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Review

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Water-Sensitive Urban Design in Sub-Saharan African Secondary Cities: Institutional Barriers, Informality, and Pathways toward Context-Sensitive Blue-Green Infrastructure Governance

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Abstract: Water-Sensitive Urban Design (WSUD) has, since its formulation in Australia in the early 1990s, become a widely referenced paradigm for integrating stormwater, groundwater, and water-supply management into urban planning. Its fullest articulation, the water-sensitive city, describes a societal transition rather than a design technique alone. Its diffusion across the Global South has, however, exposed a translation problem: frameworks developed for well-resourced, formally planned cities do not travel cleanly into the institutional, fiscal, and tenurial conditions of many Sub-Saharan African secondary cities. The region also lacks a single shared vocabulary: South Africa has a formal WSUD framework, while Kenya, Uganda, and Rwanda organise comparable interventions as nature-based solutions. This narrative review draws on 24 sources identified through a documented search and selection procedure. It synthesises the conceptual evolution of WSUD and examines four recurring barriers to its translation: legal and regulatory fragmentation; fiscal constraint at municipal level; the mismatch between formal design frameworks and informally held land; and colonial and postcolonial drainage legacies. Nigerian cities provide an illustrative lens, with Ibadan as the exemplar secondary city and Lagos as a deliberately contrasting megacity. A comparative analysis separates evidence from secondary cities from evidence drawn from capitals and megacities, and qualifies the transferability of each. The review proposes a context-sensitive blue-green infrastructure governance framework built on institutional layering, incremental legitimacy, and distributed co-maintenance. It traces each principle to its supporting evidence, distinguishes that evidence from the author's own proposals, and sets out how the principles could be operationalised and validated. It closes with a research agenda centred on comparative institutional ethnography of blue-area governance in West African secondary cities.

Keywords: water-sensitive urban design; blue-green infrastructure; institutional governance; informal settlements; flood risk; Sub-Saharan Africa; Nigeria

1. Introduction

Urban flooding has become one of the most visible and economically damaging consequences of climate stress in Sub-Saharan African cities. In Lagos, flood damage to assets, economic production, and lives has been estimated by the World Bank at almost four billion United States dollars each year [1], an institutional estimate

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used here only to indicate scale. The traditional core of Ibadan continues to record flood events almost annually, a pattern documented as far back as the 1950s [2]. These events are rarely attributable to anomalous rainfall alone. They are more accurately understood as failures of drainage governance layered onto rapid, largely unplanned urbanisation, as the association between building-code contravention and flooding in Lagos illustrates [3].

Against this backdrop, Water-Sensitive Urban Design (WSUD) has emerged internationally as an influential paradigm for reconceiving the relationship between water and the city. Rather than treating stormwater as a waste product to be conveyed away as quickly as possible through engineered drains, WSUD treats the urban water cycle (stormwater, groundwater, wastewater, and potable supply) as an integrated design problem, with the city itself functioning as a water-supply catchment [4]. The approach has generated an extensive practice literature and a wide vocabulary of cognate terms, including Sustainable Urban Drainage Systems (SUDS), Low Impact Development (LID), and green infrastructure, all of which sit on a spectrum from narrow technique to broad planning philosophy [5]. More recent work has extended this vocabulary further, under headings such as Blue-Green Cities and Sponge Cities, underscoring that the terminology is still evolving rather than settled [6].

The diffusion of WSUD beyond its Australian origin has proceeded unevenly, and it has not produced a single shared vocabulary even within Sub-Saharan Africa. A national WSUD framework and guideline document has been produced for South Africa [7]. A separate and growing empirical literature documents nature-based solutions, a related but distinct term denoting actions that work with or restore ecosystems to address flooding and other urban challenges, being piloted in informal settlements from Nairobi to Kampala to Kigali [8–10]. This review takes the position that these are not competing translations of the same idea to be reconciled by definitional fiat. They are evidence that the underlying practice of managing urban water through green and blue features is being organised under whichever institutional vocabulary is locally available: WSUD where a national design guideline exists, and nature-based solutions where donor-and-NGO-led catchment projects predominate, a pattern returned to in Sections 3.3 and 7. Because the vocabulary is unsettled, the review uses "blue-green infrastructure governance" as its organising term from this point forward, reserving "WSUD" for the Australian-derived design paradigm and its South African adaptation.

The literature repeatedly identifies a gap between design intention and institutional capacity: barriers that are disproportionately legal, financial, and tenurial rather than technical [11,12]. Nor is Sub-Saharan Africa alone in this respect. Comparable translation difficulties have been documented for water-sensitive planning in Global South cities more broadly, including a recent Delhi-focused study arguing that Western-originated water-sensitive frameworks require substantive theoretical reworking, not just technical adaptation, before they fit cities where informal settlement is the predominant form of urban development [13]. This review asks what a genuinely context-sensitive translation of blue-green infrastructure governance would require in Sub-Saharan African secondary cities specifically, using Nigerian cases as an illustrative lens. It proposes a framework built around institutional layering, incremental legitimacy, and distributed maintenance rather than wholesale technology transfer.

The focus on secondary cities is deliberate. Smaller urban centres hold nearly half of the urban population of Sub-Saharan Africa and are expected to absorb a major share of future urban growth, yet risk-governance research has concentrated on larger cities [14]. In this review, a secondary city is a sizeable urban centre below the national primate city or megacity in the urban hierarchy, with regional administrative functions and a municipal or state-level administration of constrained fiscal and technical capacity. Ibadan (Nigeria) and Moundou (Chad) are treated as secondary cities on this definition. Capitals such as Nairobi, Niamey, Kampala, Kigali, and Windhoek are not, and Section 5 therefore treats evidence from them as indirect.

Review Approach and Evidence Base

This is a narrative rather than a systematic review, reflecting the breadth of the question and the still-fragmented state of the underlying evidence base. It nevertheless follows an explicit and reproducible search and selection protocol, summarised in Table 1. Peer-reviewed literature was identified through keyword searches in Google Scholar and Scopus, using combinations of "water-sensitive urban design", "blue-green infrastructure", "nature-based solutions", "informal settlements", "urban flood governance", and "Sub-Saharan Africa", and was supplemented by forward and backward citation tracking from the key conceptual sources [4,5]. Searches were first run in July 2026 and extended during the first revision in September 2026 to include nature-based solutions and sustainable drainage governance studies from Kenya, Uganda, Rwanda, Namibia, and Chad, and a Global South comparator from India, so that the review's conclusions about Sub-Saharan Africa do not rest on the WSUD label alone.

Table 1. Search and selection protocol for the narrative review.

Element	Description
Databases	Google Scholar and Scopus; forward and backward citation tracking from conceptual anchor sources.
Search terms	"water-sensitive urban design", "blue-green infrastructure", "nature-based solutions", "informal settlements", "urban flood governance", "Sub-Saharan Africa", combined with Boolean operators.
Search dates and period covered	Searches run in July 2026 and extended in September 2026. No lower date limit for conceptual sources (WSUD guidance dates from 1994); empirical African studies retained were published between 2006 and 2026.
Language	English.
Inclusion criteria	(i) Addresses WSUD, SUDS, blue-green infrastructure, or nature-based solutions for urban water or flood management; (ii) sets out institutional, legal, fiscal, tenurial, historical, or equity dimensions; (iii) set in Sub-Saharan Africa, or a conceptual or Global South comparator source; (iv) peer-reviewed, or an institutional or legal source used only for contextual facts.
Exclusion criteria	Purely hydrological or engineering performance studies without a governance dimension; studies without an urban focus; opinion pieces without an evidence base; news-media reports (used in the first submission and removed in this revision).
Screening procedure	Single-reviewer screening of titles and abstracts, then full texts, against the criteria above. Every retained source was re-checked against its published record for authorship, bibliographic details, and the specific claim it supports.
Screening outcome	Stage-by-stage record counts were not tallied, as is common in narrative reviews. The final corpus of 24 sources is fully enumerated in the reference list and summarised below.
Final corpus (24 sources)	17 peer-reviewed journal articles; 1 book chapter; 1 conference paper; 2 technical guidelines; 2 institutional or grey-literature items; 1 reference entry covering two legal instruments. By setting: conceptual or Australian origin (6); Global South comparator (1); Sub-Saharan Africa multi-country or continental (4); Nigeria (6, including the legal-instrument entry); other African cities (7).

Because published academic coverage of blue-green governance in Nigerian secondary cities remains thin, a small number of institutional sources and legal instruments are used to supply empirical context, such as the flood-cost estimate from the World Bank and the statutory allocation of planning functions. These support contextual statements only. The review's conceptual and governance claims rest on the peer-reviewed sources. News-media sources used in the first submission have been removed, and the claims they supported have been either re-sourced or withdrawn. Each reference in the list has been re-checked for authorship and publication details.

Nigerian cases are used as an illustrative rather than representative lens (Figure 1). Ibadan is treated here as the review's exemplar secondary city: a historic, dense, largely pre-colonial urban core whose institutional constraints are broadly characteristic of the secondary cities the review is concerned with. Lagos, by contrast, is a megacity rather than a secondary city. It is included deliberately as a contrasting case rather than as a second exemplar. It is the Nigerian city with the greatest fiscal capacity, media visibility, and formal planning infrastructure, and the review returns to it in Section 4 specifically to argue that if institutional fragmentation and enforcement failure persist even where resources are least constrained, the barriers identified are not merely a function of resource scarcity. This is a comparative logic, not a claim that Lagos is itself a secondary city.

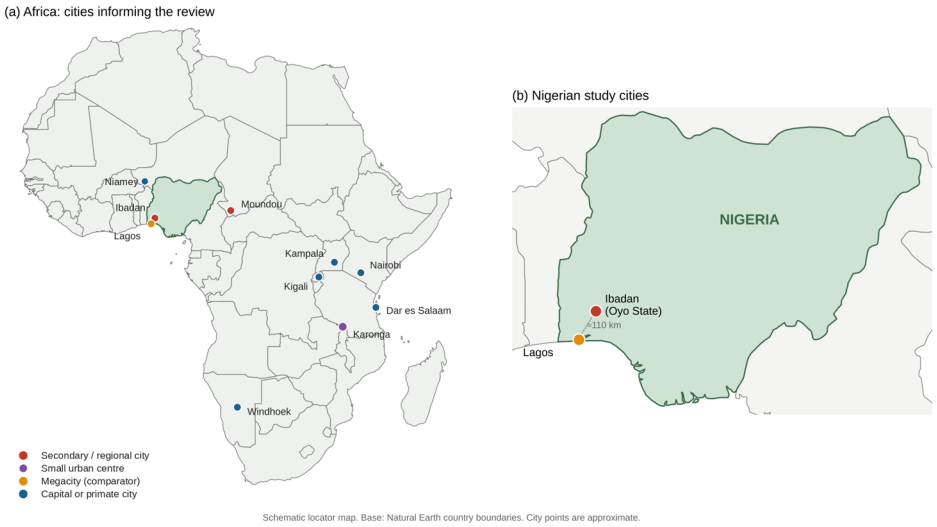


Figure 1. Study area. (**a**) Cities from which evidence is drawn, classified as secondary or regional city, small urban centre, megacity comparator, or capital or primate city. (**b**) The two Nigerian study cities, Ibadan (exemplar secondary city) and Lagos (megacity comparator). Schematic locator map; city positions are approximate.

2. Conceptual Foundations: From Water-Sensitive Urban Design to the Water-Sensitive City

The term water-sensitive urban design first appeared in Australian planning guidance in the early 1990s, with the earliest formal guidelines produced for the Western Australian Department of Planning and Urban Development in 1994 [15,16]. Early formulations focused on site-scale stormwater techniques (rain gardens, bioretention, permeable paving, and constructed wetlands) aimed at reducing the hydrological and water-quality impacts of urban development on receiving waterways [5]. Over the following two decades the concept broadened considerably. Brown, Keath, and Wong's Urban Water Transition Framework situates this broadening historically. It describes six successive service-delivery states through which cities have progressively moved, from the water supply city, through the sewered, drained, and waterways city, to the water cycle city, with the water-sensitive city positioned as the sixth and most institutionally demanding of these states [17]. Wong and Brown's influential articulation of the water-sensitive city reframes WSUD not as a set of engineering techniques but as a societal transition. It rests on three pillars of action: treating the city itself as a water-supply catchment, treating urban landscapes as providers of ecosystem services, and building the social and political capital, including the institutional networks and governance relationships needed to sustain water-sensitive practice, over time [4].

This reframing matters for how the concept is read outside Australia. Read narrowly, WSUD is a design toolkit that can, in principle, be specified in any municipal engineering manual. Read as Wong and Brown intend, it is inseparable from the institutional and social arrangements of the city in which it is embedded [4]. Fletcher and colleagues' widely cited terminological review makes a related point. It maps WSUD, SUDS, LID, and green infrastructure onto a shared conceptual space defined by scale and underlying principle, showing that these frameworks converge on integrated, decentralised, multi-functional water management but diverge sharply in the institutional traditions from which they emerged [5]. That terminological landscape has continued to shift since Fletcher and colleagues' synthesis, most notably with the consolidation of Blue-Green Cities as an umbrella term for approaches that combine flood risk management with the restoration of naturally oriented water cycles [6], a reminder that no single vocabulary in this field should be treated as final. It is precisely this institutional embeddedness, largely invisible in translated technical guidance, that becomes the central obstacle when the concept travels to cities whose planning, land, and fiscal institutions differ fundamentally from those of Melbourne or Perth.

3. Traveling Concepts, Untraveled Institutions: Barriers to Blue-Green Infrastructure Translation in Sub-Saharan Africa

A growing body of empirical work has begun to document, city by city, why WSUD and the cognate nature-based solutions vocabulary struggle to gain traction in Sub-Saharan African urban governance. Four recurring categories of barrier emerge across this literature: legal and regulatory fragmentation, financial and fiscal constraint, the mismatch between formal design frameworks and informally held or occupied land, and the structuring legacy of colonial and postcolonial drainage infrastructure. These four categories, and the framework proposed in Section 6, are drawn from a literature that remains geographically uneven and concentrated on a comparatively small number of well-studied cities. The patterns below are therefore best read as recurring findings within the cases reviewed, rather than as established regional conclusions. Table 2 in Section 5 states, for each source, the type of city it concerns.

3.1. Legal and Regulatory Fragmentation

A multi-country review of nature-based infrastructure adoption in peri-urban Sub-Saharan Africa, which screened 155 studies down to 29 studies in 24 countries, found legal and institutional barriers to be the second most frequently reported obstacle overall and the dominant barrier in Dar es Salaam specifically, with national-level barriers skewing heavily toward legal and institutional rather than technical or ecological factors [11]. A separate case study of Moundou, Chad, a provincial city, similarly found that institutional barriers (limited capacity for long-term planning, a shortage of technical expertise, and weak multisectoral coordination) constituted the single largest category of obstacle to integrating sustainability goals into urban development, ahead of economic and socio-cultural barriers. The finding is notable precisely because Moundou's urban planning apparatus is itself only partially formalised [12]. In the Nigerian context, planning, land, and environmental functions are distributed across federal, state, and local tiers: the Urban and Regional Planning Law of 1992 creates planning authorities at each level, while the Land Use Act of 1978 vests land in state governors [18]. As the Lagos and Ibadan cases in Section 4 suggest, this layering can leave flood-prone communities without a single accountable authority for channel maintenance and drainage-reserve enforcement [3,14].

3.2. Financial and Fiscal Constraints

Financial constraint operates differently at different scales of governance. At the household level, the principal barrier to adopting water-sensitive practices is typically the upfront cost of infrastructure. At community and municipal levels, barriers shift toward the cost of design expertise, ongoing performance monitoring, and long-term maintenance [11]. Maintenance responsibilities and cost burdens are likewise reported as persisting issues in participatory nature-based projects in Nairobi and Dar es Salaam [19]. In Windhoek, Namibia, municipal officials interviewed for a study of green infrastructure governance estimated that NAD 3–4 billion (about USD 200–300 million) would be required simply to service and upgrade informal settlement areas to a baseline standard, a figure that excludes ecosystem restoration and green infrastructure maintenance. The same officials acknowledged that restoration is generally prioritised toward wealthier, rate-paying areas rather than informal settlements whose residents do not pay municipal rates [20]. This fiscal logic, rational at the level of an individual municipal budget, channels blue-green investment away from precisely the neighbourhoods that carry the greatest flood exposure. Windhoek is a capital city in a dryland setting, so the finding is used here to illustrate a fiscal mechanism, not to describe secondary-city budgets directly.

3.3. Informality, Land Tenure, and the Limits of Formal Design Frameworks

WSUD guidance, including the framework explicitly adapted for South Africa, is written against an assumption of legible, cadastrally registered urban land on which a designer can specify a bioswale, a detention basin, or a constructed wetland with reasonable confidence that the land will remain available and the intervention maintained [7]. This assumption does not hold across large parts of African cities. An estimated 55.9% of urban residents in Sub-Saharan Africa live in informal settlements, according to a UN-Habitat figure reported in the Moundou study [12]. Informal settlement frequently occupies environmentally sensitive land. In Windhoek, for example, peri-urban expansion encroaches on riverbeds, hilly slopes, and other marginal land, and the study reports that most informal residents lack formal tenure [20]. Informal occupation of riparian corridors, floodplains, and wetland margins is a recurrent concern in the African green-infrastructure literature [21].

Table 2. Source cities by type, evidence tier, and transferability to Sub-Saharan African secondary cities.

City (Country)	City Type	Tier	Main Evidence	Transferability to Secondary Cities
Ibadan (Nigeria)	Historic inland city; secondary-city exemplar	A	Flood vulnerability of the Bere core [2]; case in four-city risk study [14]	Direct, but evidence is limited to the cited studies
Moundou (Chad)	Provincial city	A	Institutional barriers largest category [12]	Direct for the institutional barrier; single-city study
Karonga (Malawi)	Small urban centre (<500,000)	A	Case in four-city risk study [14]	Direct for procedural questions; smaller scale than the other cities
Nairobi (Kenya)	Capital	B	Kibera hybrid drainage projects; tenure and maintenance constraints [8,19]	Transferable at settlement scale; municipal capacity differs
Niamey (Niger)	Capital	B	Case in four-city risk study [14]	Indicative only; capital-city context differs from secondary cities
Kampala (Uganda)	Capital	B	Power in community governance of NbS drainage [9]	Transferable as a governance dynamic
Kigali (Rwanda)	Capital	B	Pre-design NbS study; resident involvement stressed [10]	Indicative only; grey literature, no outcome data
Windhoek (Namibia)	Capital; dryland	B	Fiscal prioritisation; block self-governance; colonial legacy [20]	Fiscal logic and self-governance transferable; dryland hydrology is not
Dar es Salaam (Tanzania)	Largest city	B	Legal-institutional barriers dominant in multi-country review [11]	Transferable for the barrier pattern
Lagos (Nigeria)	Megacity; comparator	C	Contravention and flooding; enforcement failure [3,22,23]; flood cost [1]	Used as contrast: enforcement capacity and visibility do not transfer
Delhi (India)	Global South comparator	C	Western water-sensitive frameworks need theoretical reworking [13]	Conceptual parallel only

It is in informal-settlement contexts, rather than in cities with formal WSUD guidelines, that Sub-Saharan African practice has clustered around the vocabulary of nature-based solutions, and the resulting projects illustrate both the promise and the governance difficulty of that approach. A study of ten completed projects featuring green-blue-grey drainage infrastructure in Kibera, Nairobi, identified the intrinsic constraints as space, contested land

tenure, participation, and local maintenance. It also found that co-development of small-scale green infrastructure changed residents' valuation and stewardship of nature-based systems, and that hybrid systems of infrastructure and governance offered a resilient route to incremental, inclusive upgrading [8]. In Kampala, Uganda, a study of community governance of nature-based sustainable drainage in the Nalukolongo catchment found that implementation outcomes were shaped less by design choice than by which actors held discursive and resource power within the local policy arrangement, with community groups typically peripheral to decisions made by government agencies and international partners [9]. In Kigali, Rwanda, a 2021 pre-design study for the flood-prone Mpazi sub-catchment proposed nature-based measures integrated with grey infrastructure and stressed the involvement of residents and businesses in design, implementation, and maintenance. As a pre-design study it documents intent rather than implementation outcomes [10].

Community-level management can also function where it builds on practice that residents already sustain. In Windhoek's informal settlements, neighbourhood groups of about twenty houses self-govern as "blocks" to mend fences, reinforce slopes, and maintain meeting areas, and community-appointed committees oversee public water points [20]. Household-level greening and informal recreational use of riparian corridors have likewise been described as resident-initiated green infrastructure practices [21]. This suggests that effective blue-green governance in informal contexts may need to formalise and support existing resident practice rather than impose an externally designed template.

3.4. Colonial and Postcolonial Infrastructural Legacies

A fourth and less frequently foregrounded barrier is historical. Gandy's historical analysis of metropolitan Lagos argues that structural factors operating through both the colonial and postcolonial periods have worked against any effective resolution of the city's infrastructure crisis [22]. Colonial legacies are not confined to Nigeria: the Windhoek study notes that town planning approaches in the region are often colonial relics with little provision for equitable land and tenure policies, and that Windhoek's physical segregation under apartheid is still visible in the uneven distribution of greening across the city [20]. Ibadan's traditional core, the Bere community studied by Salami, von Meding, and Giggins, is itself a pre-colonial urban settlement whose dense, closely built housing pattern long predates any formal drainage planning, and whose vulnerability to flooding is inseparable from this inherited settlement morphology combined with decades of subsequent under-investment [2]. Reading contemporary drainage failure only as a present-day technical or institutional gap, without accounting for this layered history, risks proposing interventions that repeat rather than repair the exclusions built into the inherited drainage network. Direct historical evidence on the drainage networks themselves is thinner than evidence on planning and land institutions. The historical barrier is therefore the least well evidenced of the four, a limitation returned to in Section 7.

4. Nigerian Cities as a Lens: Lagos as Comparator, Ibadan as Secondary-City Exemplar

Lagos and Ibadan illustrate the barriers reviewed above in concentrated form, while also showing important differences in scale and governance capacity, differences the review treats as informative rather than incidental. A GIS-based analysis of flood-prone streets in sixteen metropolitan local government areas of Lagos found that building contraventions along drainage channels and floodplains were the cause of flooding in 48.8% of 211 surveyed streets [23]. A later study of the Lagos metropolis found that contravention of building codes was strongly associated with flooding ($r = 0.926$), with about 63.5% and 63.3% of sampled buildings contravening plot-ratio and statutory setback requirements, respectively [3]. This is a pattern of regulatory non-enforcement rather than an absence of formal planning rules. The World Bank's estimate of almost four billion United States dollars in annual flood damage to Lagos indicates what is at stake [1]. That this persists in a city with Nigeria's greatest fiscal capacity and most developed formal planning apparatus is itself informative. It suggests that the region's governance barriers are not simply a function of resource scarcity that a wealthier secondary city might expect to outgrow, but are structural to how responsibility for drainage is distributed and enforced.

Ibadan presents a related but distinct picture, and one closer to the secondary-city condition this review is centrally concerned with. Its flood-prone traditional core long predates colonial urban planning, and its contemporary vulnerability reflects the interaction of pre-colonial settlement density and decades of infrastructural under-investment [2]. Ibadan is also one of four cities (with Karonga, Niamey, and Nairobi) examined in a comparative study of risk-sensitive urban development in Sub-Saharan Africa. That study argues that sustainable urban development requires a more frank focus on procedure: who makes decisions, under which frameworks, on the basis of what data, and with what accountability [14]. Taken together, these cases suggest that the binding constraint on blue-green infrastructure governance in Nigerian secondary cities is rarely technical specification. It is the sequencing

of enforcement, financing, and maintenance responsibility across fragmented tiers of authority, a constraint visible even in the city with the greatest capacity to overcome it. Evidence specific to Ibadan is nonetheless limited to the studies cited here, and the generalisation to other Nigerian secondary cities remains a hypothesis.

5. Comparative Analysis and Transferability

The evidence base varies in how directly it speaks to secondary cities. Table 2 therefore classifies each source city by type and states how its evidence is used. Three evidence tiers are distinguished. Tier A comprises evidence from secondary or regional cities (Ibadan, Moundou) and from the small urban centre of Karonga. Tier B comprises evidence from capital and primate cities, mostly from informal-settlement governance (Nairobi, Niamey, Kampala, Kigali, Windhoek, Dar es Salaam). Tier C comprises evidence from megacities and from global comparators (Lagos, Delhi) and from the Australian conceptual literature.

Three patterns emerge. First, the legal and institutional barrier is the most consistently supported across tiers. It appears in a multi-country review, in a provincial city (Moundou), in the four-city risk study that includes Ibadan, and in the enforcement record of Lagos [3,11,12,14]. Second, the evidence on tenure and informality is drawn almost entirely from capitals (Tier B). It transfers well at the scale of the informal settlement, where land, maintenance, and participation problems recur, but may transfer less well at the scale of the municipality. Secondary cities typically have smaller fiscal bases and smaller professional communities than capitals, and they attract less donor attention. These differences are plausible, but they are the author's reasoned hypotheses and are not established by the reviewed studies. Third, the fiscal evidence rests on one capital city (Windhoek), so its application to secondary cities is inferential.

What transfers with confidence is therefore the structure of the barriers and the settlement-scale lessons on co-management. What transfers with qualification is the fiscal logic of prioritising rate-paying areas and the dependence of pilot projects on external partners. What does not transfer is dryland hydrology (Windhoek) and the enforcement capacity and media visibility of Lagos. Conditions likely to affect transferability, and therefore worth testing, are city size, fiscal decentralisation regime, tenure regime, colonial administrative history, and hydroclimate. Comparable concerns about transferability arise outside Africa, as the Delhi case shows [13].

6. Toward a Context-Sensitive Framework for Blue-Green Infrastructure Governance in African Secondary Cities

Building on the barriers identified above, this review proposes that a context-sensitive translation of blue-green infrastructure governance for African secondary cities should be organised around three governance principles, distinct from, though not incompatible with, the technical vocabulary of WSUD (Figure 2). Each principle is stated together with the body of evidence from Section 3 from which it is derived, so that the framework's connection to the reviewed literature, rather than to the review's own conceptual preference, is explicit. Table 3 sets out the chain from barrier to evidence, principle, mechanism, and expected outcome. In that table the barrier and evidence columns report what the reviewed studies found, while the mechanism and outcome columns are the author's proposals and hypotheses.

The first principle is institutional layering, derived from the legal and regulatory fragmentation documented in Section 3.1 [3,11,12,18]. Rather than assigning blue-green infrastructure to a single planning or environment department, responsibility should be explicitly distributed and formally coordinated across the tiers of government that already exercise de facto authority over drainage corridors, land-use enforcement, and waste management. The fragmentation documented across the literature is rarely resolved by adding a new agency. It is resolved by clarifying and formally linking existing ones.

The second is incremental legitimacy, derived from the informality and land-tenure evidence in Section 3.3, particularly the Kibera and Kampala cases [8,9,21]. Because much of the land on which blue-green interventions are most needed (riparian corridors, wetland margins, floodplain settlements) is informally held or occupied, interventions should be sequenced to build legitimacy incrementally. They should begin with small-scale, community-negotiated pilot infrastructure of the kind documented in Kibera and Kampala, rather than requiring full tenure regularisation as a precondition for any drainage improvement, a precondition that in practice indefinitely defers investment in the highest-risk areas. This sequencing is compatible with the integration of green infrastructure into in-situ upgrading strategies advocated in the Windhoek study [20].

The third is distributed co-maintenance, derived from the fiscal-constraint evidence in Section 3.2 together with the resident-practice evidence in Section 3.3 [19–21]. Given that municipal fiscal capacity is a binding constraint in most of the cases reviewed here, blue-green infrastructure should be designed from the outset around a realistic maintenance model that formalises and resources the household and community-level relationships with

green and riparian space already documented in the literature, rather than assuming a municipal maintenance budget that the evidence suggests will not materialise. Any such framework must also explicitly guard against the gentrification risk that blue-green adaptation projects have been shown to carry elsewhere on the continent, where climate-resilience investment has, in the absence of accompanying housing and land-use safeguards, been associated with rising housing prices and population change in the neighbourhoods concerned [24]. These equity safeguards apply to all three principles and are treated further in Section 7, and Tables 3 and 4 carry them as a cross-cutting safeguard rather than a fourth principle.

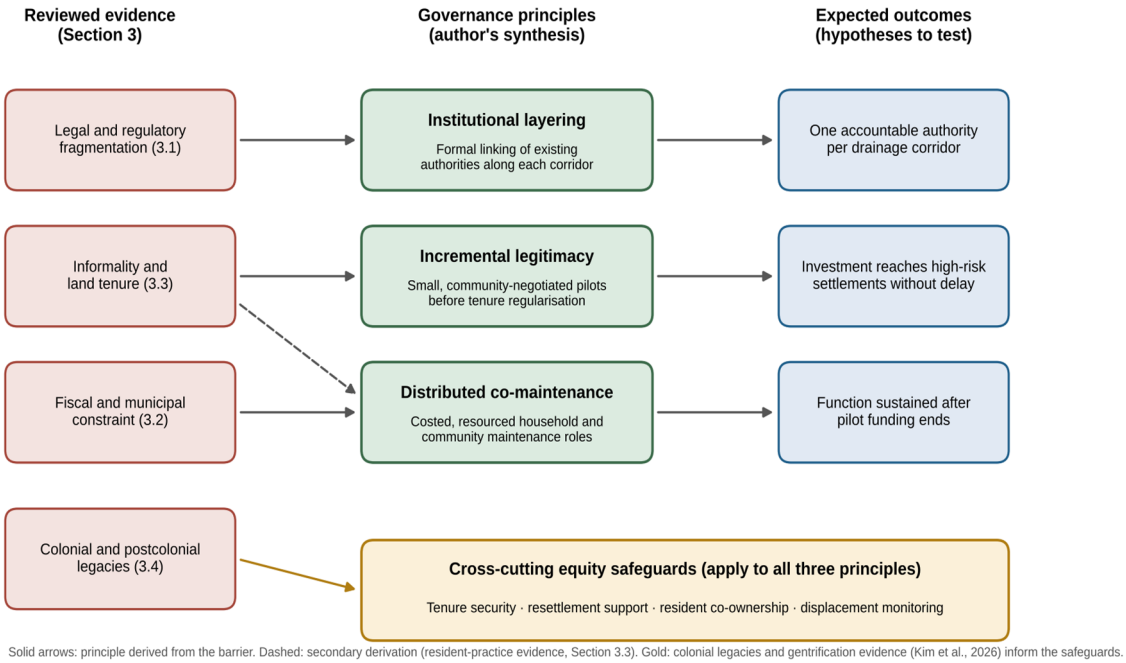


Figure 2. Conceptual framework for context-sensitive blue-green infrastructure governance in African secondary cities. Barriers and evidence derive from the reviewed literature (Section 3); principles are the author's synthesis; expected outcomes are hypotheses to be tested (Table 3).

Table 3. Traceability of the framework: from barrier to evidence, principle, mechanism, and expected outcome. Mechanisms and outcomes are the author's proposals, not findings of the reviewed studies.

Barrier (Section)	Reviewed Evidence	Principle or Safeguard	Mechanism (Author's Proposal)	Expected Outcome (Hypothesis)
Legal and regulatory fragmentation (3.1)	Legal-institutional barriers dominant [11]; institutional barriers largest in Moundou [12]; contravention and flooding in Lagos [3]	Institutional layering	A mandate matrix assigning corridor maintenance, enforcement, and waste management across federal, state, and local tiers; a named lead authority per drainage corridor; inter-agency protocol linking existing planning authorities	One accountable authority per corridor; fewer unauthorised structures on drainage reserves
Informality and land tenure (3.3)	Space, tenure, participation, and maintenance constraints in Kibera [8]; peripheral community role in Kampala [9]	Incremental legitimacy	Community-negotiated pilots with written maintenance agreements; recognised use rights over riparian strips as an interim step before full tenure regularisation	Investment reaches high-risk settlements without waiting for regularisation
Fiscal and municipal constraint (3.2)	Fiscal prioritisation of rate-paying areas [20]; maintenance costs persist [11,19]	Distributed co-maintenance	Maintenance costed at design stage; household and block groups formally recognised and resourced through small municipal contracts or in-kind support; ring-fenced maintenance line	Function sustained after pilot funding ends
Colonial and postcolonial legacies (3.4); gentrification risk	Structural constraints across colonial and postcolonial periods [22]; inherited settlement morphology in Ibadan [2]; rising prices and population change near green-blue adaptation [24]	Cross-cutting equity safeguards	Social impact screening before intervention; tenure security and resettlement support; options for resident co-ownership of upgraded assets; displacement monitoring	Upgrading does not reproduce inherited exclusions

6.1. Positioning Relative to Existing Governance Frameworks

The three principles draw on, and should be distinguished from, existing literatures on polycentric and collaborative governance, community-based infrastructure management, and nature-based solutions. Governance frameworks developed for urban green space distinguish state-led, collaborative, and self-governance arrangements and the interaction between institutional frameworks, actors, resources, and processes [20]. Institutional layering differs in taking the existing statutory tiers as given and specifying how they are linked along a drainage corridor, rather than proposing new multi-stakeholder platforms. Community-based infrastructure management emphasises participation and ownership [8,19]. Incremental legitimacy adds a specification of sequence: small, negotiated, tenure-neutral pilots precede, and may substitute for, tenure regularisation. Distributed co-maintenance goes beyond calls for community stewardship by tying the maintenance model to the municipal fiscal constraint and by pairing it with equity safeguards against displacement. The framework's contribution is therefore the combination and the sequencing, derived from secondary-city and informal-settlement evidence, and not any of the three ideas in isolation. Whether that combination performs better than alternatives is an empirical question that Table 4 is designed to address.

Table 4. Proposed operationalisation and validation pathway for the framework (author's proposal; not yet applied).

Principle or Safeguard	Candidate Indicators	Assessment Method	Validation Step
Institutional layering	Share of drainage corridors with a named responsible authority; existence of an inter-agency protocol; enforcement actions against drainage-reserve contraventions per year	Document analysis of mandates; institutional mapping of corridors; key-informant interviews	Comparative institutional ethnography in three or more West African secondary cities; test whether the indicators discriminate between cities
Incremental legitimacy	Number of community-negotiated pilots with written maintenance agreements; resident-reported tenure security before and after; time from pilot to scale	Household surveys; repeated tenure-perception scale; pilot records	Three- to five-year tracking of pilots, compared with tenure-first sites
Distributed co-maintenance	Share of maintenance cost met by municipality, community, and external partners; functioning rate of assets at 12 and 24 months	Asset functionality audits; cost tracing	Prospective monitoring of interventions in Nigerian cities; practitioner review (e.g., Delphi) of the indicators
Cross-cutting equity safeguards	Changes in housing price, rent, homeownership, and population turnover relative to matched comparison areas	Difference-in-differences on municipal data (following [24]) plus local surveys	Local test of whether the continental gentrification pattern appears in Nigerian cities, and on what timescale

6.2. Operationalisation and Validation

To move the framework beyond a conceptual proposal, Table 4 sets out for each principle, and for the cross-cutting equity safeguards, candidate indicators, assessment methods, and a validation step. The indicators are proposed for testing and have not yet been applied. The approach follows the logic of the comparative institutional ethnography proposed in Section 8, and the validation steps are the substance of the research agenda set out there.

6.3. Evidence and Recommendation

To keep the line between evidence and judgement visible, the review distinguishes three kinds of statement. Findings reported by the reviewed studies are cited to those studies. Interpretations that combine several studies, such as the identification of four recurring barriers, are the author's synthesis and are labelled as such. Recommendations, including the mechanisms in Table 3 and the indicators in Table 4, are the author's proposals and are presented as hypotheses to be tested, not as findings.

7. Discussion: Equity, Gentrification, and the Politics of Water Sensitivity

The literature reviewed here converges on a finding that should temper any straightforward enthusiasm for importing external blue-green frameworks into African secondary cities without asking who is asking for them and in what vocabulary. Interventions framed as purely technical or ecological improvements routinely carry distributive consequences. The vocabulary through which they are adopted (WSUD in South Africa, nature-based solutions in Kenya, Uganda, and Rwanda) is itself a signal of which institutional actors, national design authorities in the first case and donor and NGO partnerships in the second, are driving implementation, with corresponding implications for whose priorities the resulting projects serve.

Continental-scale evidence shows that green-blue adaptation can be associated with early-stage gentrification dynamics. A study of 5,503 municipal administrative areas within 221 urban agglomerations in 32 African countries between 2005 and 2024 found that areas with sustained green-blue expansion saw increases in housing prices, income, consumption, and homeownership, together with faster population growth and demographic change. The authors report that rent control alone did not moderate these pressures in any straightforward way, whereas municipalities with resettlement support showed smaller increases [24]. The published summaries report continental results, and whether the effect differs for secondary cities is not established in the sources reviewed here. The finding reproduces at neighbourhood scale the same exclusions that under-resourced drainage governance produces at city scale. It sits uncomfortably alongside the argument for in-situ upgrading, which seeks to preserve residents' location and the networks attached to it [20]. A context-sensitive agenda for African secondary cities must therefore treat equity safeguards (security of tenure, resettlement support, and resident co-ownership of upgraded blue-green assets) not as an optional addendum to design guidelines but as a precondition for the intervention being genuinely water-sensitive in Wong and Brown's fuller sense of building durable social and political capital around water [4], rather than water-sensitive only in the narrow, technical sense of moving stormwater efficiently.

Limitations

Four limitations qualify the review. First, it is a narrative review, and although the search and selection protocol is reported in Table 1, it was conducted by a single reviewer and cannot be claimed to be exhaustive. Second, the geographical evidence is uneven: Section 5 shows that most evidence on informality comes from capitals, and the evidence specific to secondary cities is confined to a small number of studies. Third, the historical barrier is the least well evidenced of the four, because direct studies of colonial drainage networks are scarce in the reviewed literature. Fourth, some contextual facts rest on institutional or grey-literature sources (the World Bank flood-cost estimate and the Mpazi pre-design study), which are used only for context and scale. Conclusions about regional patterns are qualified accordingly throughout.

8. Conclusions and Prospective Research Agenda

Water-sensitive urban design, and the broader family of blue-green infrastructure and nature-based solutions vocabulary it sits alongside, offers a valuable but not a settled conceptual toolkit for rethinking the relationship between African secondary cities and the water that regularly floods them. Its Australian and Northern European institutional assumptions, and even its terminology, cannot be assumed to travel intact. The evidence reviewed here indicates that legal fragmentation, fiscal constraint, land informality, and inherited colonial infrastructure are not peripheral implementation obstacles to an otherwise sound technical framework. Within the cases reviewed, they are the primary determinants of whether a blue-green intervention functions or fails in practice. A context-sensitive framework built around institutional layering, incremental legitimacy, and distributed co-maintenance, with explicit equity safeguards against gentrification, offers one route toward a translation of blue-green infrastructure governance that is answerable to African urban conditions rather than merely applied to them.

Four directions for future research follow from the gaps identified in this review. First, comparative institutional ethnography is needed across West African secondary cities, of the kind so far concentrated on Nairobi, Kampala, Kigali, and Windhoek, to establish whether the governance barriers identified here generalise or vary systematically with city size, colonial administrative history, and fiscal decentralisation regime [8,9,20]. Second, longitudinal monitoring of blue-green interventions already implemented in Nigerian cities is needed to test empirically whether the gentrification effect documented elsewhere on the continent materialises locally, and if so, on what timescale and under what tenure conditions [24]. Third, further work is needed on financing models capable of closing the fiscal gap identified in Windhoek and comparable cities, particularly instruments that do not depend on municipal rate revenue from the very informal settlements least able to pay it [20]. Fourth, the operationalisation and validation pathway in Table 4 should be tested, so that the framework can be confirmed, refined, or rejected on empirical grounds. Addressing these gaps would move the blue-green governance literature from a predominantly diagnostic account of why the concept struggles to travel toward a genuinely prescriptive and locally accountable governance agenda.

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Conflicts of Interest

The author declares no conflict of interest.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the author used Claude (Anthropic) to assist with literature searching. After using this tool, the author reviewed and edited the content as needed, verified the cited sources, and takes full responsibility for the content of the publication.

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