

Supporting health systems and environment in the Democratic Republic of Congo: A call for action

Innocent Mufungizi^{1,2,3,4}  | Inibehe Okon^{3,5}  | Mwangaza Nkundakozeza³  | Aymar Akilimali^{3,6} 

¹Faculty of Sciences and Technologies, University of Kinshasa, Kinshasa, DR Congo

²LeGeolog Research Team, Kinshasa, DR Congo

³Department of Research, Medical Research Circle (MedReC), Bukavu, DR Congo

⁴Geographical Institute of Congo, Kinshasa, DR Congo

⁵College of Medicine, University of Uyo, Akwa Ibom, Nigeria

⁶The Marine Biological Association (MBA), Plymouth, UK

Correspondence

Innocent Mufungizi, Faculty of Sciences and Technologies, University of Kinshasa, Kinshasa, DR Congo.
Email: mufungiziinm@gmail.com

Abstract

Background: Developing nations have to overcome a number of obstacles to fulfill the Sustainable Development Goals. The Democratic Republic of Congo is one of the five poorest nations in the world and faces several challenges in combating problems related to poverty, health, and sanitation while linking the environment to anthropogenic activities.

Methods: This study analyzes anthropogenic activities and their impact on the environment while providing access to the public health of the Congolese population based on the objectives of sustainable development. Thirty-five articles were selected for further analysis as well as relative data.

Results: In 2022, 21 million cases of malaria were recorded by the national malaria control program, with 13,000 cases of death. The Democratic Republic of Congo has the highest typhoid incidence, with 315 cases per 100,000 people. A number of 31,342 cases of cholera were reported in 2023, according to multiple reports, with 230 deaths, mainly affecting children. In the same year, a triple epidemic of typhoid, shigellosis, and cholera was identified, with 2389 cases and 52 deaths. These observations cause a health emergency, which can be alleviated and resolved by the establishment of an adequate sanitation system. Waste can be recycled and returned to usable raw materials.

Conclusion: Finally, it will be necessary to establish a water safety management plan to combat all diseases linked to the consumption of nonpotable water and improve national coverage on the treatment of recent cases to reduce and at best avoid observed cases of death.

KEYWORDS

anthropogenic activities, developing countries, liquid waste, public health, recycling, solid waste

1 | INTRODUCTION

The 17 Sustainable Development Goals (SDGs) are designed to enhance development at the national, regional, continental, and international levels. Sustainable economic growth is the goal of SDG 8, whereas excellent health and well-being for all ages is the objective of SDG 3. However, advancement may be hampered by poverty and inequality in Africa. The inability to fulfill SDGs 8 and 3 is a result of issues with health dynamics, the lack of human capital in the healthcare sector, the nondiversification of the economy, corruption, and conflict, all of which have an impact on SDG 6, specifically.^{1,2} The 2030 Agenda's 17 objectives are connected and indispensable. An SDG cannot be successfully achieved unless its links with the other 16 are considered. As a result, each SDG influences the others either directly or indirectly (Figure 1).^{3,4}

The Democratic Republic of Congo (DR Congo) is experiencing a problem with the sixth Sustainable Development Goal, which is access to drinking water, sanitation, and hygiene, the most fundamental human need for health and well-being, the latter directly affecting SDG 3.⁵ Thirty-three million people live in rural parts of the DR Congo, which possesses more than 50% of the water reserves on the African continent. Despite this enormous potential, 33 million people lack access to clean

water. Only 52% of people have access to improved water sources, and only 29% have improved sanitary facilities, despite ongoing efforts.⁶

In pursuit of sustainable development goals, the DR Congo has been dedicated to fostering progress through strategic initiatives. In 2001, the country embraced the Management for Development Results approach, and in 2015, it further solidified its commitment by formulating the National Strategic Development Plan. This comprehensive plan sets forth ambitious objectives, targeting a 5-year span from 2019 to 2023.⁷ The outlined objectives within the National Strategic Development Plan emphasize crucial aspects such as enhancing access to health services, ensuring the availability of clean drinking water, improving sanitation, and addressing social inequalities. This strategic focus arises from the unique challenges faced by the DR Congo, characterized by a fragile and undiversified economy and a health system frequently disrupted by various epidemics of tropical diseases. In the face of these challenges, a noteworthy trend has emerged where the populace, grappling with inadequate healthcare access, tends to resort to self-medication. Additionally, a significant number of childbirths occur at home, contributing to a rise in maternal and fetal mortality rates.

As the initial 5-year period draws to a close, it becomes evident that the balance sheet leans toward the negative spectrum. Despite

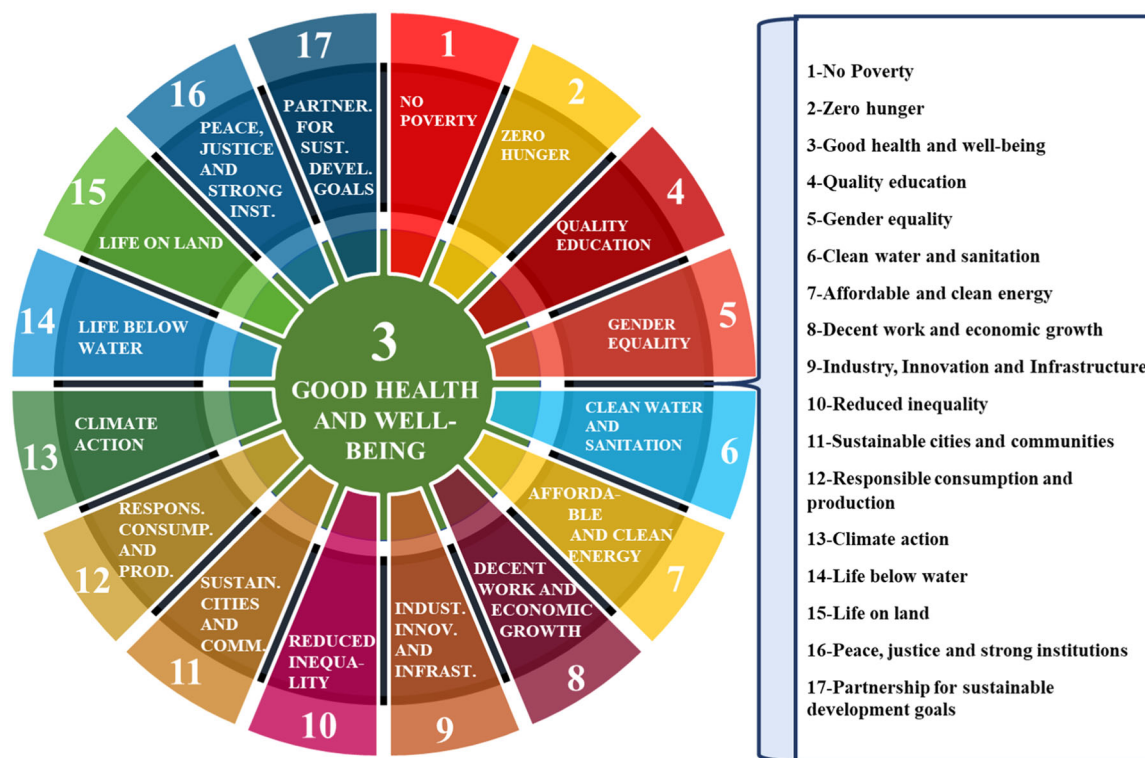


FIGURE 1 Illustration of the interaction of SDG 3 with the other SDGs and their contributions to improving health and well-being. This figure emphasizes the importance of prioritizing the health needs of the poor (SDG 1), addressing malnutrition (SDG 2), allowing to lead a healthy life and well-being (SDG 3), promoting education (SDG 4), fighting gender-based injustices (SDG 5), ensuring clean water and sanitation (SDG 6), using renewable energy (SDG 7), fostering healthy employment (SDG 8), developing national resources for medical production (SDG 9), achieving universal health coverage (SDG 10), promoting urbanization (SDG 11), preventing antibiotic resistance (SDG 12), defending health against climate threats (SDG 13), resurging fish populations (SDG 14), creating a healthy environment (SDG 15), providing local organizations with resources (SDG 16), and organizing partners to track and achieve the Sustainable Development Goals (SDG 17).^{3,4}

the initial objectives set in 2015, challenges persist in achieving sustainable improvements in health, water access, sanitation, and the reduction of social disparities.

This study examines the relationship between the environment and public health in DR Congo, emphasizing both the evident public health issues that arise from these living circumstances and the living situations of Congolese people who confront environmental and economic challenges. The multifaceted issues, including economic fragility, health system vulnerabilities, and prevailing cultural practices affecting healthcare-seeking behavior, have hindered the envisioned progress. This shows the urgency and importance of evaluating the current state of affairs in DR Congo, reflecting on the barriers to achieving the outlined objectives, and formulating targeted strategies to overcome the persistent challenges. It also sets the stage for a comprehensive analysis of the factors contributing to the perceived negative balance sheet, providing a foundation for potential interventions and policy adjustments needed to propel DR Congo toward a trajectory of positive development outcomes.

2 | METHODS

The research question arose from observations made during solid and liquid waste mapping projects in certain cities in the country and the daily lives of the Congolese. The six specific keywords (Developing countries, Solid waste, Liquid waste, Recycling, Public health, Anthropogenic activities) were submitted to a list and analyzed from the literature of scientific databases such as PubMed–Medline, and Google Scholar, as well as the official links of the World Health

Organization (WHO), the World Bank, the United Nations, and Médecins Sans Frontières. Due to the perspective nature of this article, all types of peer-reviewed articles, including original research, systematic reviews, and meta-analyses, were considered. Among all the articles, in accordance with the inclusion criteria, we selected 35 for further analysis and a narrative to be constructed.

We excluded studies that reported data and academic research that did not match the article's objective and keywords. The reference lists of the included studies were also hand-searched to identify additional relevant documents. Public health-related searches were characterized by PubMed-Medline; environmental studies were found through Google Scholar; reports directly related to the topic of this research were found through research on the WHO, World Bank, United Nations, and Médecin Sans Frontière websites. The data and observations made after the search and identification of studies were subsequently processed using Excel and Origin Pro statistical and analysis software and ArcGIS digital cartography software for the geographic distribution of detected cases. The flowchart presenting the methodological diagram is shown in Figure 2.

3 | ECONOMIC CHALLENGES AND LIVING CONDITIONS IN DR CONGO

According to the World Bank, the DR Congo was one of the economically poorest nations in the world; approximately 62% of its population, or more than 60 million inhabitants, lived on an income of

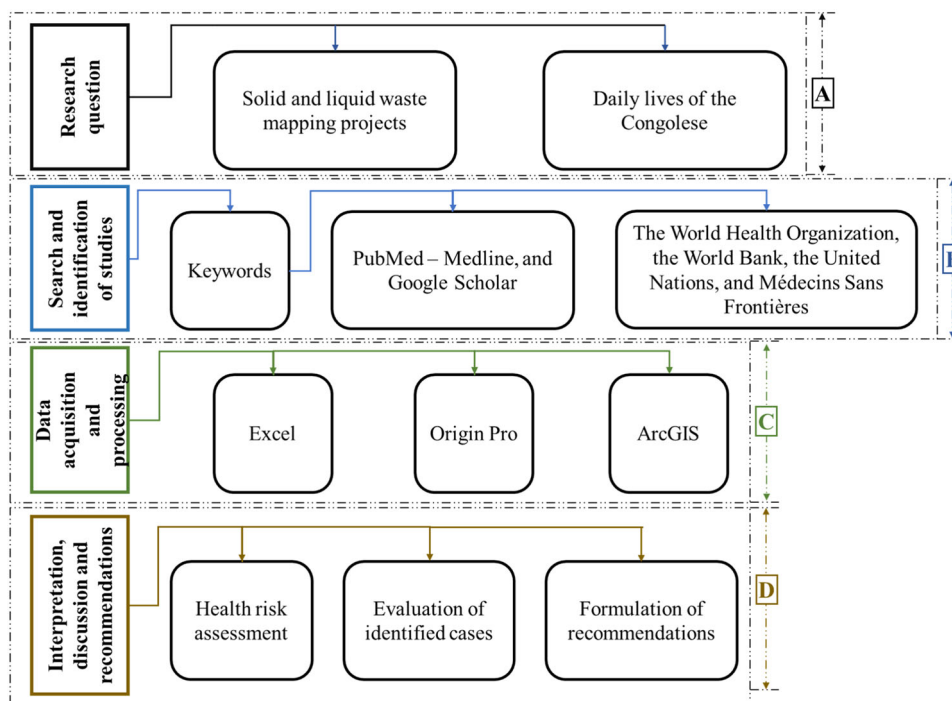


FIGURE 2 Flowchart presenting the work methodology. The first phase (A) concerns the research question; phase 2 (B) concerns the search and identification of studies; phase 3 (C) concerns data acquisition and processing; and finally, the last phase (D) concerns the interpretation, discussion, and recommendations.

less than 2.15 USD per day. These observations prove why access to health care services is very limited, as well as health coverage, which is very low.⁸ In fact, we observe, at the level of environmental management and biodiversity in the DR Congo, organic and inorganic waste, including plastics and metals, which are the cause of a major sanitation problem. Solid waste is categorized as follows: a cover of waste that appears as the spreading of waste on a surface; a pile of waste that appears as a cover on a given surface but which already begins to gain height; and finally, the wild waste site, which becomes a large mass over a large surface area with a significant height and is visible in most cases on satellite images. We therefore observe a high coverage of waste, a high number of piles of waste, and several wild wastes lacking any adequate management system.

Lacking the means to obtain drinking water, the Congolese people living in rural areas consume groundwater without any basic treatment. The same phenomenon is observed in urban areas, where the services of the DR Congo water distribution authority are not able to fully cover all cities. In certain cities, such as the capital (Kinshasa), part of the city is served by private and public water exploitation boreholes, and another part is served by water treatment plants intended for human consumption captured on the surface of watercourses. During water treatment, the distribution system focuses on clarification by adding aluminum sulfate, lime to balance the pH, and chlorine to eliminate bacteria.⁹ This treatment is not sufficient because several studies have shown the contamination of rivers where this water is captured by several other elements¹⁰⁻¹⁴ that the distribution authority cannot process because of the cost of processing. The Congolese population does not trust the water treated by the water distribution authority, which is the basis of a dangerous and uncontrolled practice called the use of chloroquine to treat water at home.

Self-medication is another phenomenon that has its roots in the issue of poverty. Many are compelled by their poverty to take their drugs without first visiting a doctor. The cost of treatment, a lack of resources and medical staff, the denigration of some illnesses, pharmacy salespeople's disregard for regulations, and public ignorance of the dangers of self-medication are additional practical reasons for self-medication.¹⁵⁻¹⁸

Aware of the problems of poverty and its impacts on access to essential health care, the Congolese government has placed emphasis on some of the objectives of sustainable development, including the third, which concerns good health and well-being; the sixth, concerning clean water and sanitation; and the tenth, which highlights the reduction of inequalities.¹⁹

4 | ENVIRONMENTAL ISSUES AND HEALTH-RELATED CHALLENGES

In certain areas and regions of the country, the DR Congo, household and industrial wastewater is not well channeled; it is directly discharged into the residence environments of the population, contaminating the groundwater and at the same time causing sources

of stagnant water, which constitutes a major health problem by allowing the development and reproduction of numerous disease-carrying insects. There is also a serious problem with access to public toilets. Some people relieve themselves easily in the river, which is unfortunately used to capture water, which is used to supply the water treatment plant intended for human consumption. This observation constitutes a very serious problem facing the health of the population.²⁰ Stagnant water causes the relative and absolute humidity of the soil, which has negative links with the progression of the epidemic of certain infectious diseases,²¹ but also the proliferation and reproduction of certain insects, which are vectors of diseases such as mosquitoes, a pathway directly towards malaria, which was recorded in 2021 with 95% of cases and 96% of deaths centralized in Africa.²² Data from the National Malaria Control Program report shown in Figure 3 show the cases of malaria recorded in 2021.²³

According to the national malaria control plan, the average proportion of suspected cases tested in 2020 and in 2021 is 85%.²³ The distribution of this proportion is presented in Figure 4 below:

According to data from the WHO report on malaria in the world in 2021, DR Congo is one of four countries in the Africa region that recorded almost half of the cases worldwide, with 26.6% for Nigeria, 12.3% for the DR Congo, 5.1% for Uganda, and 4.1% for Mozambique (Figure 5A).²⁴ Nigeria and the DR Congo occupied the first two places in terms of deaths per country due to malaria in the same year, with 31.3% and 16.6%, respectively (Figure 5B).²⁴

In 2022, statistics reported by the nongovernmental organization (NGO), Médecins Sans Frontières (MSF), citing the National Malaria Control Program, present malaria as the leading cause of mortality in the DRC, with more than 13,000 deaths out of a total of more than 21 million cases.²⁵

Several cases of typhoid fever are recorded each year, which are caused by bacterial infections due to contaminated water consumed in the region.²⁶ In 2020, 715,920 suspected cases of typhoid fever were reported, with 178 confirmed deaths. Throughout the DRC, 1,121,104 cases of typhoid were reported between January 1, 2021, and September 30, 2021, of which 19,734 were confirmed. As of right now, 411 typhoid-related deaths have occurred in the DRC.^{27,28} Updated estimates of the typhoid fever burden from six countries: Burkina Faso, DR Congo, Ethiopia, Ghana, Madagascar, and Nigeria are provided by ProMED's 4-year Severe Typhoid in Africa (SETA) initiative. It is considered a significant burden when four of these nations have more than 100 cases per 100,000 person-years of observation. The DRC has the greatest typhoid incidence, with 315 cases per 100,000 people; the highest prevalence is seen in children between the ages of 2 and 14.²⁷ Recurrent cases of cholera continue to increase due, in particular, to a lack of access to drinking water.²⁹ In the first 7 months of 2023, there were at least 31,342 suspected or confirmed cases of cholera reported nationwide, along with 230 deaths, many of which involved children. The Ministry of Public Health, Hygiene and Prevention reports that in the worst afflicted province, North Kivu, alone, there were over 21,400 confirmed or suspected cases, including over 8000 children under the age of five.³⁰

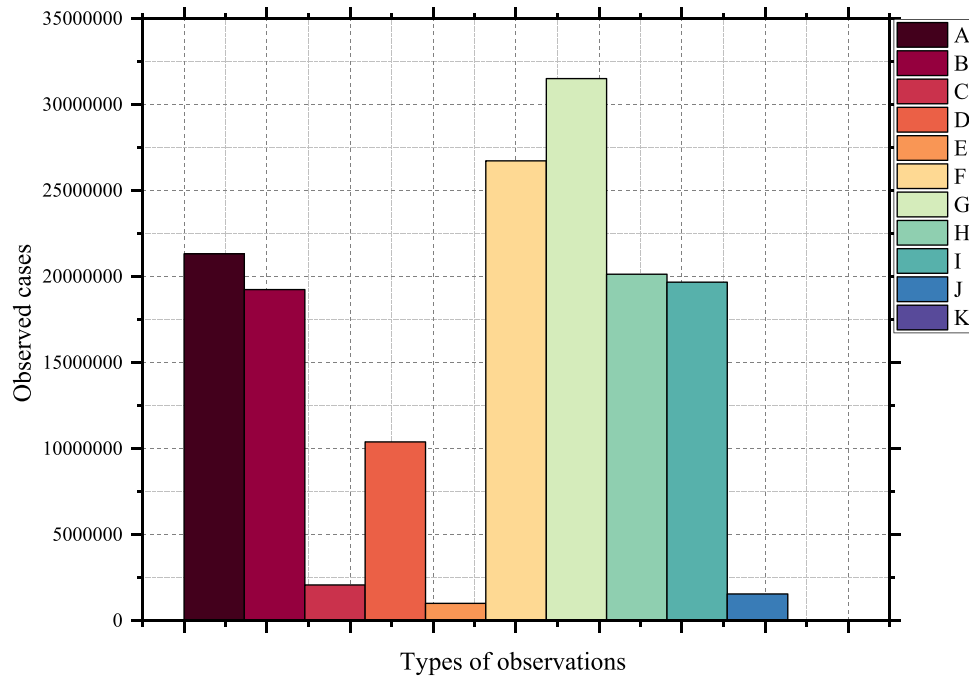


FIGURE 3 Observed cases of malaria recorded in 2021 by the National Malaria Control Program. With A: Malaria cases; B: Simple cases; C: Severe cases; D: Children under 5 years old; E: Severe cases among children under 5 years old; F: Suspected cases tested; G: Total suspected cases; H: Cases treated; I: Health facilities; J: Community health sites; and K: Death. Source data: Malaria control plan, available online at <https://www.undp.org/fr/drcongo/publications/plan-national-strategique-de-developpement>.

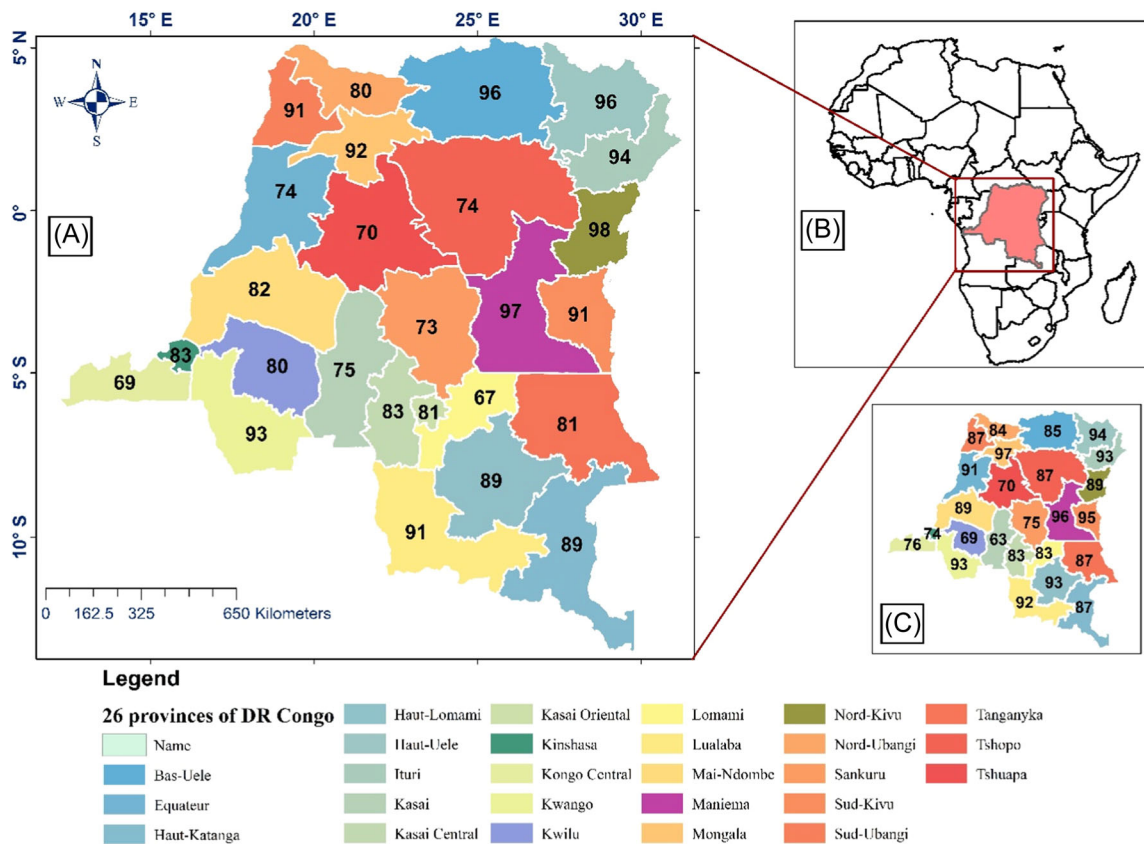


FIGURE 4 Distribution map of the proportions of suspected cases of malaria tested in the DR Congo in the 26 provinces, cases of 2021 (A) and 2020 (C) with a focus on the location map in Africa (B). The province of Maniema presents the highest proportion (97%), while the provinces of Lomami and Kongo Central present the lowest values (respectively 67% and 69%).²³ Source data: Malaria control plan, available online at <https://www.undp.org/fr/drcongo/publications/plan-national-strategique-de-developpement>.

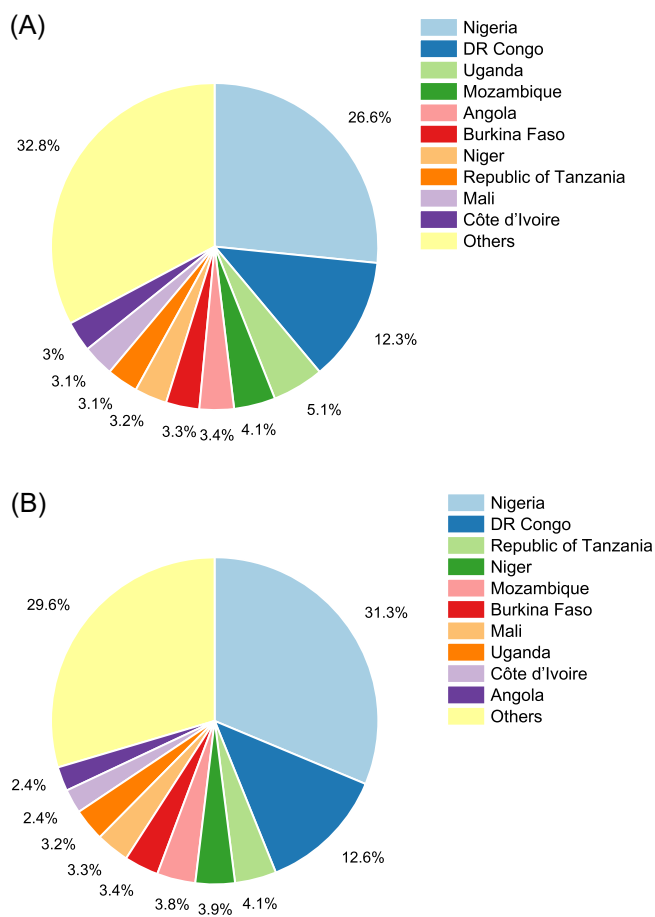


FIGURE 5 Percentage of malaria cases recorded worldwide in 2021 (A) and percentage of malaria deaths worldwide in 2021 (B).²⁴ Source data: Global Malaria Program, available online at <https://www.who.int/publications/m/item/WHO-UCN-GMP-2022.08>.

In 2023, the Ministry of Health and Population in the DR Congo declared a triple epidemic, which is considered gastroenteritis. On June 28, 2023, word of the epidemic's first case was received. There were 2389 suspected cases from this initial notice and August 29, 2023, of which 52 resulted in fatalities, for an overall case fatality rate of 2.2%. In 50.2% of these cases, typhoid fever was suspected, followed by shigellosis (46.9%) and cholera (2.9%).³¹

The following factors contribute to pollution of surface water and groundwater: industrial pollution,³² which comes from chemicals released by factories and industries, such as hydrocarbons and polychlorinated biphenyls; agricultural pollution,³³ which is caused by plant protection products/pesticides (herbicides, insecticides, fungicides) present in fertilizers and used in agriculture; domestic pollution,³⁴ which comes from wastewater from toilets, cleaning, or cosmetic products (laundry soaps, detergents), paints, solvents, used oils, and hydrocarbons; and accidental pollution,³⁵ which results in the unintentional release of toxic products into the environment.

In agricultural areas, several chemical inputs are used, such as chemical fertilizers, but are unfortunately not controlled. The most commonly used fertilizers are NPK (nitrates, phosphates, and nitrogen) and pesticides to increase agricultural production. These products

leach into the ground, contaminating the water.³⁶ In rural and urban areas, the population consumes groundwater, yet the latter is exposed to contamination not only of agricultural origin but also of mining origin by discharges during the hydrometallurgical treatment of ores. These discharges acidify the water and contaminate it with heavy metals and other toxic substances, which is a serious danger for the health of the population. In mining areas, there is also air pollution due to rock fragmentation and the circulation of heavy machinery. This dust is a danger to the breathing of the population living around mining areas.^{37,38} The problem of a lack of sanitation systems is the basis for the discharge of household wastewater into rivers, which contaminates them with fecal matter. These feces are removed during the treatment of water intended for human consumption during the disinfection phase with the addition of chlorine.³⁹ Unfortunately, due to the problem of access to drinking water, part of the population uses raw water without any basic treatment.

These major health problems that exist within the Congolese population constitute a health emergency, and the majority of these problems are preventable. So, to fight against these health problems, the steps to be taken must include both the Congolese government and its population. The government of the DR Congo, through its Ministry of Health; Ministry of Environment, and Ministry of

Agriculture, must draw up a water health security plan and respect it in all its terms, including respect for the protection perimeters of hydraulic structures for the exploitation of water intended for human consumption, the construction of public toilets that respect health standards, control of chemical inputs, monitoring of discharges from mining companies and processing industries, the sanitation of environments, and the construction of drains to channel wastewater, but also a system for treating this water before leaving it in nature for the protection of ecosystems.

5 | CONCLUSION AND RECOMMENDATIONS

In conclusion, addressing the pressing challenges faced by the DR Congo requires a comprehensive and collaborative approach from both the government and its citizens. This strategy starts upstream by educating the public about proper waste management practices, the dangers of drinking untreated groundwater, and the health risks associated with it. On the other hand, the government must assume responsibility by providing the infrastructure necessary to meet present needs, such as sanitation and the expansion of water treatment facilities meant for human consumption to address the issue of access to drinking water. Finally, the government must identify potential cases for support downstream. While the government, particularly through the Ministry of Health, plays a pivotal role in formulating and implementing health security plans, there are specific measures that can contribute significantly to the improvement of living conditions and overall well-being. A major aspect that demands attention is the promotion and support of small businesses engaged in plastic bottle and bag recycling. The Congolese state should set up a sewerage system in areas undergoing urbanization to facilitate the sanitation system with the aim of treating wastewater before it is released into nature. The construction of public toilets should also be encouraged with the aim of avoiding direct contamination of waterways by the population. Simultaneously, the importance of public awareness and education cannot be overstated. A concerted effort to educate the population on the proper management of organic and inorganic waste is essential. This involves raising awareness about the detrimental effects of improper waste disposal on public health and the environment. The collaboration between the government and the population is not only essential but also represents a shared responsibility in safeguarding the health and well-being of the Congolese people. The mitigation of the urgent health problems highlighted in this work must be taken on different levels, ranging from the elimination of the causes (waste management, treatment of contaminated water, reduction in the proliferation of disease-transmitting insects) to the care of cases tested with the aim of achieving a proportion of 100% treatment to reduce cases of death.

AUTHOR CONTRIBUTIONS

Innocent Mufungizi: Conceptualization; data curation; formal analysis; visualization; writing—original draft; writing—review & editing;

project administration; supervision; investigation; methodology; software; validation; funding acquisition; resources. **Inibehe Okon:** formal analysis; visualization; writing—original draft; writing—review & editing. **Mwangaza Nkundakozera:** writing—review & editing; writing—original draft; validation. **Aymar Akilimali:** writing—review & editing; writing—original draft; visualization; resources; project administration; supervision; conceptualization; validation; funding acquisition; methodology.

ACKNOWLEDGMENTS

The authors would like to thank the direction of research and the STAFF of Medical Research Circle (MedReC) from Democratic Republic of the Congo for the realization of this present paper. The authors declare that they did not receive any financial support for this work.

CONFLICT OF INTEREST STATEMENT

All authors have completed the ICMJE uniform disclosure form. The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data used for this work will be made available upon reasonable request from the corresponding author. The data that support the findings of this study are available from the corresponding author upon reasonable request.

TRANSPARENCY STATEMENT

The lead author Innocent Mufungizi affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Innocent Mufungizi  <http://orcid.org/0000-0001-7231-5456>

Inibehe Okon  <http://orcid.org/0009-0003-8275-5713>

Mwangaza Nkundakozera  <http://orcid.org/0000-0003-2361-3283>

Aymar Akilimali  <http://orcid.org/0000-0001-9393-1215>

REFERENCES

1. Cerf ME. The sustainable development goals: contextualizing Africa's economic and health landscape. *Global Challenges*. 2018;2:1800014. doi:10.1002/gch2.201800014
2. Bhattacharya R, Bose D. Energy and water: COVID-19 impacts and implications for interconnected sustainable development goals. *Environ Prog Sustainable Energy*. 2023;42(1):e14018. doi:10.1002/ep.14018
3. L'Agenda 2030 en France 2024. ODD3 - Donner aux individus les moyens de vivre une vie saine et promouvoir le bien-être à tous les âges, <https://www.agenda-2030.fr/17-objectifs-de-developpement-durable/article/odd3-donner-aux-individus-les-moyens-de-vivre-une-vie-saine-et-promouvoir-le?>
4. UN 2023 Water Conference 2015. Transforming our world: the 2030 Agenda for Sustainable Development. <https://sdgs.un.org/2030agenda#:~:text=We%20resolve%2C%20between%20now%20and,protection%20of%20the%20planet%20and>

5. UN2023. Objectifs de développement durable. <https://www.un.org/sustainabledevelopment/fr/water-and-sanitation/>
6. UNICEF2019. Accès à l'eau potable, l'hygiène et l'assainissement pour les communautés rurales et périurbaines de la République Démocratique du Congo. <https://www.unicef.org/drcongo/rapports/atlas-2018>
7. Democratic Republic of Congo (DR Congo). National Strategic Development Plan from 2019 to 2023; 2021. <https://www.undp.org/fr/drcongo/publications/plan-national-strat%C3%A9gique-de-d%C3%A9veloppement>
8. World Bank2023. Democratic Republic of Congo - Overview. <https://www.banquemondiale.org/fr/country/drc/overview#:~:text=La%20RDC%20est%20l'une,Afrique%20subsaharienne%20et%20en%20RDC>
9. Roccaro P, Mancini G, Vagliasindi FGA. Water intended for human consumption – part I: compliance with european water quality standards. *Desalination*. 2005;176(1-3):1-11. doi:10.1016/j.desal.2004.11.010
10. Kilunga PI, Kayembe JM, Laffite A, et al. The impact of hospital and urban wastewaters on the bacteriological contamination of the water resources in Kinshasa, democratic Republic of Congo. *J Environ Sci Health Part A*. 2016;51(12):1034-1042. doi:10.1080/10934529.2016.1198619
11. Kayembe JM, Thevenon F, Laffite A, et al. High levels of faecal contamination in drinking groundwater and recreational water due to poor sanitation, in the sub-rural neighbourhoods of Kinshasa, democratic republic of the Congo. *Int J Hyg Environ Health*. 2018;221(Issue 3):400-408. doi:10.1016/j.ijheh.2018.01.003
12. Bisimwa AM, Kisuya B, Kazadi ZM, Muhaya BB, Kankonda AB. Monitoring faecal contamination and relationship of physico-chemical variables with faecal indicator bacteria numbers in Bukavu surface waters, tributaries of Lake kivu in Democratic Republic of Congo. *Hyg Environ Health Adv*. 2022;3:100012. doi:10.1016/j.heha.2022.100012
13. Sakib SMN. Assessing enrichment and contamination of sediments in the effluent canal of the ore processing industry and naviundu river in lubumbashi, democratic Republic of Congo. *EQA -J Environ Qual*. 2023;58(1):22-33. doi:10.6092/issn.2281-4485/17639
14. Emmanuel KA, Naresh D, Amandine L, et al. Assessment of trace metal and rare earth elements contamination in rivers around abandoned and active mine areas. The case of Lubumbashi River and Tshamilemba Canal, Katanga, Democratic Republic of the Congo. *Geochemistry*. 2016;76(3):353-362. doi:10.1016/j.chemer.2016.08.004
15. Mboni HM, Tshikongo AK, Chirubagula VB, et al. Evaluation of self-medication practices and their characteristics among Uvira in Democratic Republic of Congo students. *Pan Afr Med J*. 2023;45:53.
16. Akande-Sholabi W, Ajamu AT, Adisa R. Prevalence, knowledge and perception of self-medication practice among undergraduate healthcare students. *J Pharm Policy Pract*. 2021;14(1):49.
17. Abdi A, Faraji A, Dehghan F, Khatony A. Prevalence of self-medication practice among health sciences students in Kermanshah, Iran. *BMC Pharmacol Toxicol*. 2018;19(1):36.
18. Chirubagula VB, Mboni HM, Amuri SB, et al. Prevalence and characteristics of self-medication among students 18 to 35 years residing in Campus Kasapa of Lubumbashi University. *Pan Afr Med J*. 2015;21:107.
19. UN. Objectifs de développement durable; 2023. <https://www.un.org/sustainabledevelopment/fr/objectifs-de-developpement-durable/>
20. World Bank. Kinshasa doubles its drinking water distribution capacity, 2010. <https://www.banquemondiale.org/fr/news/feature/2010/02/25/world-bank-funding-helps-kinshasa-double-its-drinking-water-distribution-capacity>
21. Jüni P, Rothenbühler M, Bobos P, et al. Effets du climat et des interventions de santé publique sur la pandémie de COVID-19: une étude de cohorte prospective. *Can Med Assoc J*. 2020;192(44):E1374-E1382.
22. World Health Organization (WHO). Paludisme; 2023. <https://www.who.int/fr/news-room/fact-sheets/detail/malaria>
23. Ministère de la santé. Programme national de lutte contre le paludisme (PNLP) – Rapport d'activités 2021. 2022. <https://pnlprdc.org/wp-content/uploads/2022/09/Rapport-annuel-2021-des-activites-de-lutte-contre-le-Paludisme-1.pdf>
24. World Health Organization (WHO). Regional data and trends: World malaria report. 2022. <https://www.who.int/publications/m/item/WHO-UCN-GMP-2022.08>
25. MSF. Rapport Annuel 2022. 2023. https://www.msf-azg.be/sites/default/files/imce/Rapport%20Annuel/AZG_activiteitenrapport2022_FR_interactive.pdf
26. World Health Organization (WHO). Typhoid fever; 2023. <https://www.who.int/fr/news-room/fact-sheets/detail/typhoid>
27. ProMED. Typhoid fever - Sub-Saharan Africa: vaccine indication; 2024. Archive Number: 20240317.8715432. <https://promedmail.org>
28. Outbreak News Today. DRC typhoid tally tops 1 million cases; 2021. <https://outbreaknewstoday.com/drc-typhoid-tally-tops-1-million-cases-58800/>
29. Kayembe, N., Harry, C. Modalités, trajectoires préférentielles et facteurs explicatifs des dynamiques de diffusion spatio-temporelle des épidémies de choléra en République Démocratique du Congo (RDC). 2023. ULiège - Université de Liège [Sciences], Liège, Belgium. <https://orbi.uliege.be/handle/2268/306009>
30. UNICEF. Les enfants en RDC sont confrontés à la pire épidémie de choléra depuis six ans. 2023. <https://www.unicef.org/drcongo/communiqu%C3%A9s-presse/pire-epidemie-cholera-depuis-six-ans#:~:text=À%20titre%20de%20comparaison%2C%205.120,pour%20les%20urgences%20en%20RDC>
31. World Health Organization (WHO). Presumed triple epidemic of typhoid fever, shigellosis and cholera-Congo. 2023. <https://www.who.int/fr/emergencies/disease-outbreak-news/item/2023-DON488>
32. Freeman H, Harten T, Springer J, Randall P, Curran MA, Stone K. Industrial pollution prevention! A critical review. *J Air Waste Manage Assoc*. 1992;42(5):618-656
33. Chen Y, Wen X, Wang B, Nie P. Agricultural pollution and regulation: how to subsidize agriculture? *J Clean Prod*. 2017;164:258-264. doi:10.1016/j.jclepro.2017.06.216
34. Cao X, Prakash A. Trade competition and domestic pollution: a panel study, 1980–2003. *Int Organ*. 2010;64(3):481-503.
35. Liu RZ, Borthwick AGL, Lan DD, Zeng WH. Environmental risk mapping of accidental pollution and its zonal prevention in a city. *Process Saf Environ Prot*. 2013;91(Issue 5):397-404. doi:10.1016/j.psep.2012.10.003
36. Ministère de l'environnement, conservation de la nature et tourisme. Évaluation environnementale et sociale stratégique du processus REDD+. 2014. <https://documents1.worldbank.org/curated/en/37487146800009785/pdf/E4838-v3-DRC-REDD-Pest-Management-Framework-12-May-2014.pdf>
37. ProminesÉvaluation Stratégique Environnementale et Sociale du Secteur Minier en République Démocratique du Congo.2014. <https://congominer.org/system/attachments/assets/000/000/511/original/Promines-2014-Rapport-devaluation-du-secteur-minier-en-RDC.pdf?1430929026#:~:text=a%20une%20incidence%20majeure%20sur%20la%20déforestation.&text=aggravés%20par%20le%20fait%20que,certains%20aires%20protégées%20du%20pays.&text=sols%20et%20du%20paysage%20par,est%20très%20important%20en%20RDC>

38. Ruppen D, Runnalls J, Tshimanga RM, Wehrli B, Odermatt D. Optical remote sensing of large-scale water pollution in Angola and DR Congo caused by the catoca mine tailings spill. *Int J Appl Earth Obs Geoinf.* 2023;118:103237. doi:10.1016/j.jag.2023.103237
39. Mohd AM, Nadeem AK, Sirajuddin A, et al. Chlorination disinfection by-products in municipal drinking water: a review. *J Clean Prod.* 2020;273:123159. doi:10.1016/j.jclepro.2020.123159

How to cite this article: Mufungizi I, Okon I, Nkundakozero M, Akilimali A. Supporting health systems and environment in the Democratic Republic of Congo: A call for action. *Health Sci Rep.* 2024;7:e2257. doi:10.1002/hsr2.2257