality and the subsidy trap. *American Economic Review*, 105(1), 35–66.

50 Andres, L. A., Thibert, M., Lombana Cordoba, C., Danilenko, A. V., Joseph, G., & Borja-Vega, C. (2019). Doing more with less: Smarter subsidies for water supply and sanitation. World Bank, Washington, DC.

51 Ashraf, N., Glaeser, E., & Ponzetto, G. (2016). Infrastructure, incentives, and institutions. *American Economic Review*, 106(5), 77–82.

52 Collier, P., Glaeser, E., Venables, A., Blake, M., & Manwaring, P. (2019). Policy options for informal settlements. *IGC Cities that Work Policy Framing Paper.*

improve service quality for complying users, and fund the administrative units required for enforcement.

✓ **Encourage private sector participation:** Fines help increase legal usage of water and sanitation services, thereby enhancing revenue collection. This strengthens the economic sustainability of these companies and improves the financial viability of water sector investments, encouraging greater private sector participation in the water and sanitation industry.

✗ **Affordability:** In cases where households are unable to afford fines or connection costs, subsidies or financing mechanisms can be a more effective option to encourage low-income households to connect.

✗ **Requires strong administration and enforcement capacity:** Administering fines requires being able to identify the property owners (some form of property rights and registry), delivering fines, following up on payments, and – for the fines to be credible – taking further action if payments are not made. In low-income and low-capacity environments, fines and sanctions are often not actively enforced.

Small-scale loans and payment plans for connection fees

In Indonesia, in 2003, the Bank Rakyat Indonesia started financing water connections through microcredits with support from USAID, helping the utility increase its customer base by 40% by 2005.

Where governments cannot afford to subsidise connections, small-scale loans and innovative payment schemes for connection fees can reduce the burden that households face in financing large one-off payments for connection fees. For example, in Indonesia, in 2003, the Bank Rakyat Indonesia started financing water connections through microcredits with support from USAID, helping the utility increase its customer base by 40% by 2005.[53] Throughout the world, Water.org's successful WaterCredit programme has combined microcredit with awareness-raising initiatives on water quality to issue 600,000 loans with 99% repayment rates.[54]

✓ **Overcomes adoption barriers due to upfront costs:** Access to microcredit and innovative financing schemes can significantly increase demand for sanitation services by reducing adoption barriers linked to high upfront costs. For example, a study in Cambodia found that access to microcredit increased the share of households willing to pay for improved latrines at the break-even price from 25% to 60%.[55] Another approach to improving affordability for low-income households is to allow payments to be spread over time. In Nyeri, Kenya, for instance, a household connection fee of KES 3,100 ($35) required only KES 2,000 upfront, and the Nyeri Water and

53 USAID. (2006). Micro-credit finance of water connections to new PDAM customers: Assessment study. *USAID Environmental Services Program*, DAI Project Number: 5300201.

54 WaterCredit. (2012). About WaterCredit: WaterCredit at a glance.

55 BenYishay, A., Fraker, A., Guiteras, R., Palloni, G., Shah, N. B., Shirrell, S., & Wang, P. (2017). Microcredit and willingness to pay for environmental quality: Evidence from a randomized-controlled trial of finance for sanitation in rural Cambodia. *Journal of Environmental Economics and Management,* 86, 121–140.

Sewerage Company has recently reduced this initial payment further to KES 1,500.[56]

✓ **Facilitates adoption of a more cost-effective technology:** Whilst the one-off cost of connection is high and may require households to save for a couple of years, the unit cost of piped water once connected is often much lower than the amount households pay for alternative sources.

> **According to World Bank data, a low-income household consuming 4m³ of water per month would spend approximately $25 per year if connected to the public utility, versus $250 per year from water tankers and informal vendors.[57]**

This compares to typical one-off connection costs of between $20-200. In this context, extending the period over which water connection fees are paid could represent a win-win for consumers and utility companies alike.

✗ **Requires access to financial services:** These financing mechanisms often come with the same challenges as other microfinance products. The percentage of the population that has access to financial services can be very limited in some areas, reducing the reach of loans as a financing mechanism. Overall, the percentage of the poorest families with access to financial services remains very low, particularly in sub-Saharan Africa.[58]

56 World Bank. (2018). Providing water to poor people in African cities effectively: Lessons from utility reforms.

57 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

58 World Bank. (2018). Providing water to poor people in African cities effectively: Lessons from utility reforms.

✗ **Repayment may prove difficult:** Microfinance products to finance household water and sanitation improvements should be designed carefully by MFIs. These loans are not targeting income-generating activities directly but instead are used to improve housing conditions. The loans will not generate returns in the same way as microfinance loans dedicated to small businesses. Hence the design, monitoring, and evaluation of these types of loans require different considerations and capabilities for MFIs, which can be absent in some settings.

Funding operations, maintenance, and expansion of the infrastructure

Once the pipes are in place and connections are made, utilities need to recoup costs, as well as cover maintenance, operations and expansion. These are often funded by a combination of user fees and local taxes. The policy challenge is making these both financially viable and socially fair: covering costs without pricing out the poor. The strong public benefits that water and sanitation bring justify public subsidies to ensure fees and taxes are affordable and maintain citizen willingness to pay. Making water and sanitation providers more cost-efficient can also have a significant impact on cost recovery.

User fees

Well-structured user fees are the most direct way to recover costs of piped infrastructure services. Since in many countries the planning horizon of governments is short, it has become common to sidestep the painful process of increasing tariffs and leave it instead to the next government. However, evidence shows that when user fees translate into improved service provision, consumers are generally willing to pay.

> **Across low- and middle-income countries, studies consistently find that households are willing to pay roughly USD 3 to USD 30 per month for improvements in drinking water access, with willingness to pay increasing with service quality and household income and often exceeding the cost of provision.[59]**

In rural India, people are willing to pay approximately USD 5 per month for delivery of bottled water, equivalent to about 4.7% of median household expenditures.[60]

In addition to funding core piped infrastructure, user fees can also be used for payment of other more localised facilities. For example, in Mumbai, where community-designed, built and managed toilet blocks serve nearly 900,000 low-income urban dwellers, households pay between USD 0.47-0.95 for a monthly pass to fund cleaning and

59 Van Houtven, G. L., Pattanayak, S. K., Usmani, F., & Yang, J.-C. (2017). What are households willing to pay for improved water access? Results from a meta-analysis. *Ecological Economics,* 136, 126–135.

60 Burlig, F., Jina, A., & Sudarshan, A. (Forthcoming). The value of clean water: Experimental evidence from rural India. *American Economic Review.*

maintenance.[61] As previously highlighted, these decentralised services can also be subject to capture by intermediaries who inflate prices. For example, in Kinshasa (DRC), water purchased from informal standposts costs about USD 1/m³, whereas the price at formal standposts is almost negligible. Similar is the case in Antananarivo (Madagascar), Lusaka (Zambia), and Cotonou (Benin), where the informal prices are more than five times higher than formal tariffs.[62]

The example of Ouagadougou, Burkina Faso, below shows how aid grants and loans built the network; however, user fees and better collection made the system financially sustainable and allowed the utility to repay its debts.

CASE STUDY: Financing piped water provision in Ouagadougou, Burkina Faso[63]

In 1990, Ouagadougou faced a severe water shortage, and even by 2000, only half the total population had access to a piped water service. However, by 2010, after a successful sequence of investments, efficiency improvements, and revenue collection drives, 94% of the total population of Ouagadougou had access to a clean, piped water service 23 hours per day, including 90% of the poorest population.

To fund this, investment totalling around $600 million was required from 2002 to 2013, with the bulk of the investment at the start of the programme. This was financed through a mixture of donor grants (52%), internal financing through operating cash flows and user fee collection (19%) and non-donor loans (29%).

Alongside loans from other development partners, the World Bank lent USD 70 million to the Government of Burkina Faso, of which USD 28 million was on-lent to Burkina Faso's national water and sanitation office, ONEA *(l'Office national de l'eau et de l'assainissement)*, and the remaining USD 42 million was given as an equity contribution. The interest rate for this loan was 5.4% and the repayment period was long and adequately flexible (20 years including a 10-year grace period). This financed the construction of the Ziga dam, Boudtenga reservoir, a water treatment plant and pumping station, and extension of the water distribution network.

61 Lucci, P., Bhatkal, T., Khan, A., & Berliner, T. (2015). What works in improving the living conditions of slum dwellers: A review of the evidence across four programmes. *Overseas Development Institute, Dimension Paper 04.*

62 Banerjee, S. (2010). Financing sanitation and wastewater services in developing countries: An analysis of the problem and potential solutions (World Bank Policy Research Working Paper No. 5384). World Bank.

63 Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). Providing water to poor people in African cities effectively: Lessons from utility reforms. World Bank.

The key to making this project both initially possible and financially sustainable in the long term was increasing ONEA's operating cash flow from user fees. Credible plans for generating cash flows were essential in securing loans on decent terms. Furthermore, the funds ONEA generated by cash flows were used not only to service the debt, but also to fund 48% of further capital investments in expanding and improving the water system.

The key factors behind increasing cash flows were, on the revenue side, increasing collection efficiency and maintaining low levels of uncharged water, and on the cost side, increasing labour productivity to allow the number of staff per 1,000 connections to fall from 8 to 3. A contract with Veolia, a French transnational water company, to help manage commercial practices was also useful in achieving some of these improvements.

The key actions policymakers need to consider are setting the tariffs at a rate that promotes cost recovery while still maintaining affordability for the poor, and also collection efficiency, which depends on metering, monitoring, enforcement and encouraging voluntary compliance.

1. Setting the tariff

Providers of water and sanitation services must generate sufficient revenue to cover both the fixed and variable costs to maintain a reliable service. Table 3 provides an overview of different tariff structures, including charging a simple flat fee, charging per unit of water consumed, or combining a fixed fee with a variable component. Each has trade-offs in terms of complexity to administer, requirement for metering, the incentives it creates for conservation of water, equity considerations, and broader impacts on economic growth.

Table 1: Comparison of different tariff structures

Tariff structure	How it works	Pros	Cons
Flat-rate tariffs	Users pay a fixed fee regardless of the amount of water or sanitation services used.	✓ Simple and easy to administer. ✓ Predictable costs for consumers. ✓ Stable revenue for utilities.	✗ Disproportionately impacts low-income households. ✗ No incentive for conservation.
Uniform volumetric tariffs	Users are charged a constant rate per unit of water consumed.	✓ Encourages conservation. ✓ Revenue aligned with usage, supporting stable utility finances.	✗ Equity concerns for low-income users with essential needs. ✗ Requires metering and billing.
Two-part tariff	Combines a fixed fee (covering infrastructure and access costs) with a variable fee based on consumption.	✓ Covers infrastructure costs while adapting to usage. ✓ Scalable for balancing affordability and revenue needs.	✗ Fixed component can burden low-income households. ✗ Complex rate-setting.
Increasing block tariffs	Water is priced in increasing blocks: initial consumption at lower rates for essential use, with progressively higher rates for greater usage.	✓ Affordable basic water for low-income households. ✓ Discourages excessive use. ✓ Higher users subsidise low-income consumers.	✗ Complex to administer. ✗ Potential revenue instability if blocks are mis-calibrated.
Decreasing block tariffs	Water is priced in decreasing blocks: higher rates for initial consumption, which decrease as consumption increases.	✓ Lower prices for large-volume users, such as businesses, promote economic activity.	✗ May incentivise wasteful consumption. ✗ Can lead to inefficiencies if overused or poorly targeted.
Social tariffs	Lower rates are provided specifically for disadvantaged groups or low-income households.	✓ Enhances equity by ensuring access for disadvantaged groups. ✓ Provides targeted financial support.	✗ Requires significant administration for eligibility criteria.

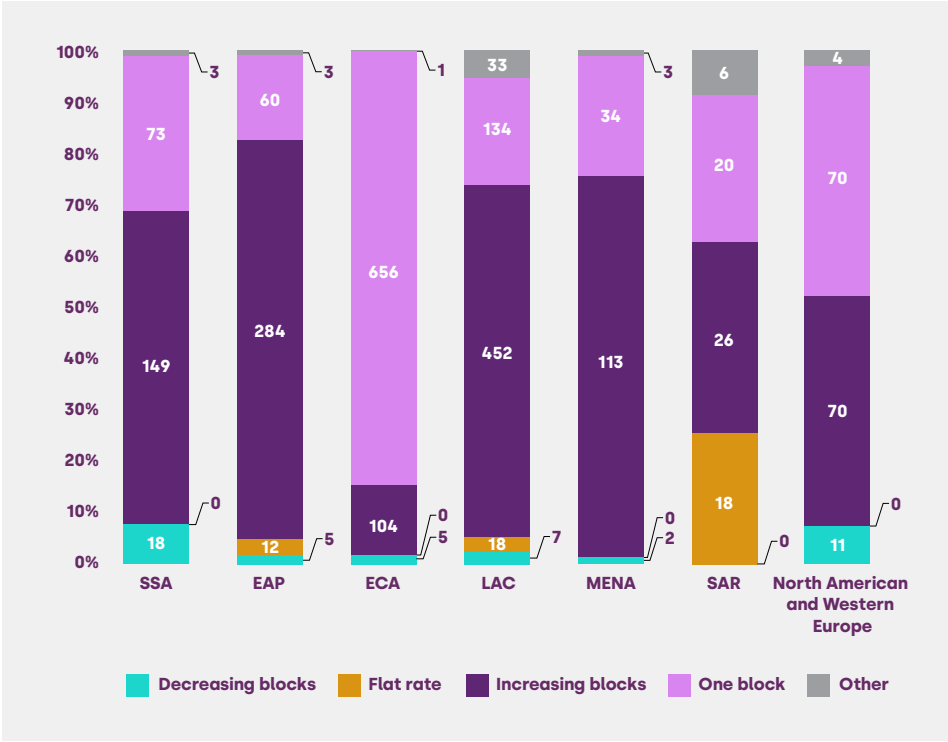
In practice, **a two-part tariff is widely considered the most fair and efficient pricing model.** This approach combines a fixed charge to help recover infrastructure costs, with a per-unit price based on consumption. By aligning usage prices with the true cost of delivering each unit, it ensures households make efficient consumption decisions without overusing or underusing the service. In contrast, flat-rate or block tariffs risk discouraging necessary use, especially among lower-income households, potentially leading to inefficiencies and welfare losses.

However, **increasing block tariffs may be better suited to achieve equity goals**, as they can be designed to cross-subsidise poorer households and support broader access to essential water and sanitation services. As **Figure 3** visualises, about half of the utilities globally use increasing block tariffs, with high adoption rates in Latin

America (LAC), the Middle East and North Africa (MENA), and East Asia and Pacific (EAP).[64]

An extreme form of block tariff is the "lifeline" tariff, which provides a certain quantity of water free of charge. The fear is that this encourages overuse and make cost recovery challenging for providers. However, a study examining free water allowances in urban South Africa found that lifeline tariffs had relatively minor effects on water usage, as most consumers consumed more than the free allocation.[65] As a result, the tariff effectively functioned as a lump-sum subsidy to low-income households.

Figure 3: Tariff structures implemented, by utilities in various regions.



Source: Authors' own elaboration, using data from "Doing more with less: Smarter subsidies for water supply and sanitation." Andres, Thibert, Cordoba, Danilenko, Joseph, and Borja-Vega. Original data Source: IBNET tariff data (2018). Data for North America and western Europe are from Global Water Intelligence (GWI).

Note: Numbers within bars represent the number of utilities with the subject tariff structure. EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MENA = Middle East and North America; SAR = South Asia region; SSA = sub-Saharan Africa.

64 Andres, L. A., Thibert, M., Lombana Cordoba, C., Danilenko, A. V., Joseph, G., & Borja-Vega, C. (2019). Doing more with less: Smarter subsidies for water supply and sanitation. World Bank.

65 Szabo, A. (2015). The value of free water: Analyzing South Africa's free basic water policy. *Econometrica*, 83(5).

Many utilities adopt different tariff structures for residential and commercial users, reflecting differences in ability to pay, usage intensity, and service requirements. Commercial users typically pay higher tariffs, effectively cross-subsidising residential users, especially in pro-poor tariff models. However, adopting such differential tariff structures requires careful design to avoid distortions.

By structuring tariffs such that high-income households or more excessive users cross-subsidise poorer users, water and sanitation services can remain affordable to low-income households without the need for additional central government subsidies.

> **In Dakar, Senegal, where 75% of urban residents have private piped connections, poorer households pay only 20% of the total cost of connection. Subsidised connections are partly financed through user fees on higher-income and commercial users.[66]**

The case study below explores how Uganda's national utility company improved affordability while increasing cost recovery.

CASE STUDY: Pro-poor pricing in Kampala[67]

Since 2004, the National Water and Sewage Company (NWSC) has implemented an affordable connections policy, reducing the cost of connections for poorer households from USD 75 to USD 35. Moreover, the company took on responsibility for connecting households within 50 metres of public supply points. This policy was financed through increasing the collection efficiency of user fees, and has resulted in a 15% annual increase in water connections in the city.

In 2006, the NWSC set up a Pro-Poor Unit, aimed at extending services to poorer areas. This unit focused on cost-effective access to water for the poor through standpipes and shared taps. By 2011, 78% of Kampala's low-income residents had access to one of these. Furthermore, the municipal tariff for water from standpipes is heavily cross-subsidised (because standpipes primarily serve the poor) at USD 0.47/m^3 (as of 2011) compared to USD 0.77/m^3 for domestic on-site piped water and USD 1.16/m^3 for larger commercial users. The overall average water and sewage tariff is USD 1.06, which is more than sufficient for cost recovery.

However, it is important that utilities consider the impact on overall cost recovery of charging certain users more.

66 Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). Providing water to poor people in African cities effectively: Lessons from utility reforms. World Bank.

67 Ibid.

When water prices were hiked in Cape Town during the 2017 drought, wealthier households were able to adapt by, for example, drilling wells to extract groundwater.

While this alleviated pressure on the municipal water supply in the short term, it created unintended, lasting consequences for the utility's revenue model. The decrease in water consumption by affluent consumers weakened the revenue base, forcing the utility to raise charges on middle-income households in the year following the crisis.[68] Furthermore, the increased reliance on privately sourced water exacerbated groundwater depletion, raising concerns about long-term sustainability and environmental damage.

Carefully conducted willingness-to-pay elicitation exercises are essential to design efficient and equitable fee structures. In most settings, residents are more willing to pay for water than sanitation, and so cost recovery can benefit from bundling them into one user fee – as explored below.

BUNDLING WATER AND SANITATION INTO ONE USER FEE

Where the willingness to pay for sanitation is low compared to water, bundling water and sanitation into a single user fee can be an effective way to fund both services. This allows utility providers to stabilise revenue streams to improve both water and sewerage infrastructure, leveraging water fees to support the less directly marketable but essential provision of sanitation services.

For example, in Zambia, a sanitation surcharge of 30% is levied on water bills to finance sewerage services, and in Lesotho this surcharge reaches 85%.[69]

In Burkina Faso, small surcharges on the water bill, labelled a 'sanitation tax', have been used successfully to finance not just piped sewerage networks, but also on-site sanitation technologies. This 'sanitation tax' has been used to finance a subsidy equivalent to approximately 30% of construction costs for on-site sanitation technologies.[70]

2. Efficient collection

In many low-income countries, over half of connected households do not regularly pay their water and sewage bills.

68 Abajian, A., Cole, C., Jack, B. K., Meng, K., & Visser, M. (n.d.). Dodging day zero: Drought, adaptation, and inequality in Cape Town. *Journal of the European Economic Association.*

69 Banerjee, S. (2010). Financing sanitation and wastewater services in developing countries: An analysis of the problem and potential solutions (World Bank Policy Research Working Paper No. 5384). World Bank.

70 Water and Sanitation Program. (2004). Mobilizing resources for sanitation (Field Note). World Bank.

Annual losses from revenue collection inefficiencies in water and sanitation utility operators have been estimated at USD 500 million across African cities.[71]

Research shows that adhering to the following principles improves revenue collection:

- ✓ **Service quality:** When the service provided is reliable and better than alternative methods of obtaining water and sanitation, consumers are generally more willing to pay for it.
- ✓ **Usage monitoring:** Effective monitoring of individual usage, both for communal toilets and for water or sewage from pipes, is crucial for revenue collection. Central to the transformation of water provision in Phnom Penh (Cambodia) was the fact that the proportion of water users being metered grew from 13% in 1993 to almost 100% by 2001.[72]
- ✓ **Easy payment:** Payment needs to be made as easy as possible. In Kampala, for example, consumers use prepaid electric tokens to access water standpipes. This not only results in increased collection efficiency, but also cuts out the middleman, ensuring that consumers can access the tariff set by the National Water and Sewage Company without extra charges. Furthermore, increasingly across low-income countries, smart meters and mobile phone payment systems are being introduced, which allow for quick, easy and efficient payments.
- ✓ **Prepaid metering:** In settings with high non-payment rates and costly enforcement, prepaid metering can improve revenue collection. For the context of Cape Town, South Africa, researchers documented that switching from monthly billing to prepaid metering for electricity led to a 14 percent decrease in usage, but nonetheless increased utility revenues due to more complete collection and lower recovery costs.[73]
- ✓ **Rule enforcement:** Clear and credible enforcement of payment rules, such as issuing disconnection notices, can substantially improve bill payment rates. Evidence from Nairobi shows that while face-to-face engagement between utility staff and customers had no impact, transparent enforcement through disconnection notices boosted revenue collection without reducing service access, tenant wellbeing, or trust in the utility company.[74]

71 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

72 Biswas, A., & Tortajada, C. (2010). Water supply of Phnom Penh: An example of good governance. *International Journal of Water Resources Development*, 26(2), 157–172.

73 Jack, B. K., & Smith, G. (2020). Charging ahead: Prepaid electricity metering in South Africa. *American Economic Journal: Applied Economics*, 12(2), 134–168.

74 Coville, A., Galiani, S., Gertler, P., & Yoshida, S. (2023). Financing municipal water and sanitation services in Nairobi's informal settlements. *The Review of Economics and Statistics.*

If implemented effectively, user fees allow utilities to break out of a negative feedback cycle of poor service, low willingness to pay, low revenue collection, and over-reliance on central government subsidies.[75]

> **Despite political fears over the public unpopularity of user fees, the weight of international evidence shows that where well-targeted and efficiently collected user fees are used to fund significantly better service provision, consumers are willing to pay these fees, and the cash generated can be used to improve and expand provision to lower-income households.**

Local taxes

An alternative source of funding, to help recover the upfront capital investment as well as ongoing operations, maintenance and expansion of the network, is local taxation – largely property taxes. These taxes can become a self-financing tool if property values rise because of improved WASH infrastructure. For example, land prices in 19th century Chicago more than doubled as a consequence of gaining sewer access.[76] Higher revenues from property tax collection could then be reinvested in further improvements and expansions of the network.

> **Research from informal settlements in Brazil shows that a USD 1/m^2 government investment to service land with water infrastructure increases the landowner's land value by USD 3-11/m^2 (see figure below).[77]**

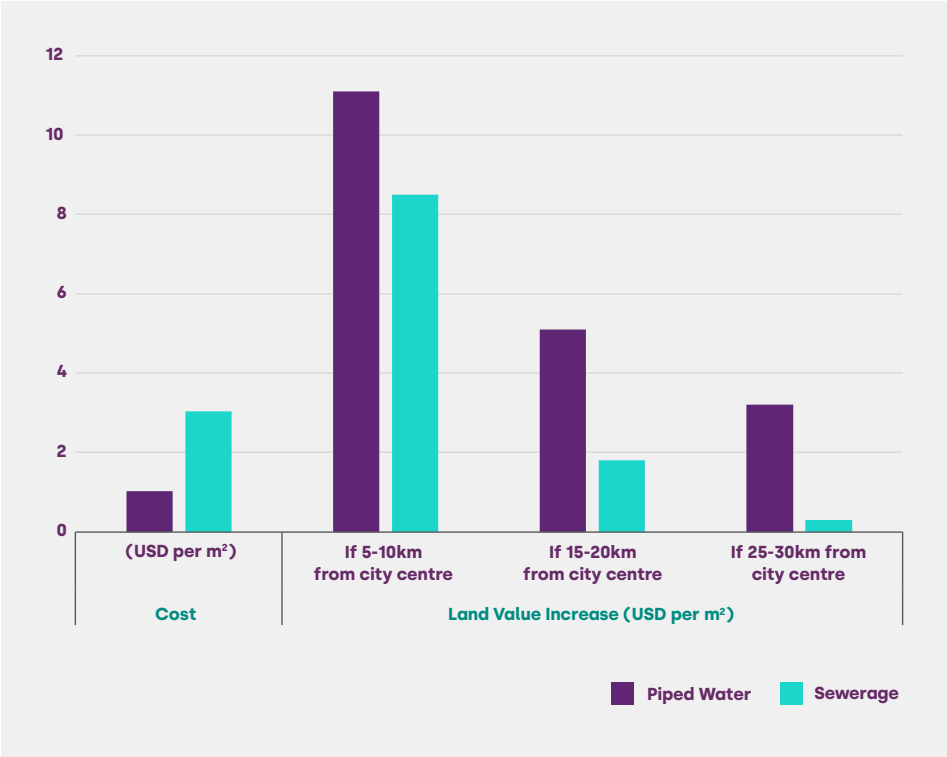
Since this increase in value is created by government investments, it is both fair and ethical for governments to recoup some of it. Furthermore, by capturing just a portion of this land value increase, governments can not only recoup their investment, but can also make further investments in the expansion and maintenance of WASH infrastructure.

75 McRae, S. (2015). Infrastructure quality and the subsidy trap. *American Economic Review,* 105(1), 35–66.

76 Coury, M., Kitagawa, T., Shertzer, A., & Turner, M. (2024). The value of piped water and sewers: Evidence from 19th century Chicago. *The Review of Economics and Statistics,* 1–47.

77 Smolka, M. (2013). Implementing value capture in Latin America: Policies and tools for urban development. *Lincoln Institute for Land Policy Policy Focus Report Series.*

Figure 4: Installing water and sewerage infrastructure would increase land values by far more than the cost of investment in Brazilian informal settlements – particularly for land close to the city centre.



Source: Authors' own elaboration, using data from Serra, M. V., Dowall, D. E., da Motta, D. M., & Donovan, M. (2005). *"Urban land markets and urban land development: An examination of three Brazilian cities: Brasilia, Curitiba, and Recife"*. In M. V. Serra & D. M. da Motta (Eds.), *Estudos estratégicos de apoio às políticas urbanas para os grupos de baixa renda no Brasil* (Enabling strategy for moving upgrading to scale in Brazil) [CD-ROM]. Washington, DC: Cities Alliance.

- ✓ **Virtuous circle of re-investment:** As the evidence from Brazilian informal settlements highlights, property taxes can become a self-financing tool to construct, operate, expand, and maintain water and sanitation infrastructure, as the latter contributes to an increase in land values.
- ✓ **Facilitate redistribution:** Property taxes from richer areas of the city can be used to fund WASH developments in poorer areas of the city where land values, and therefore property tax revenues, are lower.
- ✓ **Encourages usage:** When residents are already paying for WASH services through their tax payments, they are more likely to connect to use these services to get value from their payments.
- ✓ **Can piggy-back on existing property rates, rather than introducing new fees:** If there is already a functioning property rates system in place, governments can focus on improving this, rather than introducing a new fee for residents to pay.

✗ **High institutional requirements:** However, property taxes require some demarcation of land and property rights, which may be lacking in some areas. They also require effective tax collection systems.

✗ **No visible link between service and payments:** There is no incentive to reduce water consumption, as it has no impact on fees paid. It also limits the ability of residents to hold governments to account for poor service delivery.

Reducing operational costs

The financing of water and sanitation provision does not just require raising external funds and internal revenues, but also hinges on water and sanitation providers becoming more cost-efficient. The two primary ways of reducing costs to increase operational efficiency are tackling overstaffing and reducing leakages.

> **Overstaffing is a major issue in water and sanitation companies, particularly public ones; it is estimated to cost African water providers up to USD 400 million each year.[78]**

Tackling overstaffing may therefore be one of the most effective ways of reducing operational costs. In Dakar, Ouagadougou, and Kampala, recruitment practices were reformed, such that inefficient staff could be fired or not re-contracted.[79] In under a decade, the number of staff per 1,000 connections fell by roughly two-thirds in each of these cities, without compromising service quality. In circumstances where it is difficult to lay off existing workers, staff training exercises and limiting new recruitment drives can make staff expenditure more efficient.

System leakages, whether technical or via theft, are another large operational cost. They can be very wasteful and, if unaddressed, may lead to the malfunctioning of water points or sanitation technologies. It is estimated that system losses through water theft, unregistered water connections, and pipe leakages cost African water providers USD 400 million each year. As explained earlier, careful monitoring, more efficient revenue collection and effective service delivery can contribute to reducing water theft and unregistered water connections.

The maintenance and refurbishment of existing piped systems is crucial in addressing technical leakages. Urban water systems often date back to colonial times or ambitious post-colonial infrastructure projects and have struggled to keep pace with rapid urbanisation in recent decades. In many low-income cities, decades of insufficient pipe replacement or refurbishment have resulted in high levels of leakage. In fact, it is not uncommon for 50% of the piped water supply in low-income cities to

78 Banerjee, S., & Morella, E. (2011). Africa's water and sanitation infrastructure: Access, affordability and alternatives. World Bank.

79 Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). Providing water to poor people in African cities effectively: Lessons from utility reforms. World Bank.

be lost through leakages.[80] Reducing these losses is not only critical for financial sustainability, but also for conserving water, an increasingly vital resource in the face of climate change.

Managing behaviour around water and sanitation

In cities across the world, governments have invested heavily in water and sanitation systems that remain underused or misused. This is not only because of financial constraints, but also because households lack the incentives, awareness, or social pressure to change habits. Because the public health gains extend far beyond individual households, governments need to make these **wider social benefits** visible, showing citizens that better hygiene protects entire neighbourhoods, not just single homes.

Governments may further leverage behavioural interventions to **reduce harmful actions** such as open defecation or inappropriate use of sewer systems. In many lower-income cities, indiscriminate dumping of waste in open gutters or drains frequently leads to blockages of rudimentary sewer systems and is one of the reasons behind chronic flooding. The City of Cape Town, for example, faces growing challenges as residents dispose of solid waste through private toilets, leading to sewage blockages and outflows, which pose a risk to agriculture, fishing, and tourism.[81]

Finally, behavioural change is essential for **conserving scarce resources**. This is particularly important in regions where climate change is increasing pressure on water systems and creating a need to manage consumption in times of crisis. In 2017, severe droughts led to rapidly falling water levels of the dams supplying Cape Town, leaving policymakers with no option but to ration its citizens' water usage. Bogotá had to implement water rationing policies in 2024 to address low water levels. In Pakistan, severe water shortages are also becoming more frequent, with aquifers sinking to deeper levels, increasing water extraction costs.

Informational campaigns: education and awareness-raising

Education campaigns can make new services viable by increasing people's willingness to pay for and maintain them. For example, successful utility companies in Kampala and Nyeri regularly consult with communities to find out what services the community needs and educate

80 United Nations Environment Programme. (2008). Every drop counts: Environmentally sound technologies for urban and domestic water use efficiency.

81 City of Cape Town. (2022). Cape Town's integrated development plan 2022–2027.

the community on water and sanitation issues.[82] These campaigns are a vital complement to technical, financial, and institutional reforms - without such initiatives, some expensive but effective technologies are never adopted or are at risk of becoming underused and under-maintained.

Simple, well-targeted campaigns can shift harmful behaviours like littering and water overuse.

> **In Mozambique, flood-risk education reduced illegal dumping of refuse in open drains and gutters by up to 15%.[83] In South Africa, a campaign linking water payment to civic responsibility raised bill payments by 25% for three months.[84]**

The evidence suggests that the effectiveness of the information campaign was not driven by increasing consumer's information on the billing system, or the amount of water consumed, nor by generating a useful reminder or creating a threat of enforcement. Instead, the increase in payments was an expression of reciprocity, where consumers acknowledged the education efforts made by the water provider.

Successful education and awareness-raising initiatives have tended to be well focused, tailored towards residents' priorities and, crucially, delivered on a large scale.

- ✓ **Tailor messages to what people value.** Linking hygiene to goals families already care about – like keeping children in school – makes campaigns resonate.
- ✓ **Keep messages simple.** One clear instruction, such as "wash hands with soap", outperforms long lists of dos and don'ts.
- ✓ **Reach whole communities.** Sanitation habits change only when neighbours act together. Large-scale, community-led programmes like Thailand's *Baan Mankong* succeeded because they combined awareness with visible improvements in facilities.[85]

82 Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). Providing water to poor people in African cities effectively: Lessons from utility reforms. World Bank.

83 Leeffers, S. (2023). It will rain: The effect of information on flood preparedness in urban Mozambique.

84 Szabó, A., & Ujhelyi, G. (2015). Reducing nonpayment for public utilities: Experimental evidence from South Africa. *Journal of Development Economics*, 117, 20–31.

85 Lucci, P., Bhatkal, T., Khan, A., & Berliner, T. (2015). What works in improving the living conditions of slum dwellers: A review of the evidence across four programmes. *Overseas Development Institute, Dimension Paper 04.*

Community-built toilets in Mumbai: Raising awareness on the benefits of sanitation[86]

Mumbai's community-built toilets show that infrastructure succeeds when residents have a stake in it. The city financed construction for 900,000 people, but local groups designed, built, and managed the facilities. Separate entrances for women and better lighting created safety and dignity. Because the toilets were well designed and locally managed, residents had a sense of pride and ownership, and willingly paid small fees for maintenance, ensuring sustainability.

Historically, where such engagement has been weak, communal toilets have fallen into disrepair within months of construction, due to the lack of a sense of ownership. Failing to engage with the community may also lead to ignoring cultural norms surrounding privacy, and excluding groups, particularly women.

Leveraging cultural norms and social interactions

Water and sanitation practices are deeply social. They depend on what neighbours do and what communities value. Social norms and interactions can therefore be leveraged to design effective behavioural interventions to induce responsible use of water and sanitation services and to increase demand. They are also a cost-effective way to induce behaviour change where monitoring technologies are not well developed.

- ✓ **National pride campaigns.** Singapore's "Keep Singapore Clean" and South Korea's "Living Well" campaigns[87] were immensely successful in transforming public attitudes to water and sanitation, advertising their importance not only in terms of public health, but also more broadly for national pride, civic responsibility, and modernisation.

- ✓ **Social comparison tools.** By leveraging shared beliefs, values, and practices within a social group or community, these interventions seek to shift perceptions of what is considered acceptable or typical behaviour, encouraging individuals to align with newly promoted norms. They often showcase how an individual or household's behaviour compares to that of their neighbours. For example, during the 2017/18 water crisis, the City of Cape Town created a public City Water Map with colour-coded dots to show household water usage. This created competition and a sense of pride among neighbourhoods, encouraging peer pressure and positive social norms around water conservation.[88]

86 Ibid.

87 Black, M., & Fawcett, B. (2008). *The Last Taboo: Opening the Door on the Global Sanitation Crisis.* Earthscan.

88 **https://theconversation.com/cape-towns-map-of-water-usage-has-residents-seeing-red-90188#:~:text=How%20the%20Map%20works,litres%20in%20the%20previous%20month.** (accessed: 18 January 2026)

- ✓ **Community role models.** Influential members of a community, such as local chiefs or religious leaders, can act as role models, and teach or reinforce good water and sanitation practices.[89] A recent study documented that women attending religious classes in Jordan reduced their water consumption by 17% after receiving messages on the sanctity of water in Islam.[90] Relative to women who did not receive these messages, they were also 28% more likely to donate to a water charity dedicated to preserving water resources.

- ✓ **Public pledges.** In Bangladesh, community groups were invited to make a collective verbal and written pledge, publicly promising to install or upgrade hygienic latrines for their own households and to help neighbours do the same by a fixed date. Although the short-term effects on latrine ownership were smaller than those from financial rewards, the public pledge produced more persistent results over the following year.[91]

Although they can be highly effective, communication strategies must be designed carefully. Highlighting the prevalence of negative behaviours, such as littering or overuse of water, may backfire and contribute to normalising these actions, undermining the intervention's goal.[92] Behaviour change messages should rather emphasise that most people engage in responsible and socially desirable behaviour to help reinforce the idea that these behaviors are socially accepted and typically done by most.

> **Norm-based interventions often have spillover effects, which magnify impact. In Colombia, an information campaign targeting water consumption led to a 6.8% reduction in use in households that were targeted directly by the campaign, and by 5.8% in households that were not.[93] It ended up also reducing the use of electricity, because it encouraged broad learning on efficiency and conservation.[94]**

89 La Ferrara, E., Chong, A., & Duryea, S. (2012). Soap operas and fertility: Evidence from Brazil. *American Economic Journal: Applied Economics*, 4(4), 1–31.

90 Buccione, G. (2023). Religious messaging and adaptation to water scarcity: Evidence from Jordan.

91 Bakhtiar, M., Guiteras, R., Levinsohn, J., & Mobarak, M. (2023). Social and financial incentives for overcoming a collective action problem. Journal of Development Economics, 162.

92 Cialdini, R. (2002). Crafting normative messages to protect the environment.

93 Carlsson, F., & Torres, M. M. J. (2018). Direct and spillover effects of a social information campaign on residential water-savings. *Journal of Environmental Economics and Management.*

94 Carlsson, F., et al. (2021). Behavioral spillover effects from a social information campaign. *Journal of Environmental Economics and Management.*

In Dakar, subsidies for improved sanitation increased health outcomes in those neighbourhoods, motivating neighbours who did not receive subsidies to invest in improved sanitation as well.[95]

CASE STUDY: Complementing subsidies with awareness campaigns in Bangladesh[96]

Evidence from Bangladesh shows that neither subsidies nor awareness campaigns alone can end open defecation. However, in areas where both interventions were combined, there was a 22 percentage point increase in toilet construction and open defecation fell by 9 percentage points. Furthermore, in these areas, even for people who were not targeted by the intervention, toilet construction rose, and open defecation was reduced, suggesting that there is a social multiplier associated with changing people's sanitation habits. The lesson: behaviour change is most powerful when residents can act on new information and see the benefits of improved sanitation immediately.

95 Deutschmann, J. W., Lipscomb, M., Schechter, L., & Zhu, J. (2024). Spillovers without social interactions in urban sanitation. *American Economic Journal: Applied Economics*, 16(3), 482–515.

96 Guiteras, R., Levinsohn, J., & Mobarak, A. M. (2015). Sanitation subsidies: Encouraging sanitation investment in the developing world: A cluster-randomized trial. *Science*, 348(6237), 903–906.

Addressing institutional, regulatory, and contracting challenges to water and sanitation service provision

Getting institutions right is harder than choosing and building the infrastructure, but it matters more. Even when funding and technology are available, unclear responsibilities, weak regulation, and poor contract design can paralyse delivery. Designing an effective institutional structure underpinning water and sanitation policies requires clarifying responsibility and coordination, regulating for reliability and inclusion, and integrating WASH with broader urban policy reform.

Clear and coordinated institutional arrangements

Fragmented mandates are one of the most common obstacles to effective WASH delivery. In many countries, responsibilities for water and sanitation are spread across multiple ministries and layers of government, resulting in confusion and under-provision. In Kenya, for example, unclear institutional arrangements for water provision in the 2010 constitution have exacerbated underlying problems of scarcity and accessibility of water and sanitation.[97] In the constitution, Kenya's new county level of government was made responsible for water provision in urban areas, but no laws were passed to reallocate authority from regional and local water boards and utilities. Many cities have thus not been able to regulate water provision or extend services to lower-income areas. In Nairobi, only 36% of households in informal settlements have piped water connections, and many low-income residents are left to rely on a limited network of NGO providers and unregulated private companies, resulting in inflated water prices and poor water quality.

This can also be the case where services are provided by the private sector. The supply for on-site sanitation technologies offers a clear example. The processes involved (e.g. hygiene promotion, pit construction, and pit emptying) are fragmented across many actors, both public and private. Each actor operates according to their own individual incentives. So, if there is a lack of coordinating agency to drive reform, there is no guarantee that the supply will be effective.

> **National water and sanitation policies can be extremely useful for providing a high-level basis for legislation, strategic planning, and mapping the roles of different institutions. Such systematic planning initiatives can help to diagnose gaps in governance, and promote inter-institutional coordination.**

Establishing coordinating agencies to fill the gaps in governance and align the objectives of different stakeholders can be very effective.

97 World Bank. (2016). Kenya urbanization review. World Bank, Washington, DC.

In Senegal, a dedicated national sanitation utility, ONAS, was established to oversee both sewered and on-site sanitation services.[98] ONAS works in coordination with local governments to implement on-site sanitation solutions, particularly in low-income and peri-urban areas.

National coordination, however, works best when **sub-national governments** have real authority and resources. Decentralising the implementation of water and sanitation policy can improve service delivery, enabling implementation plans to be engineered to the specific challenges and constraints each municipality faces, and incorporated into wider urban planning. However, this needs to be accompanied by fiscal decentralisation. For example, in China, decentralisation of water and sanitation governance in 1994 was combined with laws to decentralise tax collection, enabling rapid expansion of water and sanitation infrastructure.[99]

Coordination also requires bridging departmental silos. Water systems cut across health, housing, and environmental planning. Joint planning can harness positive system interactions: in **Indore**, India, upgrading wastewater infrastructure through the Slum Network Project improved both flood management and citywide water quality.[100] In **Costa Rica**, upstream forest conservation agreements allow the city of Heredia to supply water with minimal treatment.[101] In Accra, using raw wastewater for urban irrigation has reduced treatment costs while sustaining 90% of the city's vegetable supply.[102]

Water systems cut across health, housing, and environmental planning. Joint planning can harness positive system interactions.

Impartial and effective regulation of water and sanitation providers

The objective of water and sanitation regulators is to ensure that public or private water and sanitation provision complies with existing rules, for example with respect to tariff or quality standards, such that services are provided in a manner that meets social priorities set out by policymakers (both at national and local Government level). In particular, regulation can play an important role in setting clear and realistic rules governing the expansion of water and sanitation networks, tariff levels and structure, quality requirements, and the competitive environment surrounding the main service providers. To ensure impartial and effective regulation and monitoring of water and sanitation policy implementation, it is necessary to separate the role of regulators and operators.

98 World Bank. (2012). Republic of Senegal: Water supply and sanitation sector performance review. *World Bank Water and Sanitation Program*, Washington DC.

99 Zhang, X. (2020). Local government finance and infrastructure investment in China. *Journal of Contemporary China*, 29(123), 45–60.

100 World Bank. (2004). Scaling-up urban environmental sanitation: The case of the slum networking project in Indore. Washington DC: World Bank.

101 Pagiola, S. (2008). Payments for environmental services in Costa Rica. *Ecological Economics*, 65(4), 712–724.

102 African Development Bank. (2000). Policy for integrated water resources management.

Setting realistic service standards

In many cities, utilities are tasked with reaching targets that far exceed their financial capacity. Excessively stringent regulations are often imported from high-income countries but are completely ill-fitted for the context. For example, the geophysical features (soil conditions, or temperature fluctuations) are different, making it hard to meet some of the quality standards designed for less challenging conditions.

Furthermore, reducing design specifications on water pressure or the diameter of water and sewerage pipes can allow for lower cost provision, particularly in informal settlements where ability to pay is far lower, and dense housing and narrow streets restrict the construction of large-scale piping systems. Independent regulators can therefore improve coverage and credibility by setting achievable expansion goals, defining clear metrics, and publishing data on progress.

Encouraging competition and transparency

A lack of a clear regulatory and accountability framework can result in monopolies, corruption, and poor services. New market entrants might be deterred due to lack of clarity over regulations and their requirements, or inability to access finance. At the same time, the market may become littered with many low-quality, high-cost providers. Furthermore, households need to search for providers every time they need sanitation services.

In **Dakar**, Senegal, the government created a centralised digital auction platform that allows sanitation providers to compete for customers under regulated price ceilings.[103] This model has raised quality, reduced costs, and made licensing easier to enforce. Moreover, these platforms incentivise suppliers to register with the government, which facilitates effective regulation of service quality and the enforcement of basic safety and pollution standards.

Formalising alternative informal service providers

Across much of the developing world, informal providers supply the majority of urban residents, through small-scale networks, trucked water, or community toilets. These actors are rarely recognised in law and thus fall outside regulatory oversight, enabling them to charge the most vulnerable residents very high prices for poor services. Rather than banning them, cities can bring informal providers into the formal system.

In **Ho Chi Minh City**, authorities issued five- to ten-year contracts allowing small providers to operate legally.[104] The public utility plans to take over networks at the end of the contract period, with compensation

103 Houde, J. F., Johnson, T., Lipscomb, M., & Schechter, L. (2024). Imperfect competition and sanitation: Evidence from randomized auctions in Senegal. Working Paper.

104 World Bank. (2006). Vietnam urban water supply and sanitation sector review. Washington DC: World Bank.

for existing operators. Legal recognition of alternative service providers can provide them with important security of investment, lower risk of expropriation, and improved access to finance, which allow for improved and extended service.

In **Durban**, South Africa, the municipal government formally recognised manual pit latrine emptiers and partnered with them to expand sanitation in informal settlements, improving both service quality and worker safety.[105]

Integrating water and sanitation policies into wider urban policy reforms

Water and sanitation reforms cannot succeed in isolation. They depend on how land is managed, housing is built, and local taxes are collected. Linking WASH policy with broader urban development makes investments more efficient and cost-effective.

Land rights are particularly important. Without secure land rights, owners are far less likely to invest in water connections or toilets, and they cannot collateralise land to finance these investments. Governments also cannot legally mandate wealthier property owners to connect to piped systems. As a result, in many countries, governments are reluctant to provide water and sanitation services to residents without a formal land title.

In Kampala, for example, in order to approve a water or sewerage connection, the National Water and Sewage Corporation requires a land title, lease document, or permission of the landowner or leaseholder. Since under the current tenure system many people do not have such documents, connections remain impossible.[106] Whilst the long-term solution is to register formal land rights, in the short term, a more flexible approach – such as using voter lists or community group guarantees – may be necessary. Utility companies can also work with private providers to extend water and sanitation access to the poor in informal settlements.

Due to inadequate urban planning and poorly defined land rights, informal settlers often construct their homes in under-serviced areas with no water or sewerage networks. By making water and sanitation infrastructure lead rather than lag housing construction, high-quality water and sanitation provision may be more cost-effective.

105 Mitchell, C., Ross, K., & Cotton, A. (2016). Managing sanitation services in informal settlements: The role of manual pit emptiers. *Water Policy*, 18(2), 388–403.

106 Baptista, I. (2013). *The Different Approaches to Faecal Sludge Management in Kampala, Uganda.* Environment and Urbanization.

In Ethiopia, the Integrated Housing Development Programme, which has built 110,000 housing units in the past decade, constructed water and sewage infrastructure for new houses, funded via the sales of some of the newly built commercial units. Building infrastructure for new housing developments can often be far cheaper than retrofitting. In Colombia, it has been estimated that infrastructure delivery is 2.7 times cheaper in planned developments than in unplanned, illegal housing settlements, where retrofitting often requires costly road widening or creation, repeated excavation, and piecemeal installation of services.[107]

107 Department for International Development. (2002). Key sheets for pro-poor infrastructure provision: Land tenure.

Conclusion

Urban water and sanitation policies are important contributors to public health, economic productivity, and environmental sustainability in developing cities. Evidence shows that investments in WASH infrastructure deliver multiple benefits by reducing the incidence of water-borne diseases, increasing economic productivity, and generating important social gains, such as improved educational outcomes and enhanced gender equity. Moreover, these investments help mitigate severe environmental degradation associated with poor sewage and wastewater management.

However, achieving these gains requires careful, context-specific decision making. Governments face critical trade-offs when deciding between different technologies and levels of involvement between public and private actors. While advanced solutions, such as private piped connections and sewerage systems, provide higher quality and cost-effectiveness over time, they require substantial upfront investments and institutional capacity. Conversely, decentralised solutions, like boreholes, public taps, and pit latrines, offer more affordable, immediate alternatives but may fall short in delivering the broad social and environmental benefits needed for sustainable urban development.

Financing these systems remains a significant challenge, requiring a blend of public finance, concessional loans, user fees, and property taxes depending on the context. Successful case studies from cities like Dakar, Ouagadougou, and Kampala illustrate how combining public investments with effective user fee systems can ensure long-term financial sustainability, while targeting subsidies to low-income populations expands access.

Technical and financial reforms will only succeed if accompanied by behavioural change. Information campaigns, community engagement, and the use of social norms are useful complements that can raise awareness of the wider benefits of improved water and sanitation, encourage sustainable usage, and strengthen collective responsibility for maintaining systems.

Equally important is the design of effective regulatory and institutional frameworks that clearly define roles, facilitate inter-agency coordination, ensure that both public and private providers are held to account, and ensure equitable access across all social groups. Public utilities, private operators, and community-based organisations can all deliver successfully when clear accountability mechanisms and performance monitoring are in place. Integrating water and sanitation policy with broader urban reforms can also create important synergies and reduce long-term costs.

Getting water and sanitation right is not only about providing essential services; it is about building the foundations for healthier, more productive, and more resilient cities. Governments that align technology, finance, behaviour, and governance can transform urban growth into a lasting source of wellbeing and economic opportunity.

Further reading

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Heymans, C., R. Eberhard, D. Ehrhardt. and S. Riley (2016) "Providing Water to Poor People in African Cities Effectively: Lessons from Utility Reforms", World Bank.

Jerch, R. L., and D. J. Phaneuf (2024). Cities and Water Quality. *Regional Science and Urban Economics*, 107.

Appendix 1: Assessment of water and sanitation technologies

Table 1: Assessment of water technologies

	Piped Water: Private piped connections **Improved** under WHO/JMP guidelines (assuming proper operation and maintenance).	**Piped Water: Public water taps** **Improved by design.** Actual water safety will vary depending on on-site conditions and local sanitation	**Non-piped systems** **Improved** if they are protected (e.g., a well or borehole that is properly constructed, maintained, and protected from contamination). **Unimproved** if they are vulnerable to contamination (e.g., unprotected wells, poorly managed tanks, or sachet/bottled water with inadequate regulation).
Definition	Piped water delivered directly on-premise to households and businesses.	Piped water delivered through public water taps.	Water delivered without piped networks. Either through more rudimentary on-site technologies like wells, boreholes, and tanks, or purchased directly in the form of sachet and bottled water.
Overview	Water pipes offer a safe and cost-efficient method for urban water distribution by reducing contamination risks and keeping operational costs low. However, the high fixed costs for network expansion and the growing need for maintenance as systems age create financing challenges. Integrating piped water infrastructure during early development is more cost-effective than retrofitting later. Piped water can be delivered via private piped connections or serving customers via public taps. To decide between these two policymakers face trade-offs between quality, accessibility, and costs.		Cheaper but less technologically advanced options are wells, boreholes, and water tanks. In cities where water systems are underprovided, the markets for bottled and sachet water have also expanded rapidly. In Greater Accra, the percentage of households for which sachet water was the primary source of drinking water increased from 28% to 80% between 2010 and 2017.[108]
Health impacts	✓ With sufficient investment in water treatment and pipe refurbishment, piped water quality is significantly higher than that of non-piped water sources, which are frequently contaminated by ground or surface water infiltration.	✗ While on-premise water provision eliminates the risk of contamination during transport and on-site storage, public water taps risk being contaminated on-site, particularly if nearby sanitation is not adequate. ✓ Communal piped water quality is of significantly higher quality than that communal non-piped water sources such as wells and boreholes.	✗ Wells and boreholes, even when covered, can easily become contaminated by ground or surface water, resulting in serious public health consequences. ✗ Poor regulation of vendors and water quality for sachet and bottled water can lead to inconsistencies in water quality. In some cases, bottled and sachet water may be contaminated or unsafe, especially when vendors do not follow standard treatment procedures.
Accessibility	✓ Delivering water directly to households and businesses significantly reduces the time and effort required to access water sources.	✓ Public taps are reasonably accessible at low cost in many low-income areas and can work towards longer-term goals of on-site piping. ✓ Where public taps are insufficient in number, long journeys to collect water increase the risk of water contamination and require time and effort, most usually of female household members, which could be spent on more productive activities. ✓ If maintenance is delegated to a private company, there is a risk they might charge markups on water prices, which may exclude some from accessing them.	✓ In contexts where existing piped water systems are inadequate and funding is limited, non-piped systems can be reliable and quick-to-implement alternatives, offering immediate health improvements and economic benefits in terms of time savings.
Costs	✓ On-premise piping is expensive. Particularly in informal settlements the ability to pay for such infrastructure is low. In Lusaka, Zambia, the Water and Sanitation Company estimates the costs at $960, more than double the average monthly income of $440.[109]	✓ Shared public taps avoid the higher fixed costs associated with installing on-premise piping. In Kampala, the National Water and Sewage Corporation (NWSC) has focused on providing relatively low-cost public taps since 2002.[110] ✗ The costs of maintaining public taps can become very high if coordination failures in maintaining them are not addressed. If maintenance is done by the community using the tap, free-riding can lead to under-maintenance and potential water point failure.	✓ Providing chlorine tablets at public water collection points can be an effective method of low-cost water purification. Combining non-piped systems with the provision of chlorine tablets might be a low-cost short-term solution for water provision. ✗ The unit cost of bottled and sachet water is higher than that of piped water. The monthly total of sachet water consumption cost is often higher than the monthly fees for connected water supply. Making this only a short-term solution.

108 Moulds, S., Chan, A., Tetteh, J., Bixby, H., Owusu, G., Agyei-Mensah, S., Ezzati, M., Buytaert, M., & Templeton, M. (2022). Sachet water in Ghana: A spatiotemporal analysis of the recent upward trend in consumption and its relationship with changing household characteristics, 2010–2017. PLoS ONE, 17(5).

109 Ashraf, N., Glaeser, E. L., & Ponzetto, G. A. M. (2016). Infrastructure, incentives, and institutions. *American Economic Review*, 106(5), 77–82.

110 Heymans, C., Eberhard, R., Ehrhardt, D. and Riley, S. (2016) "Providing Water to Poor People in African Cities Effectively: Lessons from Utility Reforms", World Bank.

Table 2: Assessment of sanitation technologies

	Water-borne sewerage systems Improved when effectively managed and treated. Their design minimizes direct human contact with sewage. Success depends on proper treatment and maintenance infrastructure.	**Condominial sewerage systems** **Potentially Improved** if they function as intended—channelling sewage away from users safely. However, the simplified design and common maintenance issues mean that without rigorous quality control, the systems may not fully meet improved criteria.	**Communal Toilets** **Unimproved/Limited Sanitation.** Despite providing access where private facilities are unfeasible, sharing among multiple households generally disqualifies them from being considered "improved" under WHO/JMP guidelines due to higher risks of contamination and challenges in upkeep.
Definition	Sewerage systems, generally connected to flush toilets, that collect and transport sewage.	Simplified sewerage systems with lower depth and lower quality concrete pipes.	Shared toilets, located in or near residential areas, which serve multiple households. Often found in low-income or high-density areas where individual household latrines may be too costly.
Overview	Sewage is either channelled through the same pipes as wastewater (one-pipe system) or through a separate pipe (two-pipe system). Ideally, sewage is treated at a wastewater plant, although often it is directly discharged into marshes and wetland areas.	Flexible and cheaper approach. In 'condominial' or 'simplified' sewerage systems, the depth of the sewer is limited by routing pipes through gardens, yards and sidewalks rather than main roads, and using lower quality concrete pipes to reduce construction costs. May provide a cost-effective sanitation solution but require rigorous piloting to confirm feasibility and suitability to local conditions.	Communal toilets provide shared sanitation facilities for several households. Usually managed by a community organization, NGO, or municipal government. They include basic sanitation (pit latrines, unconnected flush toilets, or ecological toilets). They are particularly common in informal settlements and areas where space or affordability limits individual toilet access. They require continuous maintenance efforts.
Health and environmental impacts	✓ Sewerage systems avoid human contact with urine and faecal matter and prevent the contamination of ground and surface water, offering significant public health and environmental advantages. In Europe, the US, and East Asian cities, large-scale public investments in sewerage systems underpinned drastic reductions in infant mortality rates, diarrhoeal infections and cholera. ✓ Investments in piped water and sewerage systems can be highly complementary in terms of public health benefits.111 ✗ Investments in wastewater treatment plants become essential. Without proper treatment, diluted sewage is discharged directly into lakes and rivers, causing environmental degradation.	✗ Many condominial sewerage projects have been less successful due to poor-quality construction, insufficient system capacity, and low maintenance, leading to serious issues of sewage leakages. In Salvador, the condominial sewerage system faced challenges due to the dense and steep nature of urban slums, inadequate community participation, and poor definition of maintenance responsibilities.	✓ Communal toilets can improve public health by providing access to sanitation where private individual toilets are lacking. ✗ However, if not well-maintained, they can become a source of water contamination and disease, with serious public health consequences, particularly in high-density urban areas.
Accessibility	✓ Because these systems reach households directly, they greatly facilitate access in terms of distance, flexibility, and availability during the whole day.		✓ Provide basic access to households without private facilities. ✗ Accessibility may be limited by distance, overcrowding, price, and lack of availability during certain hours. This is particularly the case if communal toilets are managed by intermediaries. ✗ Lack of consideration of gender and cultural norms in the design of communal toilets may exclude part of the population from accessing them.
Costs	✗ As many of the benefits of individual sewerage connections extend beyond private individuals, service users are not prepared to pay sufficiently high user fees to extend sewerage system. Constructing large-scale sewerage systems has proved financially unfeasible for many governments, particularly where existing networks are limited. ✓ Since water-borne sewerage systems are directly linked to piped water systems, investments in piped water and sewerage systems can be highly complementary. This may lead to gains in cost-effectiveness in the network construction.	✓ 'Condominial' sewerage systems in Brazil have achieved cost savings of up to 65% relative to conventional sewerage systems.[112] ✓ In La Paz, relaxing standards on piped water and sanitation networks to allow shorter and shallower networks and community participation, led to a 45-75% reduction in digging costs, and total cost-savings of 25% in expanding the sewerage network.[113]	✓ Communal toilets offer a low-cost solution for providing essential sanitation services to low-income households. ✗ However, shared facilities can lead to coordination and free-rider challenges, requiring clear assignment of responsibilities to ensure proper maintenance. Otherwise, communal technologies risk failure and increases in maintenance costs.

111 Alsan, M., & Goldin, C. (2019). Watersheds in child mortality: The role of effective water and sewerage infrastructure, 1880–1920. *Journal of Political Economy*, 127(2), 586–638.

112 Melo, J. C. (1996). Condominial sewerage systems: Reasons, theory and practice. CEF editions, 140.

113 Trémolet, S. and Halpern, J. (2006). "Regulation of water and sanitation services: getting better service to poor people". Global Partnership on Output-Based Aid, OBA Working Paper Series, Paper No. 8

	On-site – Pit latrines	On-site – Unconnected flush toilets	On-site – Ecological toilets
	Improved when designed as ventilated, individual (or minimally shared) units that effectively separate waste from human contact. Unimproved when they are basic, poorly maintained, or heavily shared—especially in settings with groundwater or flooding risks.	**Improved** if they incorporate the benefits of a water seal and effective onsite wastewater treatment (septic tanks and drain fields) and are operated individually. They face risks if the supporting wastewater management is ineffective, or maintenance lapses lead to environmental contamination.	**Improved** given their potential to contain and process waste safely while recovering resources, conditional on the user's compliance and rigorous maintenance Without proper management, these systems risk operational failure and potential public health issues, thus undermining their improved status.
Definition	Most common form of on-site sanitation technology. They comprise a concrete or plastic slab with a hole through which users defecate into the pit, typically 4-5 metres deep, and a cabin to provide cover and privacy. Traditional 'unimproved' pit latrines are often unattractive to use, with unpleasant odours and infested with insects. Ventilated improved pit latrines (VIPs) incorporate a vent pipe to draw away insects and smells from the cabin, making the latrine more sanitary for the user.	Unconnected flush toilets depend on water to dispose of sewage. The water used in flushing and maintaining the 'water seal' that prevents sewage from re-entering the toilet can be provided from a cistern or poured from a hand-held bucket. Once flushed, the sewage water either enters a pit, much like those used in pit latrines, or more typically a septic tank connected to a 'drain field' that allows wastewater to percolate through gravel-surrounded pipes to deeper and wider areas of soil. This system can deal with a greater volume of wastewater than simple pits.	Ecological toilets, or ecological sanitation (EcoSan) are based on the idea of separating urine from faecal matter and rendering both safe to reuse for agricultural purposes. Urine is diverted through one hole, and can be used as a fertiliser without treatment, whereas dry faeces are diverted through another hole, often covered in sawdust to remove the smell, and left to compost.
Overview	In the absence of well-functioning and widespread sewerage systems, many urban residents in low-income cities rely on on-site sanitation technologies and decentralized processes for sewage disposal and treatment. This includes pit latrines, flush-toilets that are unconnected to sewerage systems, and ecological toilets.114 Despite their widespread use, public funding has been highly limited, with governments seeing this as a largely private investment.		
Health and environmental impacts	✗ Both traditional and improved ventilated pit latrines can lead to hazardous contamination of groundwater where there is a high water table, and of surface water in severe cases of flooding. This contamination of water with faecal matter can spread diseases and infections, carrying serious public health consequences. ✗ Pit latrines with manual emptying can have big negative public health implications.	✓ Flush-toilets remove sewage away from the immediate household environment, and the 'water seal' prevents insects and bad odours from entering the washroom. ✗ Flush-toilets create high volumes of contaminated wastewater. In densely populated urban areas, adequately managing this wastewater to prevent groundwater contamination is generally unfeasible using simple pits and so require expensive systems of septic tanks and drain fields.	✓ Ecological toilets minimize the contamination of groundwater and surface water by containing and safely composting faecal matter. ✓ They prevent the spread of diseases that result from faecal contamination more effectively than other on-site technologies. ✓ EcoSan toilets reduce the need for water in sanitation, which may help conserve water resources in water-scarce areas. ✗ They have strict maintenance and emptying requirements. If not properly maintained and emptied, they can attract pests, lead to odors, and risk contamination. Proper management and user training are essential for their functioning.
Accessibility	✓ 'Individual' toilets or pit-latrines that service each household separately offer important benefits in terms of the accessibility of sanitation services and in terms of privacy and dignity.	✓ As with individual pit latrines, unconnected flush toilets that service each household individually offer great benefits in terms of accessibility relative to communal sanitation facilities.	✓ When installed for individual households, they provide accessible sanitation services, privacy, and dignity for users.
Costs	✓ If regularly emptied, VIPs can be a cheap and useful way of storing and removing sewage in areas without waterborne sewerage systems. ✗ The cost of emptying latrines can be substantial for some urban households. For example, in Dakar, they account for around $50 twice a year on average. ✗ Treatment stations and desludging services are needed for the safe disposal of waste from pit latrines. This adds an important cost.	✗ Constructing individual toilets beyond simple 'unimproved' pit latrines can be both expensive and very difficult to implement, particularly in the context of crowded informal settlements with narrow and winding streets between houses. ✗ Unconnected flush toilets require more significant maintenance than pit-latrines.	✓ Ecological toilets are a 'dry' technology that does not require water to operate, unlike flush-toilets. This may reduce operational costs in areas where water is scarce or expensive. ✗ Ecological toilets are often more expensive than VIPs and traditional pit latrines and can only function when people understand and comply with guidelines on how to use the technology. They require careful maintenance, emptying, and user compliance, which may incur additional training and monitoring costs. ✓ Ecological toilets have the potential to produce valuable resources from excreta, giving financial incentives for state or private sector operators to collect sewage regularly, and helping recover the cost of the initial investment.

114 http://water.worldbank.org/shw-resource-guide/infrastructure/menu-technical-options (accessed: 19 January 2026)

Cities that Work

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Cities that Work is an International Growth Centre (IGC) initiative that seeks to translate economic research and practical insight into clear urban policy guidance. Cities that Work combines new evidence and analysis of urban economics with the hard-won knowledge of urban planning practitioners and policymakers. Our aim is to develop a policy-focused synthesis of research, and a global network of individuals with a shared vision for urban policy.