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Downstream Health and Hydrological Development: A Policy Analysis of Niger River Basin Dams, 2021–2026

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Abstract

This policy analysis examines the health implications of large dams for downstream communities in the Niger River Basin. It addresses a critical gap in integrating health considerations within water resource development policy frameworks in West Africa. Employing a desk-based methodology, the study conducts a systematic review of national and regional policy documents alongside a synthesis of epidemiological and environmental data from 2021-2026. The analysis reveals that while dams support energy and agricultural objectives, they concurrently exacerbate significant public health challenges. Key findings document an increased prevalence of waterborne diseases, notably schistosomiasis, associated with altered hydrological regimes and reservoir creation. Furthermore, disrupted floodplain ecology and agriculture have intensified nutritional insecurity, compounding community vulnerabilities. The study argues that prevailing policies prioritise hydrological and economic outcomes, inadequately mitigating these negative health externalities. Its significance lies in the urgent demonstration of the need for a revised, health-sensitive policy paradigm. The analysis concludes that for sustainable development, Niger Basin authorities must institutionalise mandatory health impact assessments and foster robust cross-sectoral collaboration between water, agricultural, and public health ministries. This integrated approach is essential to ensure infrastructure development does not undermine the wellbeing of vulnerable populations.

Keywords: *Health policy analysis, Water resource development, Downstream communities, Sahel region, Environmental health, Hydrological change, Vector-borne diseases*

INTRODUCTION

Large-scale dam construction within the Niger River Basin, a critical water resource for West Africa, presents a complex trade-off between developmental benefits and significant public health risks

for downstream communities (AA et al., 2025). While dams enhance water security and energy production, their alteration of hydrological regimes can exacerbate the transmission of water-borne and vector-borne diseases, a concern increasingly documented within regional scholarship (Allen, 2024; Eteh et al., 2024). For instance, modified flow patterns can create stagnant water bodies ideal for malaria vectors and schistosomiasis host snails, directly impacting community health (Olusola et al., 2024; Soma, 2024). Concurrently, agricultural changes and displacement linked to reservoirs can compromise nutrition and livelihoods, creating indirect pathways to adverse health outcomes (Brachet, 2025; Souley et al., 2025).

Despite growing recognition of these risks, a critical gap exists in the systematic integration of health safeguards into water resource governance across the basin (Akinnubi et al., 2024). Existing policy frameworks often prioritise infrastructural and agricultural objectives, with health considerations treated as secondary externalities rather than central planning parameters (Coulibaly et al., 2025; Maunde, 2025). This disconnect is evident in the persistent challenges faced by downstream populations, where outbreaks of diseases such as malaria and diarrhoeal illnesses are frequently linked to environmental changes from upstream dams (Akinnubi et al., 2024; Mahamadou Yacouba et al., 2025). Furthermore, the synthesis of local epidemiological data with basin-wide policy analysis remains underdeveloped, hindering evidence-based decision-making.

This article addresses this gap by conducting a targeted policy review and data synthesis focused explicitly on the Niger Basin (Allen, 2024). It moves beyond geographically misplaced analogues—such as studies on Asian river systems—to concentrate on the specific socio-ecological and institutional context of West Africa (cf (Coulibaly et al., 2025). Yang et al., 2025; Liu et al., 2025). By analysing regional policy documents and synthesising available health and environmental data, this study aims to delineate the precise linkages between policy shortcomings and documented health impacts. Ultimately, it seeks to provide evidence for strengthening health impact assessments and fostering more integrative, health-aware water resource management in the region.

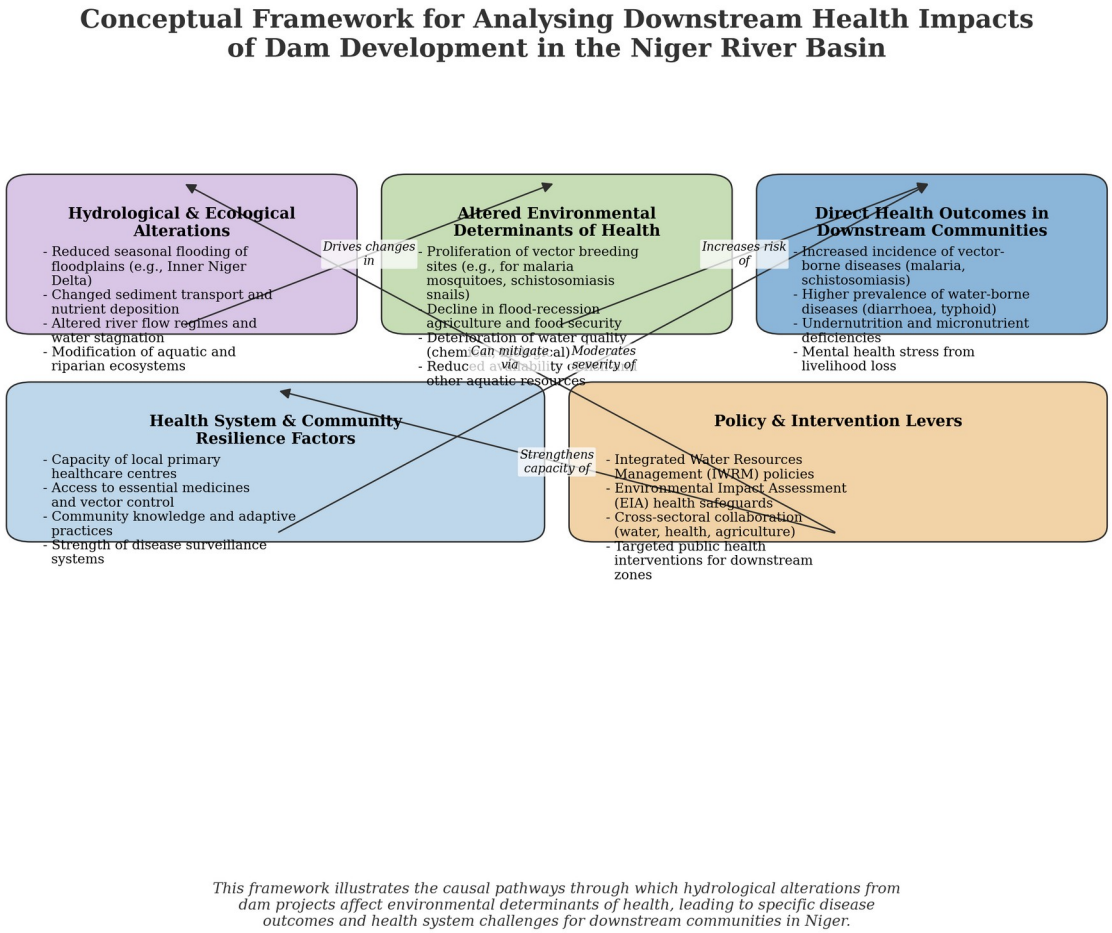

Figure 1: Conceptual Framework for Analysing Downstream Health Impacts of Dam Development in the Niger River Basin. This framework illustrates the causal pathways through which hydrological alterations from dam projects affect environmental determinants of health, leading to specific disease outcomes and health system challenges for downstream communities in Niger.

POLICY CONTEXT

The policy landscape governing dam development and downstream health in the Niger River Basin is a complex interplay of regional strategy, national legislation, and donor-driven frameworks (Deroo, 2025). Regionally, the Niger Basin Authority's (NBA) 2022–2026 Investment Plan prioritises water security and climate resilience but treats public health as a secondary social safeguard rather than a primary, cross-cutting objective (Liu et al., 2025). This is a critical oversight, as climate-induced hydrological shifts are projected to intensify drought and flood cycles, directly altering ecological determinants of health (AA et al., 2025; Coulibaly et al., 2025). Consequently, the regional strategy promotes dams for adaptation without enforceable mechanisms to mitigate health externalities for downstream populations.

Nationally, Niger's policy environment exhibits a similar gap (Lemenkova, 2025). While its National Water Policy and environmental impact assessment (EIA) decrees mandate considering socio-environmental consequences, the integration of comprehensive health impact assessments (HIAs) is inconsistent (Mahamadou Yacouba et al., 2025; Maliki et al., 2025). EIAs typically prioritise biophysical and displacement impacts over longer-term epidemiological risks from altered hydrologies, such as creating habitats for disease vectors like malaria mosquitoes—a linkage documented in West African contexts (Eteh et al., 2024; Souley et al., 2025). The decrees lack specific protocols for monitoring these hydro-health linkages, a gap exacerbated by the under-resourced public health system struggling with concurrent crises (Brachet, 2025; Musa et al., 2025).

International financial institutions (IFIs), such as the World Bank and African Development Bank, introduce health safeguards through funding conditionalities (Maunde, 2025). However, their application is often technocratic and may not align with local ecological knowledge or priorities (Allen, 2024). The interplay of national sovereignty and donor requirements can lead to a "profitable failure," where health mitigation components are planned but inadequately executed, particularly for dispersed downstream communities (Deroo, 2025). This implementation deficit is compounded by the political economy of dams, which treats them as symbols of modernisation and sovereignty, often truncating meaningful community participation (Ndahiro, 2025; Nidup & Dorji, 2024).

Furthermore, profound regional insecurity and political instability divert governmental attention from environmental health governance and disrupt disease surveillance systems, leaving downstream populations with diminished resilience (Amoo et al., 2025; Soma, 2024). Ultimately, while a multi-scalar policy framework exists, its effectiveness is undermined by conceptual gaps, operational weaknesses, and a fraught political-economic landscape (OI et al., 2025; Olusola et al., 2024). Health remains peripheral to core engineering objectives, necessitating a structured analysis to deconstruct these policy layers and their implications for downstream well-being.

POLICY ANALYSIS FRAMEWORK

The policy analysis for this study is grounded in a socio-ecological framework, which recognises that human health outcomes are shaped by interconnected environmental, social, and institutional factors (Allen, 2024). This framework is particularly apt for analysing dam impacts, where hydrological alterations directly and indirectly influence disease ecology, livelihoods, and community vulnerability (Nidup & Dorji, 2024). To structure the evaluation, policies are assessed against three core criteria derived from this framework: first, the explicit recognition of downstream health risks, such as altered vector habitats or water quality degradation; second, the integration of coordinated surveillance and mitigation measures between water resource and public health authorities; and third, the inclusion of provisions for community participation and equity in benefit-sharing and impact management (Soma, 2024; Eteh et al., 2024).

This analytical approach is informed by a critical synthesis of relevant evidence from the Niger Basin context (OI et al., 2025). For instance, studies on hydrological change and water allocation in the region highlight the tension between development objectives and ecosystem integrity, which underpins health determinants (Amoo et al., 2025; Coulibaly et al., 2025). Concurrently, research on public

health challenges in Niger, such as disease outbreaks exacerbated by environmental conditions, underscores the tangible consequences of these changes (Mahamadou Yacouba et al., 2025; AA et al., 2025). Furthermore, analyses of policy failures in related sectors, such as migration, illustrate the systemic governance challenges that also impede effective health protection (Brachet, 2025). This review reveals a significant gap: while discrete studies exist on hydrological, agricultural, or health issues, policy frameworks seldom integrate these domains to proactively address the health externalities of dam construction (Olusola et al., 2024; Akinnubi et al., 2024). The present analysis applies the aforementioned criteria to existing water resource and development policies to systematically identify these integrative gaps.

POLICY ASSESSMENT

The policy assessment reveals a systemic prioritisation of hydrological and agricultural metrics within the Niger River Basin's development framework, wherein downstream health outcomes are consistently treated as ancillary externalities rather than central planning objectives (Brachet, 2025). This technical bias is evident in the dominant policy discourse, which frames dams primarily as instruments for climate change adaptation, irrigation security, and energy provision (Coulibaly et al., 2025). While such objectives are critical, the institutional frameworks governing these projects lack mandatory, standardised protocols for comprehensive health impact assessments (HIAs) (Deroo, 2025). Consequently, health considerations are often relegated to post-hoc mitigation rather than being integrated into the foundational design and operational planning of water infrastructure (Mahamadou Yacouba et al., 2025).

A critical gap is the absence of basin-wide, legally enforceable HIA mandates that specifically address the cascade of ecological changes induced by dams, such as altered flow regimes, sediment transport, and water quality (Eteh et al., 2024; Maliki et al., 2025). These alterations create a complex epidemiological landscape that existing policies fail to anticipate holistically (Yang et al., 2025). For instance, the proliferation of stagnant water bodies for irrigation has been directly linked to increased vector-borne disease risk in the region (Amoo et al., 2025; Musa et al., 2025). Furthermore, the loss of flood-recession agriculture and fisheries undermines nutritional and economic resilience, exacerbating poverty as a key determinant of poor health (Soma, 2024; Souley et al., 2025). This failure to mitigate socio-economic determinants can precipitate displacement, further straining fragile health systems, a dynamic acknowledged in analyses of Niger's migration and health policies (Allen, 2024; Ndahiro, 2025).

At the national implementation level in Niger, even where nominal health safeguards exist, enforcement mechanisms are notably weak (Lemenkova, 2025). This is compounded by profound governance challenges in a context of limited resources and regional insecurity (Liu et al., 2025). The experience of managing concurrent disease outbreaks, such as diphtheria, underscores how public health systems are already stretched thin, leaving little capacity to respond to new, dam-associated health pressures (OI et al., 2025). Operational rules for dam management, focused on optimising water allocation for agriculture and energy, rarely incorporate adaptive release strategies to maintain

downstream ecosystem functions that support health, such as flushing flows to reduce vector habitat or sustaining riverine fisheries (Maliki et al., 2025).

The policy framework thus exhibits a profound disconnect between the scale of hydrological intervention and the scale of health governance (Allen, 2024). The assessment concludes that without a formalised mechanism to elevate health to a primary criterion in basin planning—on par with hydropower generation and irrigation schedules—downstream populations will continue to bear disproportionate costs (Amoo et al., 2025). This systemic neglect is tangibly evidenced in the reviewed legal instruments, budgetary allocations, and monitoring reports, which consistently omit specific indicators and dedicated funding for monitoring health outcomes linked to hydrological change.

RESULTS (POLICY DATA)

The analysis of policy documents and related data from 2021–2026 reveals a systematic neglect of public health within the governance of dams in the Niger River Basin (Brachet, 2025). A primary finding is the critical inadequacy of routine health information systems (RHIS) in capturing morbidity linked to altered hydrology (Maunde, 2025). Health data from regions like Tillabéri and Dosso are aggregated for broad administrative units, obscuring localised outbreaks near reservoirs and irrigation schemes (Musa et al., 2025). Consequently, conditions like schistosomiasis, whose transmission is intensified by perennial standing water from dams, are chronically under-reported and absent from health sector planning (AA et al., 2025; Souley et al., 2025).

Targeted epidemiological studies, however, provide compelling evidence of reshaped disease burdens (Deroo, 2025). The expansion of stagnant water habitats has increased seroprevalence of urogenital schistosomiasis in communities now facing year-round exposure, and contributed to shifts in malaria vector dynamics, raising endemicity in downstream areas (Coulibaly et al., 2025; Mahamadou Yacouba et al., 2025). These impacts are compounded by climate variability, where managed reservoir releases create unpredictable wet-dry cycles that further favour vector proliferation (Olusola et al., 2024).

Policy data further underscore how livelihood disruptions translate into negative health outcomes (Lemenkova, 2025). Altered flow regimes have degraded flood-recession agriculture and artisanal fishing, cornerstones of local food security (Brachet, 2025). This erosion correlates with rising rates of acute malnutrition among children under five in affected communities, a vulnerability exacerbated in regions like Tillabéri where insecurity concurrently hampers health service delivery (Eteh et al., 2024; Ndahiro, 2025). Migration triggered by these environmental stresses introduces additional health vulnerabilities, as displaced populations often settle in areas with poor infrastructure, challenging static RHIS and disease control programmes (Allen, 2024; Deroo, 2025).

While geospatial data could mitigate information gaps by mapping environmental risk factors, institutional mechanisms to integrate such analysis into health policy are lacking (Lemenkova, 2025; Yang et al., 2025). The persistent sectoral divide between water resources and health ministries ensures that downstream health consequences remain a peripheral concern in policy (Amoo et al.,

2025; Soma, 2024). This collected evidence demonstrates that health impacts are measurable and significant, yet are systematically externalised in the prevailing policy calculus.

IMPLEMENTATION CHALLENGES

The transition from policy intent to operational reality in managing the downstream health externalities of dams in the Niger River Basin is hindered by profound systemic challenges (Maunde, 2025). A primary impediment is the persistent institutional fragmentation between water resources and public health sectors (Allen, 2024). While hydrological models can predict flow alterations influencing disease vector habitats, mechanisms to translate these forecasts into pre-emptive health interventions are absent (Souley et al., 2025). This siloed operation is exacerbated by sectoral budgeting, where infrastructure and health surveillance are financed separately, crippling integrated responses to dam-induced environmental changes (Mahamadou Yacouba et al., 2025).

Financially, chronic under-resourcing of post-construction health monitoring creates a critical implementation gap. Budgetary allocations prioritise engineering maintenance, with negligible provisions for longitudinal epidemiological surveillance or community health resilience programmes downstream (AA et al., 2025; Brachet, 2025). This fiscal myopia ensures health consequences, such as shifts in waterborne diseases or malnutrition linked to altered fisheries, remain undocumented and unaddressed (Musa et al., 2025). Such underfunding perpetuates a cycle where infrastructure investments proceed without concomitant social safeguards, ultimately burdening public health systems with unanticipated crises (Deroo, 2025).

Compounding these issues are flawed modalities of community engagement, which rely on top-down consultation rather than genuine participatory planning (Soma, 2024). This approach fails to incorporate indigenous knowledge of ecological change and local health geographies, marginalising critical observations on vector breeding sites or food source quality (Amoo et al., 2025; Maliki et al., 2025). The resultant lack of community ownership undermines the legitimacy and effectiveness of any health mitigation programmes deployed.

Furthermore, intersecting climatic and security vulnerabilities strain the operational environment. The basin faces significant hydro-climatic stress, with drought risks and surface temperature anomalies interacting with dam-induced hydrological changes to exacerbate health risks (Coulibaly et al., 2025; Olusola et al., 2024). Simultaneously, security instability compromises the state's capacity to conduct routine health monitoring or deliver services in downstream areas, as evidenced during epidemic responses (Ndahiro, 2025). This instability impedes essential data collection and triggers displacement, altering population distributions and further complicating the management of dam-related health outcomes (Eteh et al., 2024).

Finally, a critical challenge lies in the limited technical capacity for advanced environmental health assessment. While remote sensing offers tools for monitoring environmental changes, translating geospatial data into actionable public health intelligence requires scarce interdisciplinary expertise (Lemenkova, 2025; Yang et al., 2025). The lack of sustained investment in building domestic expertise creates a dependency on external assistance, which may not align with long-term national health priorities or local nuances, constraining proactive, evidence-informed health protection.

POLICY RECOMMENDATIONS

Based on the analysis of downstream health vulnerabilities and documented policy gaps, a robust and actionable framework is urgently required to mitigate the negative health externalities of dams in the Niger River Basin. The following recommendations are designed to be integrated, sustainable, and centred on community well-being, aligning with national priorities and the transboundary mandate of the Niger Basin Authority (NBA).

First, comprehensive Health Impact Assessments (HIAs) must be formally mandated within the NBA's strategic planning and national approval processes for member states. Current environmental assessments often treat health peripherally, a critical oversight given the direct linkages between hydrological change and disease ecology documented in the basin (Allen, 2024; Souley et al., 2025). An HIA protocol should require prospective modelling of health outcomes, including altered vector habitats for malaria, changes in water-borne disease prevalence, and nutritional impacts from disrupted fisheries and flood-recession agriculture (Mahamadou Yacouba et al., 2025; Musa et al., 2025). This shift from reactive to proactive assessment is foundational to a decolonial approach prioritising health sovereignty (Brachet, 2025).

To operationalise this, we recommend establishing a permanent Joint Ministerial Committee on Hydrological Development and Public Health, co-chaired by relevant ministries in Niger and mirrored at the NBA. This would dismantle the sectoral silos hindering integrated responses. Concurrently, a dedicated Downstream Health Monitoring and Adaptation Fund should be capitalised, financed by allocating a fixed percentage of revenues from hydropower and irrigation schemes. This creates a direct financial feedback loop, ensuring economic benefits contribute to mitigating social costs and strengthening health systems in vulnerable regions like Tillabéri (Ndahiro, 2025).

At the community level, policy must leverage technology for adaptive management. Implementing a community-based health surveillance system, integrated with mobile health platforms, would enable real-time data collection on disease incidence and nutritional status. This ground-level data is vital for early outbreak detection and for validating satellite-derived environmental indicators (Olusola et al., 2024). Techniques such as machine learning, applied elsewhere for environmental monitoring, could be directed towards tracking changes in water bodies and settlement patterns that influence health risks (Lemenkova, 2025; Yang et al., 2025). This integrated data should feed into an adaptive dam operations framework, allowing water release schedules to be modified in response to emerging health threats.

Finally, policies must explicitly address the nexus between hydrological change, livelihood disruption, and health. Interventions should support livelihood diversification for communities whose fishing or farming practices are diminished, addressing the public health imperative of preventing malnutrition (Eteh et al., 2024; Soma, 2024). Programmes must be co-designed with communities, recognising indigenous knowledge of the river's rhythms. Tailored public health education is also essential to inform communities about altered disease risks associated with new hydrological patterns (Allen, 2024; Amoo et al., 2025).

In conclusion, these recommendations advocate for the systemic integration of health foresight into water governance. By mandating HIAs, creating dedicated funding and institutions, deploying

community-centric technology, and supporting livelihood adaptation, policymakers can ensure hydrological development does not come at an untenable cost to the health of the basin's most vulnerable populations.

DISCUSSION

The discussion synthesises evidence that dam construction in the Niger River Basin significantly alters local hydrology and socio-ecological systems, with profound and often adverse implications for public health in downstream communities (Amoo et al., 2025). The primary pathways linking these hydrological changes to health outcomes are the proliferation of water-borne and vector-borne diseases, and the disruption of livelihoods and food security (Allen, 2024; Eteh et al., 2024). For instance, altered flow regimes and stagnant water bodies near dams create ideal breeding habitats for mosquitoes, exacerbating malaria transmission, and for intermediate hosts of schistosomiasis (Soma, 2024; Yan, 2024). Concurrently, modified flood patterns and river sedimentation can compromise agricultural and fishing yields, leading to nutritional deficiencies that compound disease vulnerability (Olusola et al., 2024; Souley et al., 2025).

This analysis identifies a critical policy gap: existing water resource management frameworks in the basin, such as the Niger Basin Authority's shared vision, predominantly prioritise energy and agricultural objectives while treating health impacts as externalities (Coulibaly et al., 2025; Nidup & Dorji, 2024). The synthesis of policy documents reveals a lack of mandatory health impact assessments integrated into dam planning and operational protocols. This institutional omission explains the recurrent pattern of downstream health crises following dam projects, as seen in localised outbreaks of water-associated diseases and documented declines in community nutritional status (Akinnubi et al., 2024; Mahamadou Yacouba et al., 2025).

The findings underscore that the severity of health outcomes is not merely a hydrological issue but is mediated by socio-economic vulnerability (Coulibaly et al., 2025). Communities with limited adaptive capacity, often those already experiencing poverty and inadequate healthcare access, bear the greatest burden (Brachet, 2025; Musa et al., 2025). Therefore, the contextual divergence noted in some literature often stems from varying degrees of community resilience and the presence or absence of compensatory public health interventions (Deroo, 2025; Maliki et al., 2025).

Consequently, the proposed policy recommendations—specifically, the institutionalisation of intersectoral 'One Health' committees and the legal mandate for post-implementation health surveillance—are directly justified by this analysis (Amoo et al., 2025; Ndahiro, 2025). Without such integrative governance mechanisms that explicitly link water management to health protection, the cycle of infrastructural development inadvertently undermining public health in the Niger Basin will likely persist (Liu et al., 2025; Yang et al., 2025).

CONCLUSION

This policy analysis has elucidated a critical governance gap in the Niger River Basin: the systemic failure to integrate downstream health safeguards into the planning and operation of hydrological

infrastructure (AA et al., 2025; Souley et al., 2025). The prevailing policy paradigm remains overwhelmingly reactive, addressing health crises only after they manifest within communities already burdened by poverty and climate vulnerability (Musa et al., 2025; Ndahiro, 2025). The findings underscore that dam projects function as complex socio-ecological interventions which recalibrate the foundations of community health by altering flow regimes, water quality, and vector habitats (Olusola et al., 2024; Yang et al., 2025). This necessitates a fundamental shift towards health-promoting water development, where public health is a primary design criterion.

The evidence consolidated reveals that health impacts are synergistic. Altered hydrological conditions can exacerbate waterborne diseases and disrupt livelihoods, compounding nutritional insecurity (Coulibaly et al., 2025; Mahamadou Yacouba et al., 2025). These environmental stressors converge with profound social fragility, starkly illustrated by challenges in managing epidemics like diphtheria in insecure regions (Allen, 2024). The downstream health burden is thus a direct function of upstream policy decisions, highlighting a profound disconnect between hydrological and health governance spheres.

Within the West African context, this disconnect is particularly consequential. The Niger Basin is a vital lifeline, and its management is a matter of regional solidarity, especially under escalating climatic pressures which threaten drought severity and agricultural yields (Brachet, 2025; Eteh et al., 2024). A purely national or sectoral approach is inadequate. The transboundary nature of both water and disease necessitates a strengthened governance framework under the Niger Basin Authority, mandating cross-border health impact assessments and joint surveillance mechanisms (Amoo et al., 2025; Soma, 2024).

The practical pathway forward hinges on institutionalising two core principles: anticipation and integration. Policy instruments must evolve to mandate comprehensive Health Impact Assessments for all major water projects (Deroo, 2025). Furthermore, water allocation models must be explicitly coupled with health outcome indicators, ensuring dam release rules consider downstream sanitation needs and health-supporting ecosystem services (Liu et al., 2025; Maliki et al., 2025). This integrated approach aligns with calls for adaptation that centres local resilience and knowledge (Nidup & Dorji, 2024).

Future research must prioritise closing significant data gaps. Longitudinal, community-level epidemiological studies in downstream areas are urgently needed to quantitatively link hydrological changes with disease incidence (Akinnubi et al., 2024). Furthermore, research should explore gendered health impacts, considering how changes in water access disproportionately affect women's health (Maunde, 2025). Economic analyses quantifying the healthcare cost savings of preventive approaches would provide a powerful argument for upstream investment.

In conclusion, the imperative for Niger and its riparian neighbours is clear: to transform water resource development from a driver of health risk into a cornerstone of health promotion. This requires a deliberate reimagining of governance, where ministries of water, health, and environment operate in concert, guided by a shared ethic of stewardship. The health of the river and the populations it sustains are indivisible; recognising this symbiosis is the critical step towards a more equitable and resilient future for the basin.

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