DOMESTIC WASTEWATER MANAGEMENT AND ENVIRONMENTAL IMPACTS IN THE ZANZAN AND LYCÉE NEIGHBOURHOODS OF BONDOUKOU, CÔTE D'IVOIRE.

Abstract :

Against a backdrop of rapid and unplanned urbanisation, the management of domestic wastewater poses a major challenge for public health, environmental protection and the sustainable development of secondary towns in Côte d'Ivoire. This study analyses domestic wastewater management practices and their environmental and health impacts in the Zanzan and Lycée of Bondoukouneighbourhoods, where inadequate sanitation infrastructure encourages unregulated discharges and the deterioration of the living environment. The originality of this research lies in the integration of socio-environmental surveys, spatial analyses using GIS and a health risk assessment, with a view to proposing a decision-support approach for urban sanitation planning. The study aims to analyse domestic wastewater management in the Zanzan and Lycée de Bondoukouneighbourhoods. It involves identifying drainage methods, assessing their environmental and health impacts, and then proposing sustainable solutions. The methodology adopted combines a literature review, interviews, a survey of 200 households (100 per neighbourhood) conducted using KoboCollect, field observations and mapping using QGIS. The results show that only 33 % of households in Zanzan and 7 % in Lycée have a drainage system, whilst the majority of wastewater is discharged into the streets (57 % in Zanzan and 53 % in Lycée). This situation contributes to water stagnation, pollution, unpleasant odours and the proliferation of breeding sites. Malaria is the most frequently cited health impact, followed by tuberculosis. Furthermore, 77 % of households have not received any awareness-raising. The results demonstrate the value of decentralised approaches combining appropriate infrastructure, community awareness-raising and geospatial tools to guide urban sanitation policies. This approach, which can be replicated in secondary African cities, provides operational recommendations that contribute to the achievement of Sustainable Development Goals 3, 6 and 11.

Keywords: Domestic wastewater, sanitation, health impacts, malaria, septic tanks, urbanisation, SDGs, Bondoukou.

Introduction

Worldwide, the lack of adequate sanitation has major economic and environmental consequences. A World Bank study (Water and Sanitation Program, 2012) found that 18

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African countries lose USD 5.5 billion annually because of inadequate sanitation, equivalent to 1–2.5% of their GDP. In Côte d'Ivoire, the shortage of water collection and drainage infrastructure is a major challenge for the sustainable management of water resources and territorial development. This is the case in Bondoukou, located in the north-eastern part of Côte d'Ivoire, near the Ghanaian border. The gap between global ambitions and conditions on the ground in Bondoukou is widened by the lack of a structured drainage network amid rapid urbanisation. Bondoukou is an important geographical crossroads between the southern forest zone and the northern savannahs. Its growth has been driven by its administrative, commercial and university functions. According to the 2021 General Population and Housing Census (RGPH, 2021), its population was estimated at approximately 102,590 in 2021 and had risen to 122,309 by 2025, with a density of around 4,928 inhabitants/km². This rapid population growth has led to the emergence of new peripheral neighbourhoods through spontaneous, unplanned land occupation. The Zanzan and Lycée neighbourhoods are examples: they have become more densely populated without adequate sanitation infrastructure. The economic vulnerability of many households, whose livelihoods are mainly in the informal sector and agriculture, limits investment in compliant on-site systems (properly designed septic tanks and improved latrines). In addition, during the rainy season, the local drainage network receives substantial volumes of untreated effluent, exacerbating environmental pollution and health risks for nearby residents. The research question is therefore: to what extent do current domestic wastewater management practices in Zanzan and Lycée hinder progress towards Sustainable Development Goals (SDGs) 3, 6 and 11, and what planning measures could reverse the deterioration of the urban environment?

The overall objective is to analyse domestic wastewater management and its environmental and health impacts in the Zanzan and Lycée neighbourhoods. Specifically, the study seeks to identify wastewater management practices, analyse their environmental and health impacts, and propose sustainable planning measures.

Materials and methods

Description of the study area

Bondoukou is located approximately 425 kilometres from Abidjan. As the capital of the Gontougo Region, the town covers an area of 28.73 km². The Zanzan and Lycée neighbourhoods investigated in this study lie between northings 886,000 and 892,000 m and westings 517,000 and 526,500 m. They are located in the central part of the urban area, to the west of Bondoukou (Figure 1).

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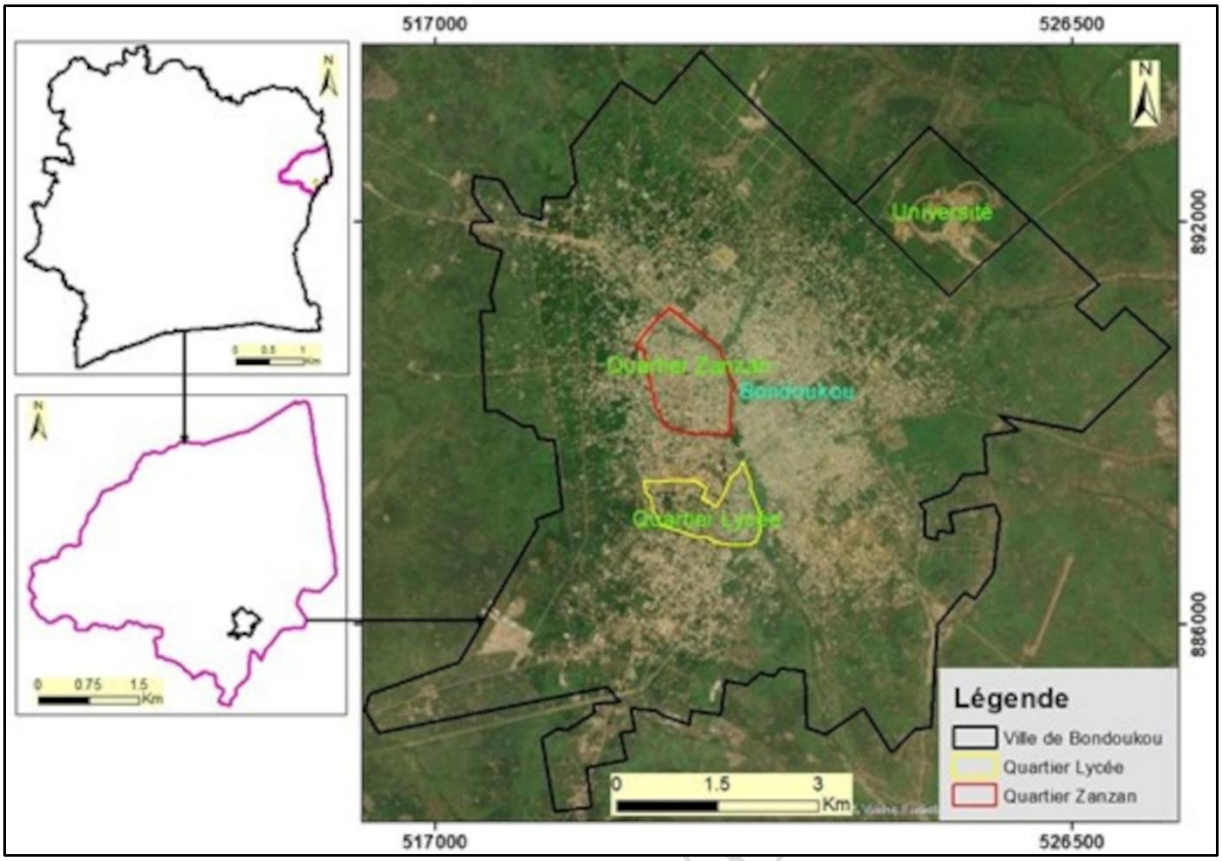


Figure 1: Location of the Zanzan and Lycée neighbourhoods of Bondoukou
Source: Konin, 2026

Materials

The materials used included digital tools: KoboToolbox and KoboCollect for creating and managing digital questionnaires and collecting georeferenced field data; QGIS and Google Earth Pro for mapping and spatial visualisation of the study area; and a digital camera to photograph sanitation conditions in the field. The datasets used included a Digital Elevation Model (DEM) to produce the location map, an interview guide to collect institutional information, and a questionnaire for the household survey.

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Methods

The approach comprised two stages. The first involved an extensive literature review of scientific publications, reports by international organisations (WHO, UN-Habitat, the World Bank and UNICEF), and recent academic research, consulted mainly through Google Scholar and HAL. This stage established the study's theoretical and conceptual framework, identified relevant indicators, and situated the local issue within the wider context of sanitation challenges in sub-Saharan Africa.

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The second stage involved field data collection. An interview guide was administered to the Regional Directorate for the Environment and the Municipal Technical Director, and a questionnaire was administered to 200 households, comprising 100 households in each neighbourhood, to characterise wastewater disposal practices and household health profiles. Direct observations of wastewater discharge points were also carried out and photographs were taken.

Results

Institutional interviews

Domestic wastewater management

The organisations involved in domestic wastewater management are the Regional Directorate for the Environment and the Technical Department of Bondoukou Town Council. The interviews revealed inadequate domestic wastewater management infrastructure, particularly open drainage channels. This may be attributable to population growth, rapid urbanisation and low levels of investment. The lack of infrastructure can lead to stagnant water and poor drainage, pollution of soil and water resources, the proliferation of disease vectors, increased flood risk and deterioration of living conditions.

Reported health impacts

The findings identify malaria as the most frequently observed health impact in the Lycée and Zanzanneighbourhoods. Tuberculosis, unpleasant odours and, in some cases, deaths associated with pits were also reported.

Measures to prevent and reduce health impacts

The stakeholders consulted reported several hygiene, sanitation and awareness-raising activities implemented in the two neighbourhoods. These included public awareness sessions on good hygiene and sanitation practices, waste management, and the daily cleaning of neighbourhoods. Such activities help maintain a healthy environment, limit the proliferation of disease vectors and reduce health risks associated with poor sanitation.

Household survey

Socio-demographic profile

The survey respondents comprised 63% women and 37% men in Zanzan, and 57% women and 43% men in Lycée.

Household size is shown in Figure 2. In Lycée, five-person households were the most common, accounting for 27%, while two-person households accounted for 20%. In Zanzan, households comprising three or six people were most common, each representing 20%.

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Modern housing predominates in both neighbourhoods (77% in Zanzan and 73% in Lycée). Semi-modern housing accounts for 17% in Zanzan and 27% in Lycée. Traditional housing represents 7% in Zanzan, whereas none was recorded in Lycée.

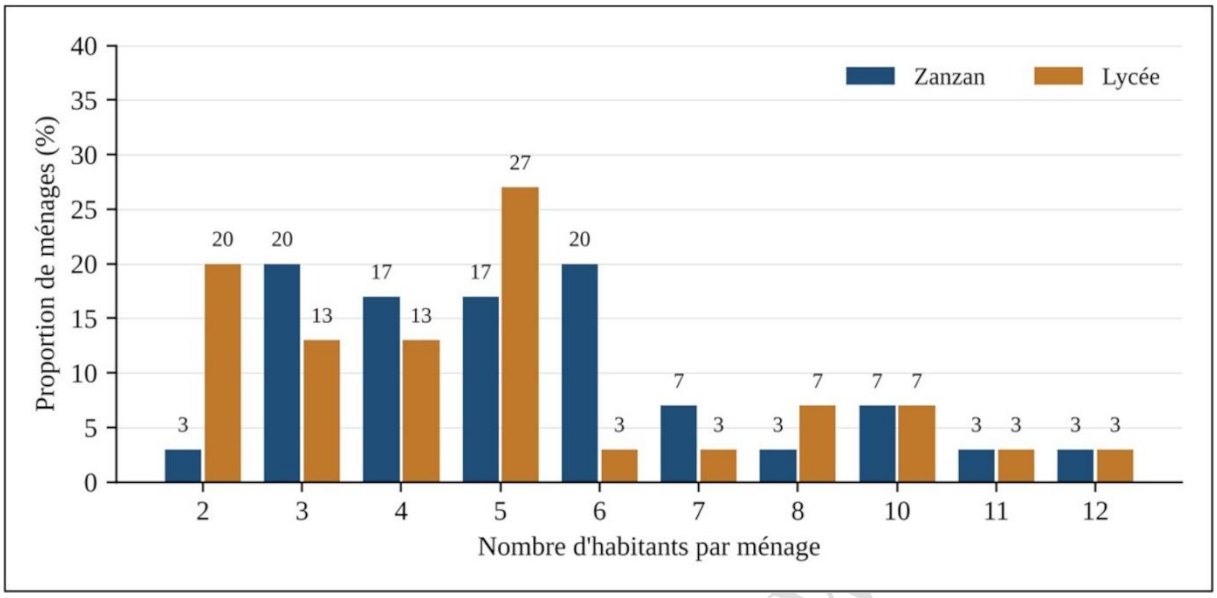


Figure 2: Household size (number of occupants) in the Zanzan and Lycée neighbourhoods
Source: Field survey, 2026

Sources of drinking water

The Zanzan and Lycée neighbourhoods have access to tap water, boreholes and wells (Figure 3). Tap water is the main source used in both neighbourhoods (93%). Well water is used by 13% of households in Zanzan, compared with 30% in Lycée. Borehole water is used by 13% of households in Zanzan and 17% in Lycée.

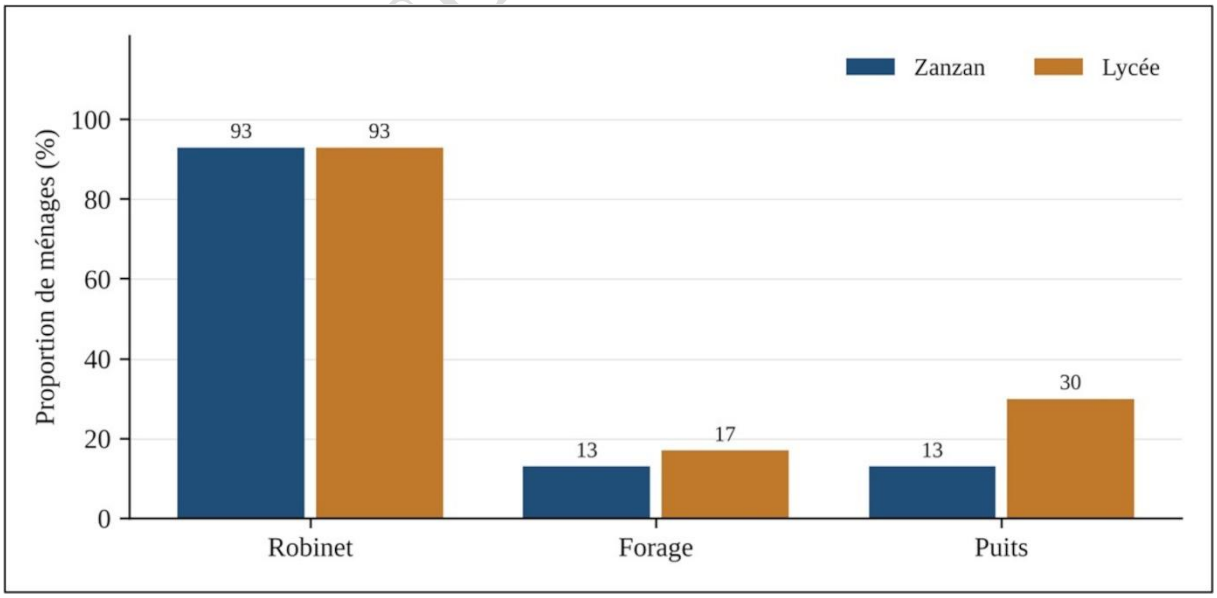


Figure 3: Main water source in the Zanzan and Lycée neighbourhoods
Source: Field survey, 2026

Stormwater drainage methods

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In Zanzan and Lycée, 33% and 7% of households, respectively, have a water drainage system (Figure 4). These systems are functional in 50% of cases in Zanzan and 100% of cases in Lycée.

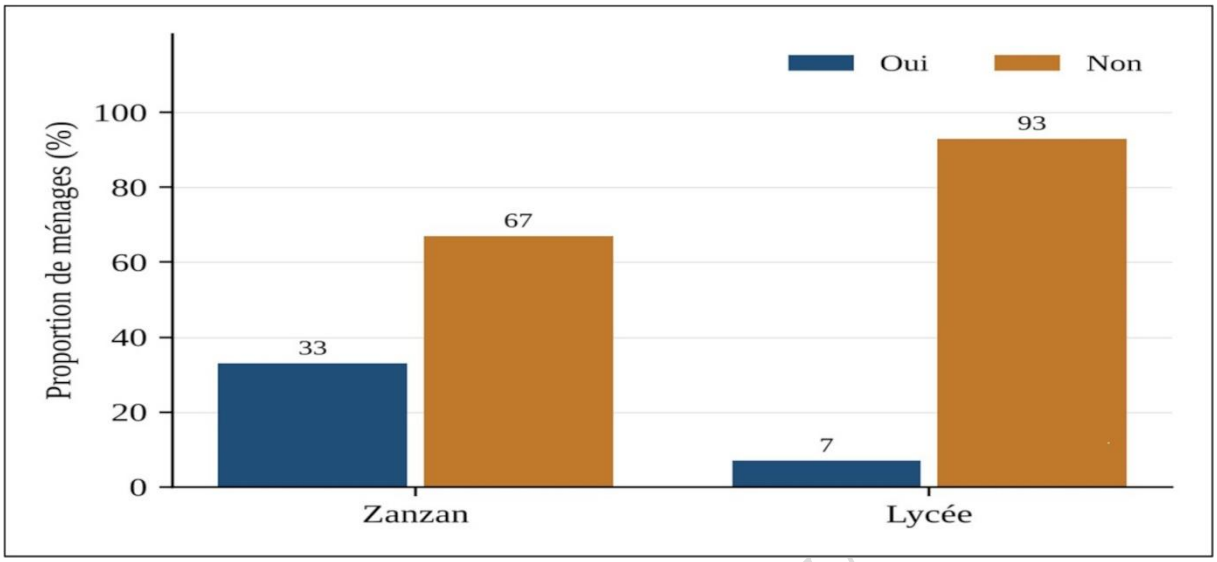


Figure 4: Households with a water drainage system
Source: Field survey, 2026

Domestic wastewater management practices

The most frequently reported discharge location for domestic wastewater is the street, accounting for 57% in Zanzan and 53% in Lycée (Figure 5). Septic tanks are used by 13% of households in Zanzan and 27% in Lycée. Drainage channels are used by 20% in Zanzan and 13% in Lycée.

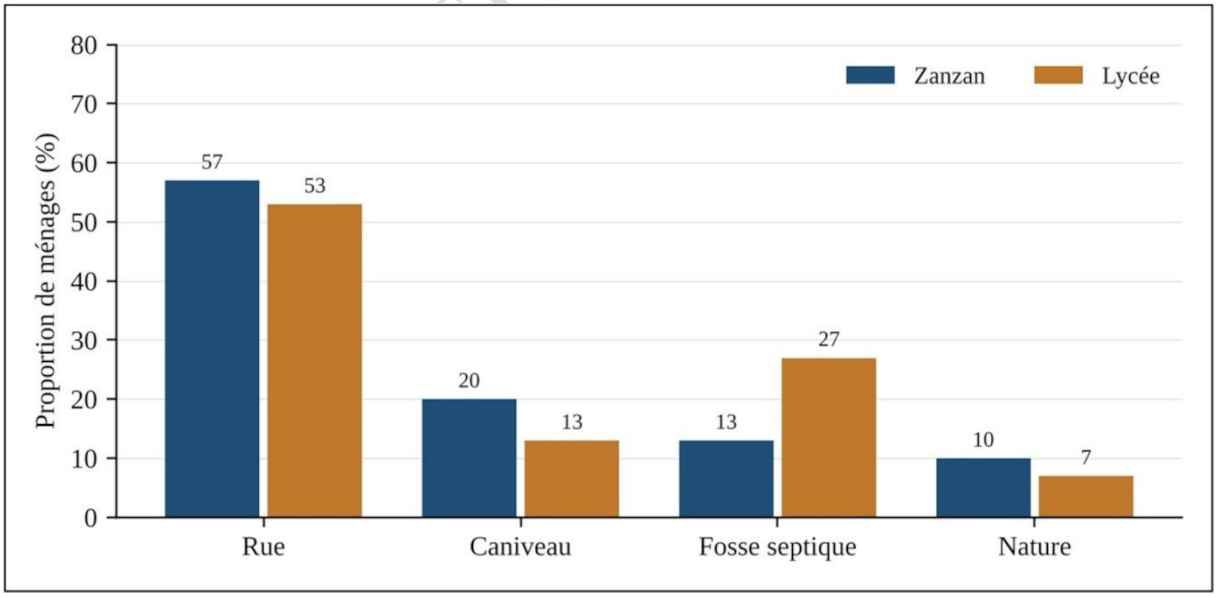


Figure 5: Domestic wastewater discharge locations
Source: Field survey, 2026

Impacts associated with domestic wastewater discharge

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In Zanzan, 20% of respondents reported problems associated with domestic wastewater discharge, compared with 40% in Lycée (Figure 6). In both neighbourhoods, the problems reported were stagnant water, water pollution and unpleasant odours.

In Zanzan, respondents did not report any water-related diseases. By contrast, 43% of respondents in Lycée reported the presence of water-related diseases, such as malaria. In addition, 77% of residents in both neighbourhoods stated that they had not received any sanitation awareness-raising.

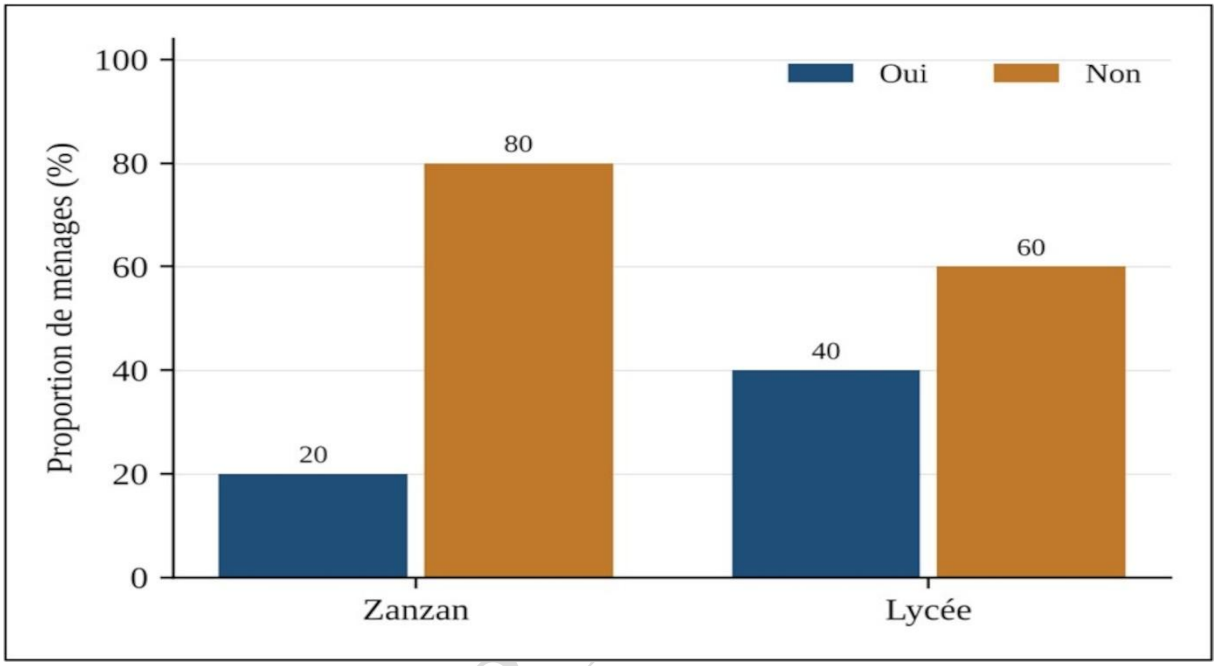


Figure 6: Households reporting problems associated with domestic wastewater discharge

Source: Field survey, 2026

Priority areas for improving the sanitation system

In both Zanzan and Lycée, 87% of residents want the sanitation system to be improved. Infrastructure is the main priority, cited by 62% of respondents in Zanzan and 65% in Lycée (Figure 8). In Zanzan, awareness-raising and waste management were each cited by 19%; in Lycée, awareness-raising was cited by 23% and waste management by 12%.

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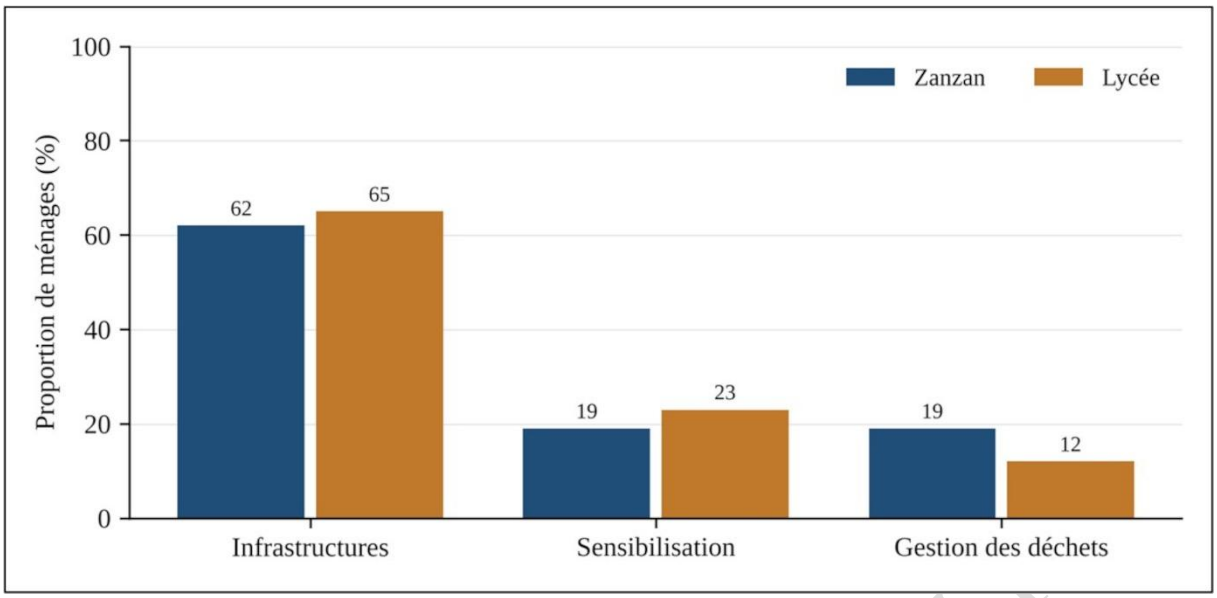


Figure 8: Priority components for improving the sanitation system
Source: Field survey, 2026

Main challenges

The challenges associated with domestic wastewater management fall into three interdependent categories:

Structural: inadequate infrastructure, particularly in peri-urban areas where access to a centralised sewerage network remains limited (identified as a priority by 62–65% of residents).

Economic: insufficient financial resources to build, maintain and adopt technical solutions.

Behavioural: household practices, including uncontrolled discharge and inadequate maintenance, which worsen the situation.

These mutually reinforcing constraints support a shift towards decentralised systems (septic tanks and soakaway pits) rather than waiting for a centralised network that may be unrealistic to provide, in line with international WASH recommendations.

Discussion

The findings reveal a structurally deficient domestic sanitation situation in the Zanzan and Lycée neighbourhoods of Bondoukou. This is characterised by low coverage of functional drainage systems (33% in Zanzan and 7% in Lycée), the predominant discharge of wastewater into streets (57% and 53%, respectively), and clearly identified environmental and health impacts, particularly stagnant water, pollution and malaria. These findings reflect a pattern widely documented in secondary towns and peri-urban neighbourhoods in West Africa, where

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rapid, unplanned urbanisation, insufficient public investment and informal wastewater management practices combine to create persistent health risks.

Inadequate infrastructure and discharge practices

Institutional interviews and household surveys consistently highlight the weakness of drainage facilities. The predominant discharge of wastewater into streets and open drains encourages stagnation, contamination of soil and groundwater, and the formation of mosquito breeding sites. These findings are consistent with those of Dongo et al. (2008, 2010) in disadvantaged neighbourhoods of Yopougon, Abidjan, where the lack of suitable networks and the use of public spaces for wastewater discharge expose residents to sanitation-related diseases, particularly malaria and diarrhoeal diseases. Similarly, Coulibaly (2024) reported that 68.63% of laundry and dishwashing wastewater was discharged into streets in Bromakoté, Bouaflé, alongside a high reported prevalence of malaria (69%). These similarities indicate that Zanzan and Lycée illustrate a recurring pattern of informal wastewater management in Ivorian secondary towns, where centralised sewerage networks are inaccessible or non-existent.

At regional level, the WHO/UNICEF Joint Monitoring Programme (2023) reports that only 31% of Africa's population had access to safely managed sanitation in 2022. Achieving universal coverage by 2030 would require a considerable acceleration in progress (a 23-fold increase for safely managed sanitation). In this context, the widespread discharge of wastewater into the open environment or stormwater networks observed in Bondoukou reflects structural failures described by Ouattara et al. (2023) in Abidjan's sanitation systems and more broadly in sub-Saharan Africa, including illegal dumping of solid waste into drains, unauthorised connections, ageing infrastructure and inappropriate household practices.

Health impacts and risk perception

Malaria was the health impact most frequently cited by both institutional stakeholders and households (43% of respondents in Lycée reported water-related diseases). This association is biologically plausible and widely documented. Stagnant water in open drains and streets provides suitable larval habitats for Anopheles gambiae sensulato, a major malaria vector in sub-Saharan Africa (Castro et al., 2010; Fillinger et al., 2010). Studies in Dar es Salaam, Tanzania, found that drains accounted for 42% of aquatic habitats and contained a substantial proportion of sites positive for Anopheles and culicine larvae; stagnant drains were 8.8 times more likely to contain Anopheles than normally flowing drains. Recent reviews of urban malaria in sub-Saharan Africa confirm that unplanned urbanisation, ineffective drainage and human-made stagnant water can increase transmission (Doumbe-Belisse et al., 2021).

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Tuberculosis, unpleasant odours and risks associated with non-compliant pits, as mentioned by institutional stakeholders, are also among the nuisances associated with poor sanitation. The absence of reported water-related diseases in Zanzan, despite comparable sanitation conditions, may reflect under-reporting, differences in perception or differences in exposure. This intra-urban variation warrants further epidemiological investigation combining health surveillance data with environmental indicators.

The low level of awareness (77% of households in both neighbourhoods had received no awareness-raising) is a major obstacle to adopting good hygiene practices. Existing activities, including awareness sessions and daily cleaning, are positive, but their coverage remains insufficient given the scale of the problem. WHO (2018) emphasises that sustainable improvements in sanitation depend on combining infrastructure, behavioural change, service management and governance?

Community priorities and structural challenges

Nearly 87% of residents support improvements to the sanitation system. Infrastructure ranks first among their priorities (62–65%), followed by awareness-raising and waste management. This ranking is consistent with the integrated approach promoted by WHO and UNICEF, which recognises that technical solutions alone, without behavioural and institutional support, struggle to deliver lasting results. The main constraints identified—limited financial resources, inadequate infrastructure and household practices—are consistent with structural factors frequently reported in African urban and peri-urban areas (WHO/UNICEF, 2023; Ouattara et al., 2023).

Rather than waiting for a centralised network, which is often costly and takes a long time to implement in secondary-town neighbourhoods, the findings support a gradual strategy based on suitable decentralised solutions: compliant septic tanks; properly designed soakaway pits where hydrogeological conditions permit; and improved latrines combined with regular emptying and faecal sludge management. This approach is consistent with the direction of the National Office for Sanitation and Drainage (ONAD) and national programmes to establish faecal sludge treatment plants, for which Bondoukou is listed as a priority site.

Implications, limitations and prospects

These findings confirm that inadequate domestic sanitation in Bondoukou is not merely a technical problem; it is a social determinant of health closely linked to rapid urbanisation and unequal access to basic services. Differences between Zanzan and Lycée (a higher rate of reported problems in Lycée and a higher proportion of septic tanks there) highlight intra-urban variation that should be considered when targeting interventions.

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The study's limitations include the self-reported nature of household data (recall and social desirability bias), the relatively small sample, the absence of quantified contamination measurements (microbiological indicators in water and soil), and the lack of longitudinal data on the actual incidence of disease. Further research combining socio-behavioural surveys, environmental analyses and public health data would help quantify more precisely the relationships between sanitation practices and health impacts.

Conclusion

The findings clearly demonstrate the urgent need to improve domestic wastewater management in the Zanzan and Lycée neighbourhoods of Bondoukou. Despite the predominance of modern housing and widespread access to piped water, inadequate drainage systems, the predominant discharge of wastewater into streets and low levels of awareness perpetuate a vicious cycle of stagnant water, pollution and health risks. Malaria, tuberculosis and unpleasant odours were among the impacts most frequently reported, confirming the close link between poor sanitation, deteriorating public health and declining living conditions.

These findings call for an integrated approach combining appropriate infrastructure, behavioural change and stronger local governance. Such a strategy is essential to reduce health risks, sustainably improve residents' living conditions and contribute to the Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities), in Ivorian secondary towns.

In the short term, priority should be given to a large-scale door-to-door and community awareness campaign on the health risks associated with wastewater discharge and on good hygiene and sanitation practices. In the medium term, households should be encouraged and supported, technically and potentially financially, to build compliant septic tanks and properly designed soakaway pits. In the longer term, the Zanzan and Lycée neighbourhoods should be incorporated into a municipal urban sanitation project led by the Town Council in collaboration with the Regional Directorate for the Environment and the Ministry of Construction. Finally, establishing a local monitoring committee involving local authorities, community leaders and residents would help ensure that actions are sustained and construction standards are respected.

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