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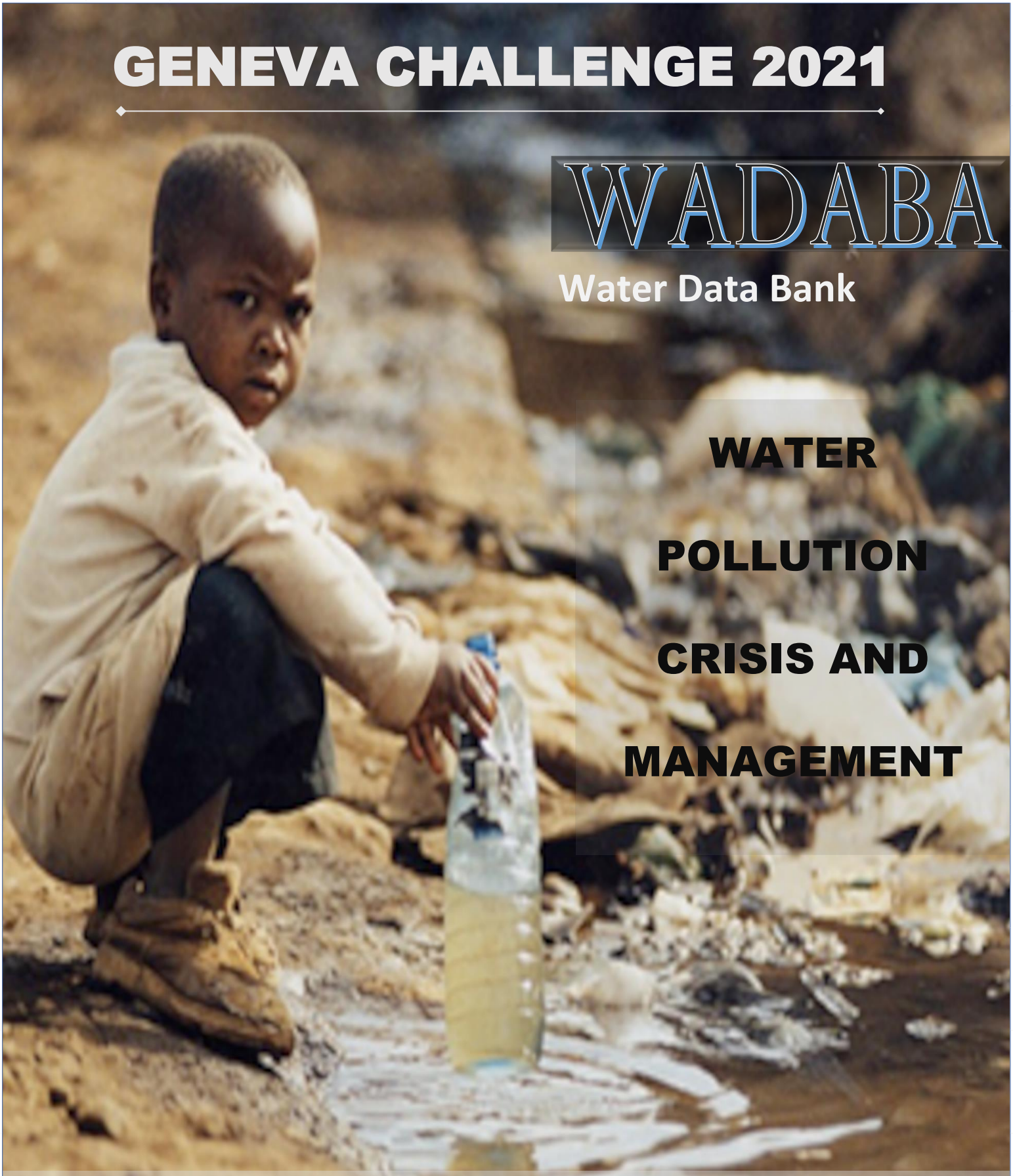

WADABA

Water Data Bank

WATER POLLUTION CRISIS AND MANAGEMENT

Ewube Kelly Laure Egbe - Crésus Hammer Kodongo Ndrou - Christian Murhula Shaburwa - Nkenen Brendaline Shieke - Benjamin Bonkoungou

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ABSTRACT

Water pollution is a major concern all over the world, most especially in developing countries. In crowded urban environments like the city of Likasi, DRC, happens to be a practical example of a locality where pollution created by a single individual can meet many others, placing all residents at risks of poor sanitation and hygiene. Likasi is vulnerable to the effects of economic activities such as mining especially on their water resources and is therefore in need of practical up-to-date information and data covering records of all economic activities affecting major water sources of the area. This study therefore employs citizen science together with other techniques and ideas to address the problem under study.

The Team

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Crésus Hammer KODONGO NDROU is a multi-talented engineer of Central African origin. He is currently training at Pan African University Institute of Water and Energy Sciences, Algeria Pauwes where he does water engineering. Always in search of knowledge, he has proven himself in the field of rural hydraulics, before working as a Wash Facilitator and as Responsible of the sustainable project at the National Agency of Water and Sanitation in Central Africa.

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1. BACKGROUND

1.1 Introduction

Water is life. This is a small phrase that summarizes thousands of research studies that have demonstrated the importance of water in all aspects of life on earth. Indeed, the maintenance of a healthy environment and the good health of human beings depend largely on access to water. However, it should be noted that this is only possible if there is a good supply of water in quantity and quality. Concerns about the physical availability of water are real and specific from one region to another, ranging from a slight insufficiency to a total water shortage (Garrick et al., 2020). Water crisis in the world is becoming more and more acute. According to (Kummu et al., 2010), the global population experiencing severe water scarcity has increased from 32 million people in 1900 to a projected 3.1 billion people by 2050. As for the quality, the consumption of contaminated water is the cause of many waterborne diseases such as cholera, hepatitis A, amoebiasis, typhoid fever and many other parasitic, bacterial and viral diseases (Kangombe, 2020) and causes the death of millions of people worldwide. In the period from 2008 to 2012, the total number of cholera cases in 69 endemic countries, mainly located in Sub-Saharan Africa and South-East Asia, was estimated at between 1.3 and 4 million, leading to the death of between 21,000 and 143,000 people each year (World Health Organization, 2018). According to the UN report, in 2019, more than 2.1 billion of the world's population do not have access to safe drinking water services (UNESCO, 2019). Today, due to other driving parameters such as climate change, income and population growth, the situation is deteriorating further and without clever intervention and implementation this challenge will continue to intensify and spread as demand grows (Jaeger et al., 2017).

1.2 Problem Statement

Despite the physical freshwater scarcity in the world, some regions still have sufficient water resources and water pollution is their main concern. The Democratic Republic of

Congo (DRC) is a typical example. Indeed, the DRC has huge water reserves: Democratic Republic of the Congo (DRC) contains 35% of the world fresh water reserves (Xu, 2021), its surface water represents about 52% of Africa's water reserves, while its reserve represents 23% of the continent's renewable water resources (United Nation Environmental Programme, 2011).

Furthermore, described as a "geological scandal", the DRC is known worldwide for its vast and diverse mineral resources. This makes mining not only the centerpiece of the Congolese economy (Direction générale du Trésor, n.d.), but also one of the major sources of air, soil and especially of water resources pollutions (Friends of the Earth Netherlands; SOMO & The Good Electronics Network & Friends of the Earth Netherlands, SOMO, 2015). In the Haut Katanga province (pilot area: Likasi), rich in cobalt and copper, some industrial mining companies operate, provoking significant pollution of water sources, seriously affecting the local population. A combination of factors can be detected, inter alia lack of enforcement of regulation, structural corruption, influence peddling, conflicts of interests, lack of compliance by the mining sector and, in the end, a de facto impunity vis-a-vis the polluting companies that leaves the main problem unresolved. Agriculture is also an important activity in the area and could be an important source of contamination.

According to a report by the Water and Sanitation Program (WPS), in 2012, as a result of poor water quality and lack of sanitation and hygiene, 90,400 Congolese, including 74,300 children under the age of five, die each year from diarrhea (Toni & Sylvia, 2012). The majority of the cases have been registered in the south-eastern part of the country, former province of Katanga. In 2016, of the 41.9 million people affected by the cholera epidemic in the 26 provinces of the DRC, Haut-Katanga province had the highest number, that is. 747,260 ((WASH Cluster, 2017)).

1.3 Project Scope

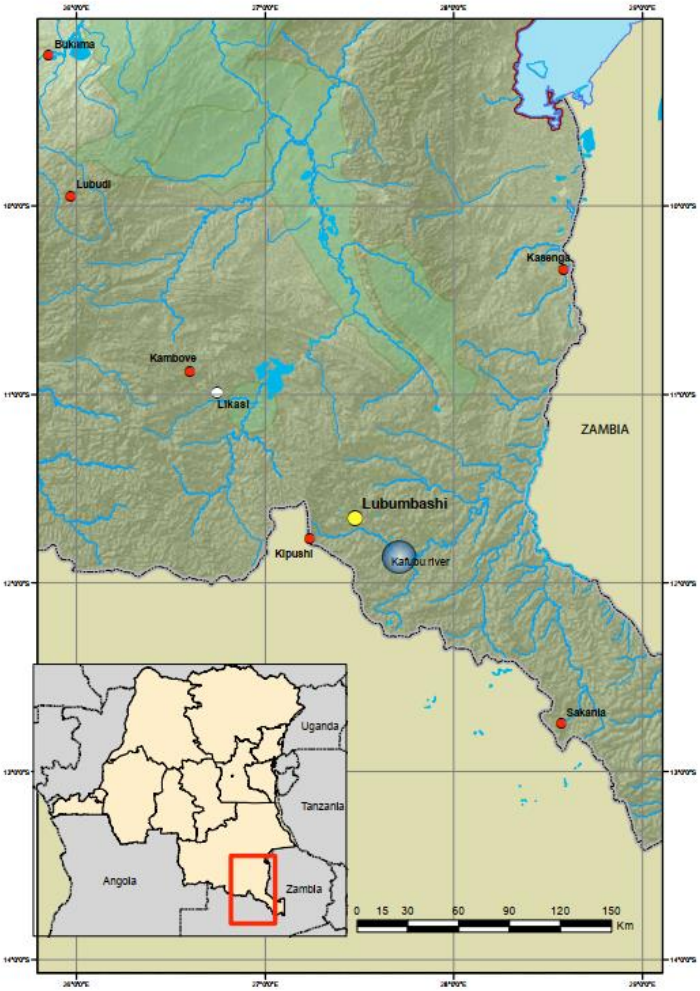
Located between 26° 44′ - 27° 00 ′ East longitude and 10° 50′ - 11° 55 ′ South latitude and at an average altitude of 1,300 m, in the province of Haut-Katanga in the South-East of the DRC, Likasi is a city with a population of approximately 635,463 in

2016 over its 245 km2 area. Its climate has two seasons: a dry season (April to September) and a rainy season (September to April). Temporary and spatial variations over the last 50 years gives the city an average rainfall of 1150mm. The average annual temperature is about 20 degrees Celsius. The city is drained by eight small rivers which are: Likasi, Buluo, Panda, Kikula, Nguya, Kampumpi, Kanona and Kampemba. The vegetation is characterized by fruit trees on a sandy clay soil and a rugged relief characterized by hills and mountains.

Likasi is one of the towns in the "Katangan copperbelt" located in the province of Haut-Katanga, formerly Katanga province. The region holds one of the world's largest reserves of metals, mainly copper, cobalt and lead (Friends of the Earth Netherlands; SOMO & The Good Electronics Network & Friends of the Earth Netherlands, SOMO, 2015). As in the whole region, the rivers and other water sources in the city of Likasi have become repositories for tons of polluting dumps from mining, making them vulnerable to pollution.

Likasi is chosen as a pilot city for our project for some major reasons. First, the city is a relatively small area (population 2015; 635,000) which will allow us to pilot the project in a controlled environment. Secondly, the city harbors important water resources for the local population inter alias the Lufira, Panda, Buluo, Lufira,

Kamatanda rivers, reported to being polluted by some mining activities (MULOBE, 2013)



Finally, the city is rich in mining industries. Companies such as Gécamines-sarl, Concorde Mining, Metal mines, SMCO, CJCMC, MJM, BOLFAST COMPANY, JMT, RUBAMINES, CAM RESSOURCES, HUACHIN have been at times accused of polluting the water bodies (MULOBE, 2013). There is therefore a potential discharge of wastewater into the rivers or water bodies resulting in the water being polluted and often unfit for human consumption by local communities. In fact, the local communities directly use the river or groundwater for consumption. In 2016, a dozen people were treated at the DACO General Reference Hospital in Katanga Province for having consumed the water of the Panda River. Dozens have also experienced burns on their bodies after bathing from the same river.

1.4 Justification of the Project

The town is particularly characterized by its vast mineral deposits consisting of copper, cobalt, gold and other semi-precious stones. This makes mining the main economic activity in addition to agriculture, handicrafts, trade and hotels. The reality is that for several years now, mining companies dump their waste directly into nature and it is the population, the environment and the water resources that pay the price (Scheele et al., 2016). As a result of decades of mining conducted without any account of the

environmental and human impacts taken, the local population tends to suffer dramatic consequences, including the degradation of water quality, which also affects the quality of the soil and limits and/or destroys agricultural production and causes waterborne diseases. Malaria, acute respiratory infections, diarrheal diseases, typhoid fever and malnutrition are recurrent diseases that are the cause of most deaths in the town (Cellule d'Analyses des Indicateurs de Développement, n.d.). The gravity of the situation can be felt in an article from infoCONGO which reports that 10 people were put in hospital for observation after drinking water from the Panda River and 19 others suffered burns on their bodies after bathing in the same river (David, 2016). Again, in a report by Stichting Onderzoek Multinationale Ondernemingen- SOMO, which mentions the countless consequences of mining in the Katangan Copperbelt on the health of the local population and on all ecosystems (Scheele et al., 2016).

Unfortunately, there is a lack of comprehensive data. Most of the studies carried out in this regard are made by academics or NGOs as part of wider projects. In fact, the Congolese government has not implemented a water quality-monitoring program that would allow it to perform water quality studies, evaluate the actual status of water quality throughout the country and to examine future trends. It is therefore with this in mind that we decided to carry out this project which will consist of creating a database on some key parameters that will allow us to know the level of pollution of water resources in the Democratic Republic of Congo, specifically in the city of Likasi city. It is important to specify that the choice of our project is by no means a matter of chance, but rather the result of a long process of observation and reflection.

2. LITERATURE REVIEW

2.1 Water Pollution

Water covers about 70% of Earth's surface. Safe drinking water is a basic need for all humans. Some regions have sufficient water resources, but water pollution is still a concern (Koshal, 1976). Today, due to the increase in socio-economic activities, water resources are under threat. Indeed, water reserves have become the final destination of hundreds of kilograms of industrial, agricultural and domestic pollutant loads. This situation is worsened as the population grows and the ecosystem is unable to assimilate all this waste (Kangombe, 2020). Among the many sources of pollution of water resources, mining is one of the most polluting anthropogenic activities. Although it is essential and vital for human socio-economic development, mining leads to the contamination of aquifers, groundwater and surface water, sometimes with irreversible consequences for the environment and the health of local populations (Mustafa et al., 2021; Santana et al., 2020)

2.2 Physical Contamination

Physical contamination refers to contamination affecting physical properties of water: coloration, odor, suspended matters and pH. Such contamination of water does not directly harm people's bodies, but domestic use of the water is very harmful. Problems related to the contamination affecting physical properties are color contamination, offensive odors, corrosiveness (pH), turbidity. Color contamination of water bodies is caused by metals, dye pollution, soil particles, and by the occurrence of water bloom (Inamori & Fujimoto, 2010)

2.3 Chemical Contamination

Metals are considered major environmental pollutants as they are non-biodegradable, cytotoxic, mutagenic and carcinogenic in nature. Heavy metals are present in natural

water as they are dissolved by it while flowing, human activities such as use of chemicals in agriculture, disposal of industrial and domestic waste into water bodies add these metals into ground and surface water making it unsuitable for human and aquatic life (Bhangaonkar & Patel, 2019).

Drinking water sources may contain a variety of contaminants that, at elevated levels, have been associated with increased risk of a range of diseases in children, including acute diseases such as gastrointestinal illness, developmental effects such as learning disorders, endocrine disruption, and cancer (Smeenk, 1983).

2.4 Biological Contamination

Microbial hazards make the largest contribution to waterborne disease in developed and developing countries. Nevertheless, chemicals in water supplies can cause serious health problems – whether the chemicals are naturally occurring or derive from sources of pollution (Thompson et al., 2007).

Microbial contaminants include bacteria, viruses, and protozoa that may cause severe gastrointestinal illness. Children are particularly sensitive to microbial contaminants, such as Giardia, Cryptosporidium, E. coli, and noroviruses, because their immune systems are less developed than those of adults.

Intracellular water, which comprises approximately 80% of the mass of most living cells, has been the focus of many investigations to determine the quality of water (Mathys & Knorr, 2009). Untreated drinking water and faecal contamination of water is the major cause of diarrhea. The cholera is caused by contaminated water and Vibrio Cholera is responsible for this disease. This bacterium produces toxins in digestive tracts (Koshal, 1976).

2.5 Relationship Between Water Pollution and Health

Contamination of drinking-water is a significant concern for public health throughout the world. Heavy rainfall and floods are related to extreme weather and creating

different diseases for developed and developing countries (Bhangaonkar & Patel, 2019). There is a big association between pollution and health problems. Disease causing microorganisms are known as pathogens. Industrialization, discharge of domestic waste, radioactive waste, population growth, excessive use of pesticides, fertilizers and leakage from water tanks are major sources of water pollution. Most water bodies have become polluted due to industrial growth; urbanization and manmade problems mainly the result of population growth. These wastes have negative effects on human health (Koshal, 1976). Poor sanitation and contaminated drinking water arising from human activity and natural phenomena create serious problems in human health. The WHO reports that 80% of diseases are waterborne. Sewage and other waste, industrial effluents, agricultural discharges and industrial wastes from chemical industries, fossil fuel plants and nuclear power plants, create a larger problem of water pollution rendering water no longer fit for drinking, agriculture and, as well as for aquatic life (Pandey, 2006).

2.6 Water Pollution Challenge in SDG 6

Commonly referred to as the "water goal", SDG 6 is one of 17 SDGs established by the United Nations and consists of "Ensuring availability and sustainable management of water and sanitation for all". This goal reflects a particular focus on water and sanitation issues in global policy and takes into account the importance of all the different aspects of the water cycle in development as well as the direct and indirect role that water can play in achieving the other SDGs (Ortigara et al., 2018).

The ambition of this goal is therefore to ensure that every human being has access to safe drinking water and adequate sanitation. For water, the goal is not only limited to the issue of access but also aims to ensure availability, accessibility, quality of services and sustainable management of water resources (Génevaux et al., 2018).

Its particular interest in water quality is manifested through its target 6.3 which consists of improving, by 2030, the water quality by reducing pollution, eliminating waste dumping and minimizing emissions of chemicals and hazardous materials, halving the proportion of untreated wastewater, and significantly increasing the safe

recycling and reuse of water globally (Progress on safe treatment and use of wastewater: piloting the monitoring methodology and initial findings for SDG indicator 6.3.1, 2018).

This project will permit us to assess the progress of the city of Likasi in achieving this target by deducing and measuring certain key parameters, the proportion of water resources with good quality which is the subject of indicator 6.3.1.

2.7 Lack of Data for Assessment and Monitoring of Pollution

Today when the world is concerned about the sustainable management of natural resources, data is an essential ingredient in the success of this quest. In the water sector, data on the quality, quantity, supply, use, treatment and other parameters related to water are of paramount importance and crucial for a good assessment as well as an excellent sustainable management.

Different chemicals have different effects depending on their locations, kinds and concentration in a water body. Bacterial, viral and parasitic diseases like typhoid, cholera, encephalitis, poliomyelitis, hepatitis, skin infection and gastrointestinal disease are spreading through polluted water. In developing countries contamination of water with heavy metals is a major problem. There is a need to assess and evaluate suitability of water bodies for drinking and agricultural purposes (Bhangaonkar & Patel, 2019).

Thus, knowing the quality of water in rivers, lakes and groundwater in this part of RDC is essential. It will allow us to detect areas where water resources are most vulnerable to pollution or not and to understand the temporary evolution of the impact of socio-economic development on the quality of freshwater reserves.

Unfortunately, in DRC, data on water use is neither up to date nor sufficiently detailed (United Nation Environmental Programme, 2011). This is one of the main causes of the management crisis of the Congolese water sector. According to the Sustainable Development Report 2020, The lack of data makes the assessment of some SDG 6 indicators impossible in DRC (Sachs et al., 2020). Hence the need for a water quality database-Water Data Bank.

3. THE SOLUTION: WADABA

3.1 The Data Bank

Experience shows that there can be no effective management of water resources without effective access and management of necessary data and information. Given the increasing challenges facing water resources management, access to information regarding the status and trends of the water resource and its uses is a critical component of water policy in the City of Likasi. Water resource administrators responsible for regulatory actions, planning, risk management and public information need reliable, up-to-date and relevant information to make sound water management decisions.

Unfortunately, the necessary data are often generated and managed by disparate organizations in different sectors, with little coordination between them. Many systems and data already exist, but in many cases, professionals and policymakers still lack critical data, and the plethora of sources makes it difficult to identify the most appropriate data sets, as well as to assess the quality of the information provided.

Our solution, the data bank, will host equipment capable of handling the data put in and analyse it so as to calibrate models that can track the water situation in each location of the project. The database will be structured as follows:

- Attributions and responsibilities of the bank, useful means and installations (exploitation on smartphones, computers and tablets; reception and control of the data; treatments archiving and restitutions).
- Data Processing: Primary data on selected parameters are collected by the technical team and/or through citizen science; then analysed and processed before moving to archiving or use.
- Standardization: in accordance with the water management policy in the commune of Haut Katanga, specifically in Likasi, frameworks will be standardized and composed of digital support, files and web applications which will be developed.

3.2 Data Collection Process

In the first stage of our project, a predefined set of locations will be selected for the water sampling, which will be carried out by our trained agents. At the same time, a selected number (08) of volunteers will be provided smartphones with which they will participate in sending captured images of noticeable possible pollution points. This will help for the second stage which will involve more citizens as the project will move towards citizen science. Thus, prior to every sampling, our agent would contact citizen scientists to arrange a convenient time. The collected and labelled samples will be appropriately stored for later analysis or analyzed on the field depending on the parameter. The parameters that will be monitored are described in the next section.

3.3 Parameters to Monitor

The choice of parameters is based on the presence of industrial activities in the zone, which constitute the source of pollution.

In view of protecting the water sources from physical contamination, the following physical parameters will be monitored through a continuous sampling and analysis.

- pH,
- Turbidity / water transparency,
- Total suspended solid
- Color

In fact, changes may be brought about by the intrusion of other waters and by discharge to the water bodies. These discharges may significantly affect the pH, and the turbidity and the total solid composition of the water. Besides, the changes in the color will be easily detected by the citizens.

Chemical contamination is an important aspect in the study zone due to the presence of multiple industries. The United Nations Children's Fund (UNICEF) advises the

monitoring of the content of fluoride, arsenic (most often found in mining areas), and nitrates. Therefore, parameters such as,

- Hardness
- Alkalinity
- Nutrients
- Dissolved oxygen
- Fluoride
- Heavy metals (Cobalt, Copper, Lead, Arsenic)

will be analyzed. Heavy metals, particularly Cobalt and Copper are of great interest. Many mining industries extracting copper and cobalt in the area are discharging their wastewater to the rivers.

Biological parameters such as;

- Faecal coliforms
- Total coliforms

Will also be considered in the analysis.

For the purpose of sampling and analysis, different instruments will be purchased and put at the disposition of the technicians.

3.4 Instruments of Measurement

Thanks to chemistry, it is now possible to detect thousands of chemical substances in water, even at very low concentrations. The list of available tests is already impressive, but it is growing with time and most methods require state-of-the-art laboratory equipment. But fortunately, there is no need to test for every element in the water, hence, a smaller and more practical set of tests is all that is needed to get a good idea of the chemical quality of the water.

To carry out our measurements, and also for one of the precision analyses, we opted for the ProQuatro Multiparameter Meter. The ProQuatro meter meets the demands of true field work and is an ideal choice for low-cost water quality sampling. It allows the

measurement of multiple parameters such as dissolved oxygen, conductivity, specific conductance, salinity, resistivity, total dissolved solids (TDS), pH, ORP, pH/ORP combination, ammonium (ammonia), nitrate, chloride and temperature.

3.5 The WADABA-Dashboard: User-interface

The interface will help visualize the parameters according to the sampling locations. The interface is interactive, allowing the user to choose a location of interest and display the parameters and their values. The table view contains the parameter, the last measured value of the parameter, the standard value, the sampling location coordinates and the date of the measurement.

The database interface will have five sections including:

- Home: This section will briefly explain what WADABA is, what we do, our vision and goals
- About: Here we will introduce the city of Likasi by giving information about its geographical location, its demography, its water resources, its challenges in managing these water resources. In addition, we will talk about the parameters we will analyze, and how we will do it.
- Citizen Science: This section will first explain what Citizen Science is and show how the population will be involved in the realization of our project.
- Data: This will be the database where all the data from the different analyses will be stored in tabular form.

- Graphs: to show the evolution of the parameters over time and their interpretation

4. INSTITUTIONAL AND POLICY CONTEXT

The DRC's mining code was redacted by experts from the World Bank, and was adopted in 2002, shortly after Joseph Kabila came to power. By weakening several existing regulations, including that on taxes, it was seen by civil societies, and the International Monetary Fund (IMF) (International Monetary Fund, 2015), as extremely favorable to foreign investors. It has thus made it possible to attract many companies to the territory: going from 35 mining companies in 2002 to 482 at the end of 2016. This code was almost a win-win deal, economically and politically, for businesses and the power in place. On the other hand, it was of less interest for the State and the Congolese population which, in the end, have benefited littles from the profits of mining.

In 2012, the Congolese government launched a revision process. This of course did not please the companies who saw their economic interests threatened. On paper, the new code further protects local populations and the environment. Industrial responsibility is reinforced. Whereas before the communities had to prove the existence of negative consequences of pollution, henceforth, any holder of a mining and / or quarry right will be automatically considered responsible for the damage caused to people, property and the environment, and this even in the absence of any fault or negligence. He will be required to repair them and can only be exonerated from his liability if he provides proof that such damage comes from a cause unrelated to his mining activity (Article 285).

These are good elements for local communities and for the protection of the environment. But so far, no local community appears to have been consulted. And, it is not always clear who will be in charge of monitoring these rules (Ulu & Justice, 2019). It is therefore essential to make local communities aware of their rights and to inform them of the possible remedies in order to be able to claim respect for these standards. Our project will play a major role in the monitoring and ensuring that companies are held accountable for the pollution they cause.

5. PROJECT IMPLEMENTATION

5.1 Logical Framework

The project will contribute to the implementation of the measures taken in the new mining code by strengthening the monitoring of pollution. This will be achieved through evidence-based and data driven policy making. Although this project directly contributes to the achievement of SDG 3 and 6 other goals will be achieved through the implementation of the project. A comprehensive logical framework explaining project goals, outcomes, outputs, performance indicators, contribution to the SDGs goals is given in Table 1.

	Result Chain	Performance Indicator	Source	SDG Contributed to
Outcomes	Reduced pollution to the water sources	Incidence of pollution reduced by 50%	Ministry of Water Resources	
	Companies held accountable for any pollution		Ministry of Mining	
	Improved health of citizen	Reduced cases of water borne diseases caused by consumption of unsafe water by 20% by end of 2020	Ministry of health	
	Better educated citizen the local on their rights	A dozen of citizen effectively trained by 2023	Survey Report	

Outputs	A monitoring system created	The selected parameters continuously monitored	Project Report	
	A databank created			
	A significant number of citizens trained to collect and analyze the data	Increased awareness among the citizen		
	An attainment of all the goal	Partnership for data sharing formed with international organizations, government agencies, etc		

5.2 Stakeholder Analysis

Table 2 summarizes the project main stakeholders categorized into several groups with their various influences and interest to the project.

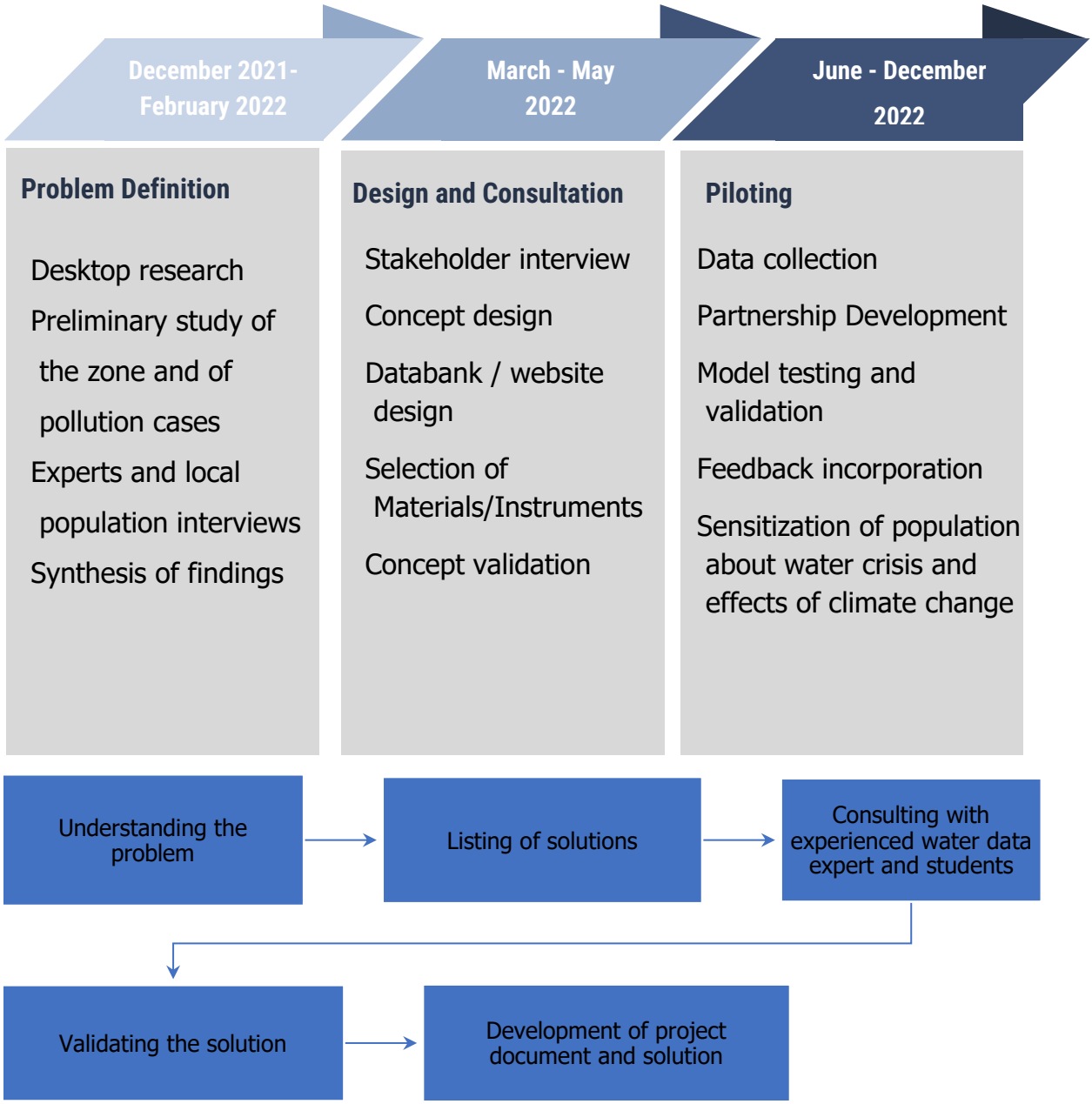
	Stakeholder	Role
Beneficiaries	Local communities: . Households . Farmers . Agro-pastoralists	Benefit from: .Safe drinking water . Better access to natural resources .Improved income

Potential Clients	Government's agencies such as: . Ministry of health . Ministry of mines . Ministry of water resources . Ministry of agriculture Non-Governmental Agencies such as: . Humanitarian aid . Research Organization	. Use WADABA data to monitor pollution water quality and determine causes of disease outbreaks . Use the data for water supply projects . Use the data to enforce the regulations on the codes. . Use WADABA data to held companies responsible and accountable
Potential Partners	. UMOJA . Water Aid	. Use WADABA in the advocation of the local communities' rights

6. PROJECT TIMELINE AND BUDGETING

6.1 Timeline

The project implementation phases will span a period of 12 months starting from December 2021. A detailed timeline is given below in the figure below.



6.2 Project Budget

The projected expenses of the project are found on the following table

Materials and Equipment			
	Quantity	**Unit Price**	**Total Price**
Multiparameter Meter (Proquatro)	02	$1,140.00	$2,280.00
Smartphones	08	$350.00	$700.00
Hard disk	03	$19.50	$58.50
Laptops	02	$2,999.11	$5998.22
Database hosting	24	$20.00	$480.00
TOTAL	**$9516.72**		

The potential/expected sources of income are;

- GIZ sponsorship
- African Union sponsorship
- Private companies' sponsorship
- Ministry of Health and Environment, DRC
- Ministry of Mines, DRC
- Pan African University Scientists

7. FUTURE VISION

Reducing the risks of water resources to water pollution and tracking of water usage within separate sectors in terms of quality and quantity to enhance sustainability and resource protection is the future vision of this project. Also, to promote healthy food systems and families is paramount. Providing information for policy framing and implementation to guide different sectors which will enhance growth and development.

Complete WATER DATA BANK being used in the community of Likasi to provide data about vulnerable water resources contamination which is leading to widespread diseases, shall guide policy draft and implementation to reduce the vulnerability of the community to mining polluted water and encourage the safe use of water.

It is expected to reduce the rate of water pollution activities through quality control provided by the bank which in turn reduce the contraction of waterborne related diseases in the communities; safe health. Thus, by providing safe drinking water to families will eliminate the risk of death. Also providing a reliable database for future research and innovation projects which will build and construct strong national and international reliability ties on the water resource.

After implementation of the WADABA in Likasi, this technology shall be extended as well to other rural communities in DRC and other countries as well with the end goal of ensuring water data availability and educating the people on the importance of saving the water resource in accordance with SDG goals, clean water and sanitation as is in SDG 6 which is a priority to achieve good health. Therefore, this project if implemented will help promote SDG 6, 3,4, 11,13 and 17.

8. RISK ANALYSIS

Every project is in one way or the other associated with likely risks that are capable of threatening the attainment of the project's objectives. It is therefore necessary to recognize likely risks to any project before the execution of the project and provide essential moderation actions in order to ensure a smooth execution process.

Thus, for this project, below in the table is the list of the seven (7) risks that we will likely face during the expansion and implementation of the project as well the mitigation actions that will be assumed.

Risks	Mitigation Actions
Rivalry There exist an increasing number of initiatives, groups, NGOs and private organizations working on improving the access to water data at local, regional and national scales.	The project team has done a wide-ranging search and did not find any idea related or comparable to the team's idea which makes the invention exceptional.
Absence of Government's attention Government's water, agricultural, mining, external relations, housing and town planning ministries will be one of the key partners of the project, specifically regarding the policies on the use of water in relation to quantity and quality. Their interest and backing are therefore fundamental for project success	Adequate networking with the Ministers of Water, Education, Mining, Agriculture and external relations. The team will understand well the concerns of the government to permit them to integrate in project design. Constant actions with government officials are paramount.
Trans-boundary water corporations The concerns from other countries in shared water resources is in most cases a hindrance to project realization.	International link base recognition through legal and institutional recognition in pitching events integrated with grounded support from home government.
Inadequate Project funding The project requires funding for working expenses before the project turns out to be economically self-sustained and model change.	The team intends to explore numerous funding tactics and pitch the idea to a variation of potential funders such as student competitions, NGOs, international organizations, government agencies, and foundations with profound interest in water safety. Likewise, the team hopes to apply for grants from international sponsors. The

	team intends to sell data (depending on data needed) to international investors in need of necessary information.
Low acceptability It is likely that since the idea is pioneering and new, the general population might face challenges in accepting the idea.	Promotional activities, Movements and sensitization sessions will be carried out on a regular basis to validate the procedure and profits of the data bank to the community and country members as a whole. Consistent feedback will be steered in order to associate the feedback into the design of the product.
Project Practicability After the designation and operation of the project, the action expenditures are not predictable to be significant. The project would however be able to generate revenue in order to be self-sufficient. This product is expected to be environmentally, socially and economically justifiable.	The team members will pull on local and regional contacts and resources to confirm that the project fits into the rural context and is implementable on the ground since the idea is generally for rural and urban communities. There would be development of a progression plan to warrant that the project will recuperate, and expand to serve its recipients even beyond the test location. Monetarily, the project will become justifiable after project initiation since the clients will pay for the product to cover working costs.
Low Community Involvement Apart from governments participation, this project is community grounded and so immense community contribution would donate greatly to the achievement of the project.	The project would provide career opportunities for people specifically women who would be involved in point data collection and recording.

9. CONCLUSION

An area like Likasi in the Katanga region suffering from the pollution of its water resources is bound to experience serious health challenges which makes the inhabitants unproductive in an economy which is in need of development. The availability of water data which keeps track of the misuse and pollution of the water resources is of great importance to such an economy if it must attain economic growth. The entire idea of the WADABA will bridge the gap between single exploitation of water resources and provide available information required for accountability, innovation and research. WADABA, as a databank and a digital platform, has the advantage of flexibility. In fact, new and advanced functionalities can be added later and the project can be replicated to other geographical areas to support wider needs of existing and new clients for better water resource management, pollution reduction and accountability. The project is also unique and innovative as it will evolve to a citizen science project.

10. BIBLIOGRAPHY

Bhangaonkar, P. D., & Patel, J. S. (2019). Assessment of heavy metals in surface water of Vishwamitri River. *International Journal of Hydrology Science and Technology*, *9*(6), 675–689. https://doi.org/10.1504/IJHST.2019.103449

Cellule d'Analyses des Indicateurs de Développement. (n.d.). *Ville de Likasi – CAID*. Retrieved May 10, 2021, from https://www.caid.cd/index.php/donnees-par-villes/ville-de-likasi/?domaine=fiche

Direction générale du Trésor. (n.d.). *Le secteur minier en République Démocratique du Congo*. Retrieved July 5, 2021, from https://www.tresor.economie.gouv.fr/Pays/CD/le-secteur-minier-en-rd-congo

Friends of the Earth Netherlands; SOMO & The Good Electronics Network, & Friends of the Earth Netherlands, SOMO, T. G. E. N. (2015). *Katanga Calling. Congolese Cobalt and Consumer Electronics*. https://www.somo.nl/katanga-calling/?noredirect=en_GB

Garrick, D. E., Hanemann, M., & Hepburn, C. (2020). Rethinking the economics of water: An assessment. *Oxford Review of Economic Policy*, *36*(1), 1–23. https://doi.org/10.1093/oxrep/grz035

Génevaux, C., Le Jallé, C., Allély, D., Dussaux, V., Aubourg, G., Ndiaye, D., & Malafosse, G. (2018). *Les objectifs de développement durable pour les services d'eau et d'assainissement*. 55. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjClPvVlb7tAhXFQRUIHbEfBdsQFjADegQIAhAC&url=http%3A%2F%2Fwww.bfc-international.org%2FpS-Eau-Guide-Les-Objectifs-du-Developpement-Durable-pour-les-services-d-eau-et&usg

Inamori, Y., & Fujimoto, N. (2010). Physical/Mechanical Contamination of Water. In *WATER QUALITY AND STANDARDS*. Naoshi Fujimoto. http://www.eolss.net/Eolss-sampleAllChapter.aspx

International Monetary Fund. (2015). *2015 Article IV Consultation—Press Release; Staff Report; and Statement by the Executive Director for Democratic Republic of the Congo* (Issue 15).

Jaeger, W. K., Amos, A., Bigelow, D. P., Chang, H., Conklin, D. R., Haggerty, R., Langpap, C., Moore, K., Mote, P. W., Nolin, A. W., Plantinga, A. J., Schwartz, C. L., Tullos, D., & Turner, D. P. (2017). Finding water scarcity amid abundance using human–natural system models. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(45), 11884–11889. https://doi.org/10.1073/pnas.1706847114

Kangombe, T. K. (2020). *Approvisionnement en eau potable en milieu rural en République Démocratique du Congo face à l'Objectif 6 de Développement Durable, Exemple de la province du Maniema*. Selinus University of Science and Litterature.

Koshal, R. K. (1976). Water pollution and human health. *Water, Air, and Soil Pollution*, *5*(3), 289–297. https://doi.org/10.1007/BF00158344

Kummu, M., Ward, P. J., De Moel, H., & Varis, O. (2010). Is physical water scarcity a new phenomenon? Global assessment of water shortage over the last two millennia. *Environmental Research Letters*, *5*(3), 034006. https://doi.org/10.1088/1748-9326/5/3/034006

Mathys, A., & Knorr, D. (2009). The properties of water in the pressure-temperature landscape. *Food Biophysics*, *4*(2), 77–82. https://doi.org/10.1007/s11483-009-9103-1

MULOBE, P. (2013). *Rapport de l'atelier strategique de reduction de la pollution de l'environnement due aux activites minieres*.

Mustafa, G., Shahzeb Khan, M., Asif, M. I., Ullah, A., Khan, I., & Ullah, I. (2021). Water pollutants and nanosensors. *Aquananotechnology*, 105–133. https://doi.org/10.1016/B978-0-12-821141-0.00018-5

Ortigara, A. R. C., Kay, M., & Uhlenbrook, S. (2018). A review of the SDG 6 synthesis report 2018 from an education, training, and research perspective. *Water (Switzerland)*, *10*(10), 1353. https://doi.org/10.3390/w10101353

Pandey, S. (2006). Water pollution and health. *Kathmandu University Medical Journal*, *4 NO. 1*(13), 128–134.

Sachs, J., Schmidt-Traub, G., C., K., Lafortune, G., Fuller, G., & Woelm, F. (2020). The

Sustainable Development Goals and COVID-19. Sustainable Development Report 2020. In *Cambridge: Cambridge University Press* (Vol. 53, Issue 9). https://s3.amazonaws.com/sustainabledevelopment.report/2020/2020_sustainable_development_report.pdf

Santana, C. S., Montalván Olivares, D. M., Silva, V. H. C., Luzardo, F. H. M., Velasco, F. G., & de Jesus, R. M. (2020). Assessment of water resources pollution associated with mining activity in a semi-arid region. *Journal of Environmental Management*, *273*. https://doi.org/10.1016/J.JENVMAN.2020.111148

Scheele, F., Haan, E. De, & Kiezebrink, V. (2016). *Cobalt blues: Environmental pollution and human rights violations in Katanga's copper and cobalt mines* (Issue April).

Smeenk, J. G. M. M. (1983). Drinking water contaminants [2]. *Environmental Science and Technology*, *17*(9), 21–23. https://doi.org/10.1021/es00115a611

Thompson, T., Fawell, J., Kunikane, S., Jackson, D., Appleyard, S., Callan, P., Bartram, J., & Kingston, P. (2007). *Chemical safety of drinking-water: Assessing priorities for risk management*.

Ulu, T., & Justice, C. (2019). *Code minier en RD Congo : les enjeux de la réforme*. *32*(0).

UNESCO. (2019). Leaving No One Behind. In *The Sage Learning of Liu Zhi* (Vol. 1).

United Nation Environmental Programme. (2011). *Water Issues in the Democratic Republic of the Congo Challenges and Opportunities*. 98.

WASH Cluster. (2017). *RDC - Cluster l'eau, hygiène et assainissement - Réponse aux problèmes humanitaires 2017 (janvier 2017)*. *2017*(janvier), 2017.

World Health Organization. (2018). *World health statistics 2018: monitoring health for the SDGs, sustainable development goals*. World Health Organization.

Xu, J. B. C. Y. (2021). Water supply and sanitation in the Democratic Republic of the Congo. In *Sustainable Groundwater Resources in Africa* (pp. 226–241). CRC Press. https://doi.org/10.1201/9780203859452-20