Oxford Development Studies

ISSN: 1360-0818 (Print) 1469-9966 (Online) Journal homepage: www.tandfonline.com/journals/cods20

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To cite this article: Ronald Sakaya, Christoph Lüthi, Abishek Sankara Narayan & Charles. B. Niwagaba (04 Nov 2026): Breaking sectoral silos: an integrated planning framework for water, sanitation and solid waste in small towns in Uganda, Oxford Development Studies, DOI: 10.1080/13600818.2026.2759265

To link to this article: https://doi.org/10.1080/13600818.2026.2759265

Published online: 04 Nov 2026.

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OXFORD DEVELOPMENT STUDIES
https://doi.org/10.1080/13600818.2026.2759265

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Breaking sectoral silos: an integrated planning framework for water, sanitation and solid waste in small towns in Uganda

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ABSTRACT

Water, sanitation, and solid waste management are intertwined urban services with clear physical interactions throughout their service chains. Despite synergies to maximise positive interlinkages and minimise negative interactions, few systematic planning frameworks integrate these three service chains during planning. While existing sectoral frameworks emphasise integration, no procedural framework guides an integrated approach to planning water, sanitation, and solid waste management into a coordinated, financially viable, modular service delivery plan. The proposed Integrated Planning Framework (IPF) encompass five stages: (1) an enabling environment assessment; (2) an integrated baseline assessment; (3) road-mapping and solution profiling; (4) modular and coordinated planning; and (5) implementation and adaptive management. It aligns key actors, manages interlinkages across services, co-develops a roadmap with community buy-in, and was tested and validated in two Ugandan towns. Lessons include the need for political-economy change, pragmatic sequenced action, and municipal leadership.

ARTICLE HISTORY
Received 8 June 2026
Accepted 13 October 2026

KEYWORDS
Integration; water supply; sanitation; solid waste management; sectoral governance; Uganda

JEL CLASSIFICATION
Q53

Introduction

In many small towns across sub-Saharan Africa, rapid urbanisation and limited resources have led to poor access to essential urban services, such as water, sanitation, and solid waste management (SWM). In efforts to provide individual services such as water, sanitation, or solid waste management, service providers often overlook the impact of limited water or solid waste collection services on sanitation, and vice versa. Understanding these linkages is vital for enhancing synergistic benefits, such as reusing treated wastewater and solid waste, and minimising negative outcomes, such as sewer blockages, quick filling of containments with rubbish and water contamination (Narayan et al., 2021). Improving one system (such as water supply) can have direct consequences for another (such as urban drainage) or solid waste management. There may be benefits when a synchronised approach to service improvements is done, rather than siloed, sectoral improvements (Mitlin & Weldeghebrael, 2025).

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Although high-income countries have little or no shortage of access to safe SWM, the technologies and approaches used in such contexts cannot be directly replicated in the Global South, where the challenges are unique and varied (Abrams et al., 2021; Narayan et al., 2021). Innovative, cost-effective, and locally appropriate technology and management approaches are required to achieve sustainable access to water, sanitation, and waste services in low-and middle-income countries (LMICs). This is even more relevant for the 'missing middle' small towns, often intertwined between the interfaces of urban and rural areas (Marks et al., 2020). Models for water supply and sanitation are often developed for large urban areas or for rural contexts, while solid waste management models largely exist for only urbanised areas. The 'missing middle' small towns lack proven models for integrated service provision.

Despite potential synergies and opportunities to maximise positive and minimise negative interactions, few attempts have been made to integrate these three services beyond sectoral silos (Lüthi et al., 2023). Studies have highlighted the need for collective solutions and movement from sector silos to improve urban service delivery in LMICs (Scott et al., 2019). The implementation of combined interventions remains fragmented, requiring greater integration. Furthermore, SWM is almost always excluded from water supply and sanitation discussions, even though it is part of environmental sanitation along with greywater and storm water management (Lüthi et al., 2011).

Little research has been conducted on coordinated planning and implementation of basic services that present cross-sectoral interactions. This is particularly true in small towns and intermediate urban centres in sub-Saharan Africa (Sakaya, Niwagaba, et al., 2025). Integrated urban services are rarely planned and implemented because doing so is highly complex (Lüthi et al., 2011) and cuts across institutions with different, and often conflicting mandates (Bates, 2023). Misaligned departmental imperatives and siloed funding cycles are specific mechanisms through which institutional fragmentation is manifested (Hermanus & Rose Cirolia, 2024; Scott et al., 2019). This siloed approach is embedded in the political economy of contemporary urban service delivery. Sakaya, Narayan, et al. (2025) show that fragmentation in Ugandan small towns stems from the distribution of power, resources, and mandates, with different ministries and local authorities operating in isolation with conflicting priorities.

A cross-disciplinary research program, WABES (Water, Behavioural Change, and Environmental Sanitation) has been investigating the potential of sector integration in two small towns in Uganda for the past four years. This applied research program sought to generate cross-sectoral evidence and translates these results into national planning tools and approaches.[1]

This paper addresses this gap by presenting the Integrated Planning Framework (IPF), a five-phase methodology for coordinating water supply, sanitation, and solid waste management service provision in small towns. Drawing on four years of applied research in two Ugandan towns, we demonstrate how the IPF was operationalised, the outcomes achieved, and the lessons learned for replication. Our contribution is threefold: (1) a replicable planning framework for integrated service delivery; (2) empirical evidence of its application in resource-constrained small-town contexts; and (3) insights into the political and institutional enablers of integration.

Knowledge gaps in integrated service provision

Several complexities are involved in integrating water supply, sanitation, and solid waste management, revealing the multiple contamination pathways that emerge when these systems are planned in isolation (Figure 1). Examples include uncollected waste blocking drainage, unlined latrines contaminating groundwater, and untreated faecal sludge compromising groundwater sources, demonstrating why no single-sector intervention can resolve what are inherently interconnected problems.

Despite the growing recognition of the need for an integrated approach, there are still significant knowledge gaps. Firstly, there is surprisingly little research into the physical and institutional interactions between water, sanitation, and solid waste services. While the technical literature is replete with sector-specific studies, few examine how failures cascade across service chains or how positive synergies might be deliberately designed (Narayan & Boller, 2023; Narayan et al., 2021).

Secondly, existing planning methodologies poorly anticipate or manage these interactions. A previous evaluation of over 25 planning tools, including excreta flow diagrams (SFDs) and frameworks such as community-led urban environmental sanitation (CLUES), revealed sectoral siloing (Lüthi et al., 2023). While most tools cover sanitation (15), water supply (6), and solid waste management (8) follow behind in terms of coverage. No widely used methodology addresses all three sectors comprehensively.

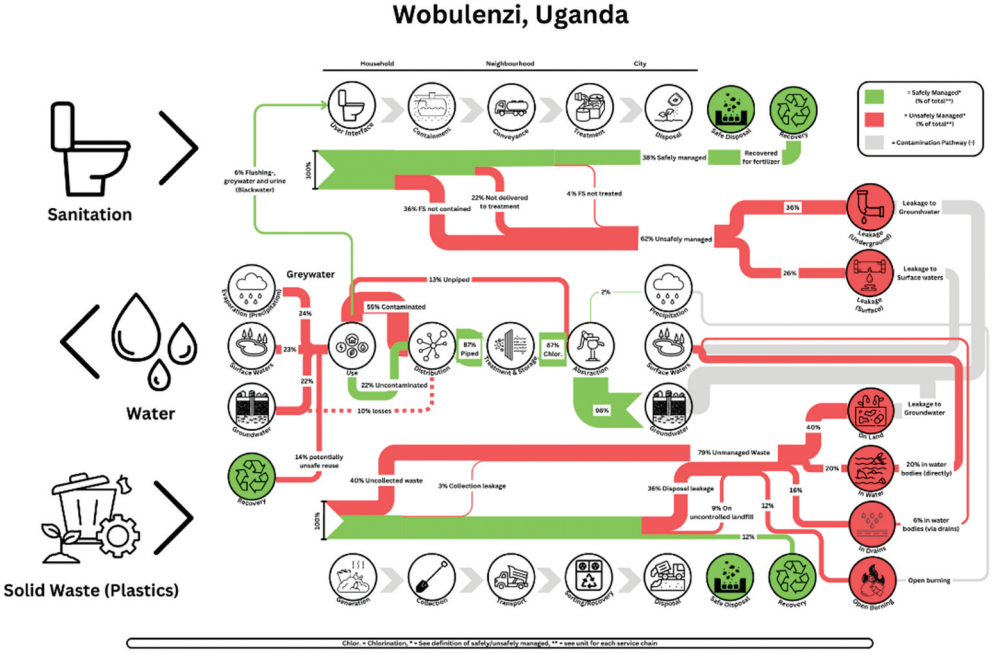


Figure 1. An illustration of the water, sanitation and solid waste management flows as an integrated flow diagram. Green flows indicate safely managed, and red indicate unsafely managed flows that lead to contamination of the environment or negative interlinkages with other services. Source: adapted from Fritzsche (2024), based on the water, shit flow, and waste flow diagram methodologies developed by (Bouman et al., 2024; Yadava, 2024).

Even 'integrated' frameworks, such as CLUES and City Sanitation Planning (CSP) lack operational guidance for joined-up sector planning.

Thirdly, most available planning and programming tools are designed for well-resourced urban contexts or data-rich environments, making them poorly suited to capacity-constrained small-town contexts. Research in Uganda (Sakaya et al., 2026; Sakaya, Niwagaba, et al., 2025) revealed that methodology complexity and data intensity are among the most severe barriers to the effective use of state-of-the-art planning tools. High implementation costs, lack of in-house technical expertise, and reliance on external consultants create a cycle in which methodologies are abandoned after project funding ends (Sakaya et al., 2026).

A profound gap exists between endorsing integration and practical guidance for achieving it. While literature on conceptual development exists, evidence of implementation documenting actual integration remains limited, making service integration largely aspirational (Narayan et al., 2021; Tsinda et al., 2021). Research in Ugandan small towns reveals a funding imbalance, with water infrastructure receiving most funding while sanitation and waste management remain under-resourced (Sakaya, Niwagaba, et al., 2025). This creates a cycle in which water investments are disproportionate to sanitation and solid waste management, with the unfunded sectors negating gains made in the water sector. The problem is particularly acute in towns with populations between 10,000 and 100,000, which experience urban service demands yet have rural governance capacities (Agergaard et al., 2019; Farine et al., 2025).

The integrated planning framework: a structured response

In response to these gaps and practical challenges, we developed an integrated planning framework (IPF) for water supply, sanitation, and solid waste management addressing the service challenges in small towns. The IPF was developed through research in Kakooge Town Council in Uganda (population 24,200), with insights from the Wobulenzi Town Council (population 36,000). The framework is based on three main conceptual pillars:

Systems thinking, which recognises water, sanitation, and waste as interconnected parts of urban metabolic systems. Failures in one sector affect others, creating service degradation cycles that require coordinated responses. Participatory co-creation, which emphasises solutions developed with stakeholders from households to national ministries, ensuring locally developed and adaptable solutions as well as ownership through monitoring and adjustment. Pragmatic incrementalism, which acknowledges resource constraints and advocates modular approaches that prioritise quick gains that build toward long-term visions (Parkinson et al., 2014). The IPF encompasses five recursive phases (Figure 2), that address distinct aspects of fragmentation while simultaneously enhancing local capacity for sustained integrated planning. The phases, along with their associated approaches and outcomes, are detailed in Table 1 and Figure 2. Excerpts from the integrated strategic roadmap and the tiered indicator framework for monitoring integration are provided in Tables A1 and B1, respectively (see Appendices A and B).

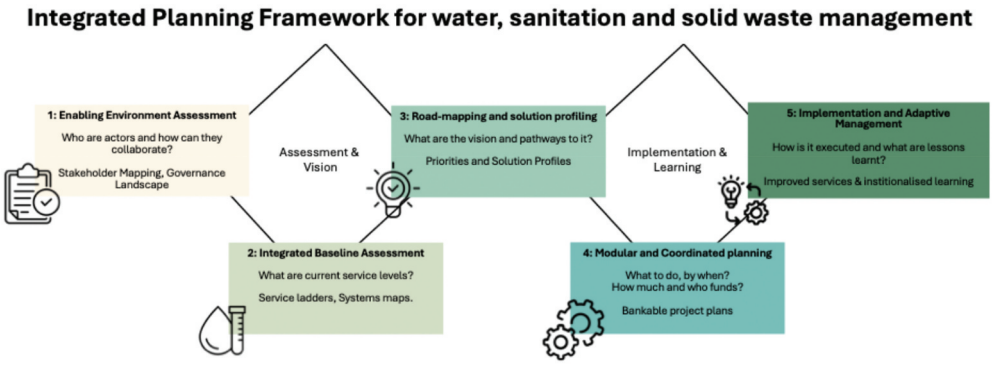


Figure 2. Schematic view of the five-phase integrated planning framework.

Discussion of the integrated planning framework in practice

The small towns validation cases provide validated evidence that integrated service delivery in resource-constrained, unplanned settlements is not only necessary but achievable through a deliberate, sequenced framework that prioritises governance reform, shared evidence, and pragmatic adaptation. Our application of the five-phase Integrated Planning Framework over a 12-month period between 2023–25 in the two towns demonstrates a pathway to move beyond the sectoral silos that typify such contexts. The findings from each phase, detailed in Table 1, reveal both the profound depth of fragmentation and the mechanisms by which it can be systematically overcome, though not without encountering distinct challenges.

Diagnosing the enabling environment

The PCC was a foundational governance intervention. A stakeholder analysis and 48 key informant interviews revealed that institutional silos existed, with the water supply managed by the CUWS, solid waste and sanitation services (managed by the Town Council) operating under separate reporting lines and budgets. Financial mapping revealed significant inequity in public investment, with water infrastructure receiving most spending, while sanitation and SWM remained severely underfunded (Sakaya, Niwagaba, et al., 2025). By establishing a platform to manage cross-sectoral outcomes, the PCC addresses this institutional root cause by creating a structure for negotiated action between previously uncoordinated actors. This phase is critical for exposing the political and financial drivers of fragmentation, building trust through participatory diagnosis and securing high-level buy-in by establishing a formal cross-sectoral decision-making body (Movik et al., 2016). However, this process is time-consuming and resource intensive. Its success depends on the willingness of powerful actors to participate and potentially share authority. In contexts of political instability or the absence of formal structures, establishing an effective PCC may necessitate longer-term facilitation and trust-building.

Table 1. The integrated planning framework (IPF) in practice: a five-phase process.

Phases	Approach	Outputs & Outcomes
Phase 1: Enabling Environment Assessment to diagnose the political, institutional, and financial root causes of sectoral fragmentation.	- Mapping of formal and informal actors, their relationships, and influence. - Semi-structured interviews. - Analysis of policies, budgets, and financial flows across the three sectors.	A multi-stakeholder platform (Town Council, Umbrella Water, informal providers, NGOs, community groups) with terms of reference to oversee IPF, enabling cross-sectoral negotiation and decision-making. A visual map of relevant actors, their mandates, and informal relationships, showing institutional silos such as fragmented water, sanitation, waste mandates) and power asymmetries. Quantification of investment inequities across water, sanitation, and waste sectors.
Phase 2: Integrated Baseline Assessment (IBA) to develop a spatially explicit, quantifiable, and shared evidence base of service levels and their interlinkages.	- Mapping of water points, sanitation facilities, and waste sites. - Household Surveys: Random sample (statistically chosen) assessing access, practices, willingness to pay. - Water quality testing, sludge volume estimates, and waste characterization.	Maps showing priority "hotspots" where service failures converge, creating health risks and making contamination pathways visible. A quantifiable fact-base that transforms abstract concepts into reality, fostering Stakeholder consensus on problem scope and urgency.
Phase 3: Road mapping and Solution Profiling to translate diagnostic evidence into a costed, prioritised, and socially endorsed action plan.	- Planning Coordination Committee (PCC) members screen interventions against criteria of affordability, acceptability, capacity to manage, and potential to address interlinkages. - Coupling interventions across sectors to create reinforcing outcomes such as linking sanitation improvements with water source protection.	A costed action plan with lead agencies and financing strategies, phased over short-, medium-, and long-term horizons (see Table 2 for excerpt). PCC endorsement signifies a binding commitment from each member to deliver assigned actions, transforming the roadmap from a technical document into a political agreement. Evidence-based interventions that address full-service chains such as coupling unlined pit resolution with clustered emptying services to ensure safe sludge transport to the FSTP).
Phase 4: Modular & Coordinated Planning to translate the strategic roadmap into discrete, fundable, and technically coherent projects.	- The roadmap is segmented into fundable modules including emptying services, ward-level waste collection, treatment plant rehabilitation. - The PCC serves as a platform to review modules, ensuring optimized integrated outcomes and logical sequencing.	A set of sound project documents where interventions enhance effectiveness and service integration (for example coordinating scheduled emptying with waste collection and water source protection). Modules aligned with funding cycles of different actors (national government, development partners, annual municipal budgets), enabling a shift from project-based to systems-based financing and planning.
Phase 5: Implementation & Adaptive Management to execute the plan while iteratively learning and adjusting based on real-world performance.	- PCC develops framework tracking service outputs, integration, and institutional strength. - PCC meetings review module performance data against baselines and adjust strategies.	The PCC becomes the locus for adaptive management, using evidence to refine bylaws, schedules, and investments based on performance data. A continuous improvement process enabling the system to respond to challenges and opportunities (e.g. adjusting enforcement when bylaws prove ineffective), moving beyond static implementation towards dynamic delivery.

Table 2. Common implementation challenges encountered and possible mitigation strategies.

Challenge	Mitigation Strategy
Limited municipal capacity	Use phased capacity building; engage external technical support for complex tasks; pair external experts with local counterparts.
Political interference	Establish formal PCC with clear terms of reference; build cross-party support; maintain transparent decision-making processes.
Data quality issues	Provide rigorous enumerator training; implement data validation protocols; triangulate multiple data sources.
Stakeholder fatigue	Link IPF activities to existing municipal processes; demonstrate early wins; limit meeting frequency and duration, design well-structured workshops that engage stakeholders.
Funding constraints	Modularise plan to attract incremental funding; align with existing budget cycles; diversify funding sources.
Resistance to integration	Demonstrate co-benefits early; showcase successful examples; build trust through participatory processes.

The integrated baseline assessment (IBA)

An integrated baseline assessment (IBA) is more complex to deliver, as it combines baseline assessments of all three sub-sectors simultaneously – water, sanitation and solid waste – and therefore requires solid preparation and training of enumerators. An IBA combines three levels of information: (i) town level infrastructure observations, policy analysis, and key informant interviews; (ii) a household level survey covering all three sectors, and (iii) a detailed sampling at a system level (waste characterisation, sludge accumulation, water quality tests from source to distribution) (Narayan et al., 2024).

The IBA revealed invisible risks spatially. The identification of contamination pathways, with 80% of pit latrines in Kakooge town unlined near groundwater sources and dumpsites in wetland leachate zones, provided evidence to advocate for integration (Farine et al., 2025). Figure 3 for Kakooge town shows interlinkages and cross-sectoral spatial 'cold and hot spots', where groundwater contamination, flooding and informal waste dumping converge. The results legitimise informal providers and build collective ownership of identified problems. However, there is also a risk of analysis paralysis, whereby lengthy data collection can delay action. Further challenges that need to be addressed include managing data quality, synthesising the baseline results and communicating them to all relevant parties.

Once developed, the results of the integrated baseline assessment should be updated by the planning department within the town councils, to support monitoring, evaluation, feedback and re-planning.

From diagnosis to a social contract

Diagnostic evidence was crucial in the collaborative development of the roadmap. The issue of unlined pits could not be resolved through technical subsidies or promotional efforts alone. Instead, the design incorporated a clustered and schedule faecal sludge emptying service to ensure a complete chain from containment to treatment. This transition from a project-based approach to a systems approach ensured that solutions addressed the entire service chain. Public endorsement by PCC members transformed the technical document into a binding social contract for action. This phase ensures that

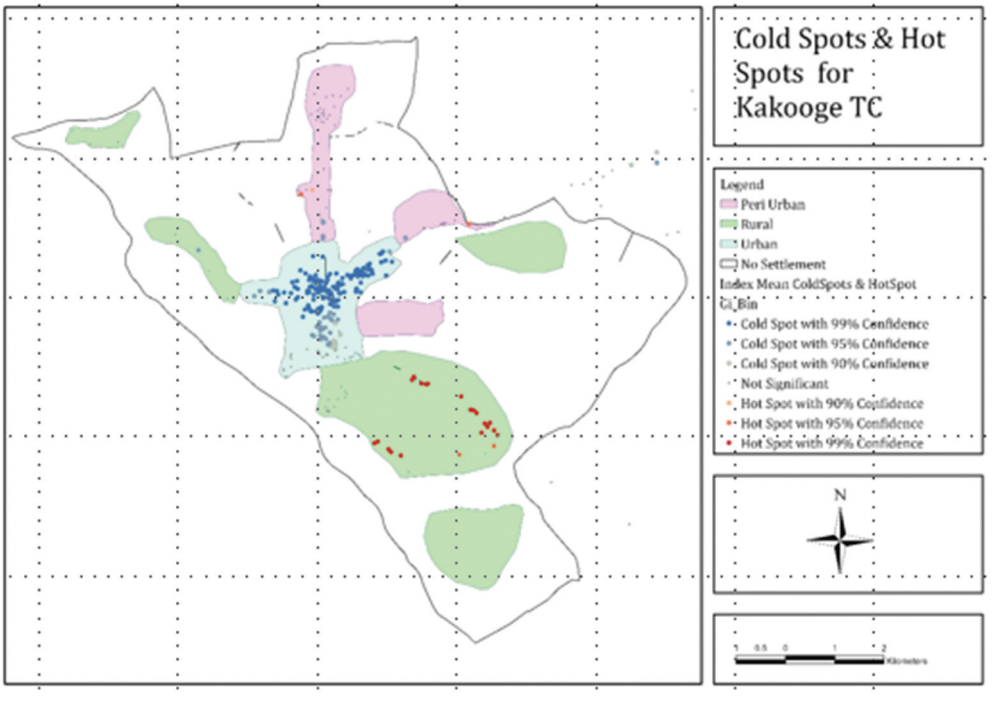


Figure 3. An illustration of the spatial hot and cold spots for the interlinkages between the sectors in the town of Kakooge, in Uganda (adapted from Narayan et al., 2024).



Figure 4. Road mapping exercise (phase 3) at the Kakooge Town Council Hall. Source: Sakaya, Niwagaba, et al. (2025).

solutions are context-specific and socially endorsed, as well as addressing interlinkages. The solutioneering process in (Figure 4), builds consensus and creates a feasible plan. Public endorsement establishes mutual accountability (Sakaya, Niwagaba, et al., 2025). However, facilitating co-creation among diverse actors with varying levels of power and technical capacity is complex. Powerful actors may dominate, and reaching consensus on

priorities can be time-consuming. While the resulting plan is integrated, it may represent a compromise that dilutes technically effective but politically challenging interventions (Tapia et al., 2025). While the solution profiling phase provides a structured approach, we acknowledge that the specific toolkits for detailed options analysis require further development and refinement in future research.

Avoiding the master plan trap

The modular approach enabled IPF to avoid creating unfunded and unrealistic master plans. By segmenting the roadmap into fundable modules, for example scheduled emptying services or ward-level waste collection, the framework enabled actionable project implementation. PCC oversight ensured coordination across municipal services, with emptying services planning occurring alongside water source protection. This resulted in interconnected interventions that enhanced effectiveness, impossible under the previous siloed system approach. Sequencing low-cost, high-visibility actions initially generated momentum for complex investments (Kayaga et al., 2020). Modularisation makes the plan bankable and adaptable, allowing actions to build trust and show early successes. PCC coordination ensured the modules' collective impact surpasses individual contributions, maintaining the integrated vision. However, dividing a strategic plan into modules risks losing long-term vision without proper coordination. Funders may pursue easier (siloed) modules, undermining the integrated design. Sustaining coordination across modules requires a robust and strategic PCC secretariat (Wright et al., 2024).

Implementation and adaptive management

The framework advanced beyond static implementation by institutionalising learning. The PCC's tiered indicator framework (see Table B1, Appendix B), which monitors service outputs, system integration and institutional strength, established benchmarks for assessing the impact of integration. Quarterly learning forums promoted adaptive management by using data to refine by-laws, schedules and investment plans. This phase enhances system resilience, enabling a response to unforeseen events and facilitating evidence-based adjustments. It has transformed the PCC from a planning entity into a permanent, learning-oriented management platform. However, effective adaptive management requires consistent, reliable data, which is costly to maintain. It also requires flexibility from the implementing agencies and donors, who are often constrained by fixed logframes and budgets. The transition from rigid implementation to responsive learning requires a cultural shift that remains challenging to sustain.

The work tested in the towns of Kakooge and Wobulenzi builds upon participatory planning methodologies (Lüthi et al., 2011), offering enhanced focus on institutional and political economy fragmentation while providing adaptive management post-implementation. The success of the IPF depends on alignment with existing municipal plans, which poses challenges in unplanned settlements where such plans are lacking. In contexts with limited institutional capacity, as in Kakooge, utilizing private expertise to supplement the coordination committee was a strategic design feature that provided the PCC with essential technical and facilitation skills. The IPF represents a replicable

process for navigating the complex political and technical landscape of integrated service delivery in challenging urban environments.

The practical application of the IPF's strategic roadmap and its monitoring framework is further illustrated in the excerpts provided in Appendices A and B, which detail the sequenced action plan, and the tiered indicators used to track progress across service delivery, integration, and institutional strength.

Operationalisation of the IPF

To enhance replicability, we provide comprehensive implementation guidance for each of the five phases, with emphasis on required resources, and success factors.

Phase 1: Enabling Environment Assessment. This phase involves conducting stakeholder mapping through participatory workshops and semi-structured interviews, analysing policy documents, budgets, and financial flows, and mapping formal and informal actors and their relationships. It necessitates 1–2 facilitators with political economy expertise, access to municipal budgets and policy documents, and funding for stakeholder workshops. Success is contingent upon high-level political commitment, the willingness of actors to share information, and neutral facilitation to build trust.

Phase 2: Integrated Baseline Assessment. This phase includes spatial mapping of water points, sanitation facilities, and waste sites; implementing household surveys with a statistically valid sample; testing water quality and characterizing waste; and identifying contamination pathways and spatial 'hotspots'. It requires 5–10 trained enumerators, GPS devices, water quality testing kits, survey software, and data management capacity. Success depends on the training of enumerators, community engagement for survey participation, and the integration of data from multiple sources.

Phase 3: Road mapping and Solution Profiling. This phase involves facilitating multi-stakeholder workshops, screening interventions against affordability, acceptability, and capacity criteria, and developing a sequenced action plan with lead agencies. It requires the involvement of experienced technical experts for each sector, visualization materials, and documentation support. Success is ensured through inclusive participation, transparent decision-making, and realistic costing and sequencing.

Phase 4: Modular and Coordinated Planning. This phase entails segmenting the roadmap into fundable modules, aligning modules with funding cycles, developing detailed project documents, and sequencing interventions for maximum synergy. It requires project development expertise, knowledge of financing mechanisms, and a coordination secretariat. Success is achieved by aligning with existing budgets and funding streams, ensuring strong PCC coordination, and maintaining flexibility to adapt modules to funding opportunities.

Phase 5: Implementation and Adaptive Management. This involves establishing a monitoring framework, convening quarterly learning forums, reviewing performance data against baselines, and adjusting strategies based on evidence. It requires structured monitoring and evaluation capacity, data management systems, and a PCC secretariat for coordination. Success is contingent upon consistent data collection, willingness to adapt, sustained political commitment, and an institutionalized learning culture.

Conclusion

The water, sanitation and solid waste service crisis faced by small towns in sub-Saharan Africa stems from a failure of collective action, rather than a lack of technical solutions. Research from two small towns in Uganda, shows that service failure is caused by fragmented governance, misaligned incentives and inadequate planning frameworks. The IPF highlighted in this paper, provides a structured approach to addressing these issues together. Three key conclusions emerge. Firstly, rethinking sector governance through a planning process enables integration. The PCC at municipal level created an arena for negotiation and accountability, forcing sectoral actors to address their interconnected impacts.

Secondly, collaborative evidence-building catalyses collective ownership, especially when the goal is clarified towards real change. The integrated baseline assessment transformed the concept of integration into a tangible reality by providing evidence of contamination pathways and service interdependencies that were generated collaboratively.

Third, pragmatic sequenced action with stakeholder involvement maintains momentum. The IPF's modular approach generated early wins and brought stakeholders together to co-create systems-based solutions while acknowledging the realities of small-town resource constraints. Solutions such as scheduled sludge emptying services and lining of household latrines using local prefabricated liners shows the practicality of implementing such plans.

Finally, this study documents the integration requirements and governance arrangements that enabled successful integrated planning in two towns in Uganda using the 5-phase IPF model. The IPF is a blueprint for planning integrated basic urban service provision while accounting for the political and infrastructural realities and reconciling them with visions and appropriate community-led solutions in small towns.

Note

1. WABES integrate is a research project between Makerere University (Uganda), Eawag, the Swiss Federal Institute of Aquatic Science and Technology (Switzerland) and the Kakooge and Wobulenzi Town Councils in Uganda. The aim is to develop an integrated planning framework for water, sanitation and solid waste management services. The project is funded by the Swiss Agency for Development and Cooperation (SDC) and ETH4D. See www.sandec.ch/wabes.

Acknowledgments

The authors wish to thank the whole WABES project team for their contributions in shaping this framework through internal workshops, the members of the Town Councils from Wobulenzi and Kakooge for their support in the planning process, the WABES enumerators for their support with data collection. The funding from the Swiss Agency for Development and Cooperation is greatly acknowledged.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Abrams, A. L., Carden, K., Teta, C., & Wågsæther, K. (2021). Water, sanitation, and hygiene vulnerability among rural areas and small towns in South Africa: Exploring the role of climate change, marginalization, and inequality. *Water*, *13*(20), 2810. https://doi.org/10.3390/w13202810

Agergaard, J., Tacoli, C., Steel, G., & Ørtenblad, S. B. (2019). Revisiting rural–urban transformations and small town development in Sub-Saharan Africa. *European Journal of Development Research*, *31*(1), 2–11. https://doi.org/10.1057/s41287-018-0182-z

Bates, R. H. (Ed.). (2023). *Toward a political economy of development: A rational choice perspective*. University of California Press. https://doi.org/10.1525/9780520314054

Bouman, L., Spuhler, D., Bünzli, M.-A., Melad, A., III, Diop, L., Coelho, O., & Meierhofer, R. (2024). The water flow diagram. *Frontiers in Water*, *6*, 1360515. https://doi.org/10.3389/frwa.2024.1360515

Farine, C., Lüthi, C., Niwagaba, C. B., Morgenroth, E., & Narayan, A. S. (2025). Interlinkages and indicators: Novel assessment of water, sanitation and solid waste services in schools in two Ugandan towns. *Frontiers in Water*, *7*, 1544779. https://doi.org/10.3389/frwa.2025.1544779

Fritzsche, J. (2024). *SFD (Lite) report - Wobulenzi (Technical report)*. Eawag-Sandec and ETH Zurich. https://www.susana.org/knowledge-hub/resources?id=5534

Hermanus, L., & Rose Cirolia, L. R. (2024). Distributed energy technologies, decentralizing systems and the future of African cities. *Environment and Urbanization*, *36*(1), 53–68. https://doi.org/10.1177/09562478241226782

Kayaga, S., Fisher, J., Goodall, S., Kanyesigye, C., Kaggwa, R., Nambiro, M., Kitakufe, R., Otema, J. B., Mafunguro, R., & Ahabwe, G. (2020). Enhancing livelihoods of the urban poor through productive uses of utility-supplied water services – evidence from Kampala, Uganda. *Cities*, *102*, 102721. https://doi.org/10.1016/j.cities.2020.102721

Lüthi, C., Morel, A., Tilley, E., & Ulrich, L. (2011). *Community-led urban environmental sanitation planning: Clues*. Eawag, Swiss Federal Institute of Aquatic Science and Technology. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/CLUES/CLUES_Guidelines.pdf

Lüthi, C., Narayan, A. S., & Fritzsche, J. (2023). *Overview of existing planning & programming approaches and tools* [technical report]. Eawag-Sandec, Swiss Federal Institute of Aquatic Science and Technology. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/WABES/integrated_planning_tools_overview.pdf

Marks, S. J., Clair-Caliot, G., Taing, L., Bamwenda, J. T., Kanyesigye, C., Rwendeire, N. E., Kemerink-Seyoum, J. S., Kansiime, F., Batega, D. W., & Ferrero, G. (2020). Water supply and sanitation services in small towns in rural–urban transition zones: The case of Bushenyi-Ishaka Municipality, Uganda. *NPJ Clean Water*, *3*(1), 1–9. https://doi.org/10.1038/s41545-020-0068-4

Mitlin, D., & Weldeghebrael, E. H. (2025). The contribution of urban reform coalitions to inclusive and equitable cities. *Environment and Urbanization*, *37*(1), 3–20. https://doi.org/10.1177/09562478251327007

Movik, S., Mehta, L., & van Koppen, B. (2016). Emergence, interpretations and translations of integrated water resources management in South Africa. *Water Alternatives*, *9*(3), 456–472. https://hdl.handle.net/10568/78535

Narayan, A. S., & Boller, M. (2023). To integrate or not to integrate? Water and waste as unified basic services. *PLOS Water*, *2*(9), e0000180. https://doi.org/10.1371/journal.pwat.0000180

Narayan, A. S., Marks, S. J., Meierhofer, R., Strande, L., Tilley, E., Zurbrügg, C., & Lüthi, C. (2021). Advancements in and integration of water, sanitation, and solid waste for low- and

middle-income countries. *Annual Review of Environment and Resources*, *46*(1), 193–219. https://doi.org/10.1146/annurev-environ-030620-042304

Narayan, A. S., Niwagaba, C. B., Sakaya, R., & Batte, A. (2024). Integrated baseline assessment of water, sanitation and solid waste management. *Sandec News*, *25*, 34–35. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/news/news_25.pdf

Parkinson, J., Lüthi, C., & Walther, D. (2014). *Sanitation, 21: A planning framework for improving city-wide sanitation services*. International Water Association, Eawag-Sandec, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). https://www.susana.org/knowledge-hub/resources?id=2712

Sakaya, R., Lüthi, C., Narayan, A. S., Fritzsche, J., Katukiza, A. Y., & Niwagaba, C. B. (2026). The context-conundrum: Why existing planning methodologies fail in the integration of water, sanitation and solid waste management services in small towns. *Environmental Science: Advances*, *5*(8), 1918–1929. https://doi.org/10.1039/D5VA00471C

Sakaya, R., Narayan, A. S., Katukiza, A. Y., Niwagaba, C. B., & Lüthi, C. (2025). Political economy barriers on the integration of water, sanitation, and solid waste management services in Ugandan towns. *International Journal of Urban Sustainable Development*, *17*(1), 320–335. https://doi.org/10.1080/19463138.2025.2587382

Sakaya, R., Niwagaba, C. B., Katukiza, A. Y., & Lüthi, C. (2025). Influence of national government and development partners on Uganda's water, sanitation, and solid waste services delivery: A review. *World Water Policy*, *11*(4), 939–952. https://doi.org/10.1002/wwp2.70028

Scott, R., Scott, P., Hawkins, P., Blackett, I., Cotton, A., & Lerebours, A. (2019). Integrating basic urban services for better sanitation outcomes. *Sustainability*, *11*(23), 6706. https://doi.org/10.3390/su11236706

Tapia, F., Ochoa-Peralta, D., & Reith, A. (2025). From design to action: Service design tools for enhancing collaboration in nature-based solutions implementation. *Journal of Environmental Management*, *379*, 124739. https://doi.org/10.1016/j.jenvman.2025.124739

Tsinda, A., Abbott, P., Chenoweth, J., & Mucyo, S. (2021). Understanding the political economy dynamics of the water, sanitation and hygiene (WaSH) sector in Rwanda. *International Journal of Urban Sustainable Development*, *13*(2), 265–278. https://doi.org/10.1080/19463138.2021.1881787

Wright, J., Dzodzomenyo, M., Hill, A. G., Okotto, L. G., Thomas-Possee, M. L. H., Shaw, P. J., & Okotto-Okotto, J. (2024). Integrating urban household solid waste management with WASH: Implications from case studies of monitoring in sub-saharan Africa. *Environmental Development*, *50*, 100990. https://doi.org/10.1016/j.envdev.2024.100990

Yadava, H. (2024). Shit flow diagram (SFD): A resource book for practitioners. *Centre for Science and Environment*. https://www.susana.org/knowledge-hub/resources?id=5308

Appendices

Appendix A

Table A1. Excerpt from the integrated strategic roadmap.

Time Horizon	Focus	Integrated actions	Lead Agencies
Short-Term (0–12 months)	Build trust and address acute public health risks	1)Launch integrated sensitization campaigns 2) Pass and enforce bylaw prohibiting new unlined pits in water source protection zones 3) Implement shock chlorination of contaminated boreholes 4) Sequential upgrade of the solid waste dumpsite	Town Council, CUWS, Community Task Forces
Medium-Term (1–2.5 years)	Strengthen core service delivery and institutional reform	1) Establish scheduled, clustered faecal sludge emptying service 2) Deploy ward-level primary solid waste collection points 3) Formalize and train associations of informal pit emptiers and dealers in segregated wastes destined for recycling	CUWS, Town Council, Private Operators
Long-Term (2.5+ years)	Achieve integrated resource recovery and system resilience	1) Operationalize FSTP with co-composting component 2) Institutionalize the PCC and IPF process	PCC, Town Council, Private Sector

Appendix B

Table B1. Excerpt from the tiered indicator framework for monitoring integration.

Tier	Focus	Example indicators
Service delivery	Basic functionality and coverage	Percent HH with access to safe water source m^3 faecal sludge safely treated per month Percent HH served by regular solid waste collection
System integration	Effectiveness of intersectoral linkages	Improvement in groundwater quality near sanitation hotspots Tons of compost produced from co-processing faecal sludge and organic waste Reduction in flood events attributed to cleared drains
System strength	Institutional and financial sustainability	CC meeting frequency and decision implementation rate Cost-recovery ratio for operational expenditures Citizen satisfaction scores from feedback surveys