POTABLE WATER ACCESS AND MANAGEENT IN AFRICA: IMPLICATIONS FOR POVERTY, HUNGER AND HEALTH

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Abstract

This review study analyzed secondary data for situational analysis of poor access and management of potable water in Africa. Corruption and poor governance in water sector are contributory factors. In many African countries, up to 50% water is wasted to leakages in pipes and canals and illegal connections. Two-fifth of Africans lack improved water supply, 60.2% have access to improved drinking water source, and 36% have access to improved sanitation facilities. Only 1.6% gain access annually to improved drinking water sources, while 1% gain access annually to improved sanitation facilities. About 20.7% of African countries had less than 50% of their population with access to potable water in 2004. Lack of access to potable water exacerbates poverty and dictates health and economic crises. Health issues are miscarriages, birth defects, and infantile health challenges, such as methaemoglobinemia and dehydration, among others. People suffering from illnesses related to poor sanitation occupy 50% of hospital beds in sub-Sahara Africa. And, these illnesses account for 12% of the health budget. Commitment to provision of potable water, improved water management and supply, and sound pro-poor health policies are recommended to provide the needed preventive healthcare against water-related maladies in Africa.

Keywords: *Africa, Access to potable water, Corruption in the water sector***.**

Introdution

Water is so critical to life that a person can live for only a few days without it. Man uses water for drinking and sanitation, and for agricultural activities to produce food. The need of water to quench thirst, maintain hygience and provide food is, therefore, indispensable for man's living. Probably, this is why the benevolent Nature made the planet Earth to be literally awash with water, such that about 70% of the globe is covered by it. Yet, most countries face increasing challenge of access to potable water. More people die annually from unsafe water than from all forms of violence combined, including war. Sapiets [1] reported that fresh water is under pressure. Water demand is increasing rapidly towards its supply limits and regional over-exploitation is occurring more and more frequently due to changing consumption patterns against the backdrop of climate change. Already around 12% of the world's population suffers from water stress; estimate for 2025 is 37% (3 billion people). Aquifers are increasingly depleted due to growing demand. In this situation, the efficient use and protection of underground and surface water is essential.

Townsend [2] pointed to water being an abundant chemical on our planet and a dominant agent in geologic and climatic changes. Yet, it is not always available when it is needed, or where it is wanted in sufficient quantities and quality, or in the appropriate form. Many people take water for granted, yet for others, the problems of supplying sufficient and sustainable fresh water, where it is needed, are already acute, especially in Africa. The problems are increasing globally and water-stressed areas are predicted to expand ever more rapidly, making the development of sustainable, energy-efficient water technologies that are sufficient to meet the needs of a growing world population one of the highest priorities that mankind faces globally today.

Potable water is more scarce in Africa. The continent is immersed in continuous, endemic water and sanitation crisis that debilitates and kills huge numbers of people, threatens the health of the workforce, stands in the way of economic growth, and limits access to education and life opportunities. Every year, an estimated one million Africans die from diseases related to unsafe drinking water, poor sanitation and poor hygiene. Health, dignity and development are at stake – for millions of individual Africans and Africa as [3].

Of the 962 million Africans, only 602 million (60.2 %) had access to improved drinking water source and 360 million (36 %) had access to improved sanitation facilities in the mid-2000s. Only 15 million Africans (1.6 %) gained annually access to improved drinking water sources, while 10 million (1 %) gained annually access to improved sanitation facilities. The Millennium Development Goal (MDG) No. 7 seeks, among others, to halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. To meet the target, Africa needed to have been providing annually from 2008 to 2015 access to improved drinking water source for at least 33 million people (3.43 %) and improved sanitation facilities for 45 million people (4.68 %) [3].

According to the Earthwatch [4], about 5.7 million South Africans lacked access to basic water services and 18 million had no basic sanitation in the late 2000s. Eneh [5] reported that only 54 % Nigerians had access to safe drinking water and 53 % had access to adequate sanitation in 1999. The figures were lower at 48 % and 44 % respectively for rural areas, which harboured over 70 % of the citizens [6]. Mdoe and Buchweishaija [7] reported that both surface and underground waters in Dar es Salaam, Tanzania are hazardous if taken raw and in large quantity.

The Transparency International and Water Integrity Network [8] lamented that corruption in the water sector put the lives and livelihoods of billions of people at risk and slowed development and poverty reduction efforts. Water corruption could assume many forms with diverse effects. For example, a lack of integrity inflates the basic cost of infrastructure. It forces citizens to pay bribes to connect to water pipes. It diverts water intended for irrigation away from poor villages, which could use agriculture to pull themselves out of subsistence survival. Corruption allows the dumping of pollutants in or close to water bodies. Falsified metre reading, ill-advised procurement of expensive but poorly constructed facilities, and bought directorships all work against sustainable water management.

More recent reports show that water-related diseases claim more than 5 million people every year. Worldwide, one billion people cannot get any water within a 15-minute walking distance from their homes. Even, in the wake of the 21st century, one-sixth of the world's population (1.1 billion people) had no access to improved water supply and two-fifths (2.4 billion people) lacked access to improved sanitation. The majority of these people live in Asia and Africa, where fewer than one-half of all Asians have access to improved sanitation and two-fifth of all Africans lack improved water supply. In the decade 1990-2000, the proportion of the world's population with access to excreta disposal facilities increased from 2.9 billion to 3.6 billion people (or 55 % to 60 %). This was made possible by increasing the percentage of people served with some form of improved water from 4.1 billion (or 79 %) in 1990 to 4.9 billion (or 82%) in 2000 [9].

Access to potable water in Africa: A situation analysis

The African Development Bank [10] gave statistics on the percentage of Africans with access to potable water in 2004 (see Table 2.1). From the available data, only 22 % of Ethiopians had access to safe water, 42 % of the population of Chad had access to potable water, and 43 % of the population of Angola had access to potable water.

Table 2.1: ***Africans with access to potable water (2004)***

S/N.	Country	% Population with access to potable water 2004
1.	Algeria	85
2.	Angola	53
3.	Benin	67
4.	Botswana	95
5.	Burkina Faso	61
6.	Burundi	79
7.	Cameroun	66
8.	Cape Verde	80
9.	Central Afriican Republic	75
10.	Chad	42
11.	Comoros	86
12.	Congo	58
13.	Congo Dem. Rep.	46
14.	Cote d'Ivoire	84
15.	Djibouti	73
16.	Egypt	98
17.	Eritrea	60
18.	Ethiopia	22
19.	Gabon	87.9
20.	Gambia	82
21.	Ghana	75
22.	Guinea	50
23.	Guinea Bissau	59
24.	Guinea Equatorial	43
25.	Kenya	61
26.	Lesotho	79
27.	Liberia	62
28.	Libya	72
29.	Madagascar	50
30.	Malawi	73
31.	Mali	50
32.	Mauritania	53
33.	Mauritius	100
34.	Morocco	81
35.	Mozambique	43
36.	Namibia	87
37.	Niger	46
38.	Nigeria	48
39.	Rwanda	74
40.	Sao Tome/Precipe	79
41.	Senegal	76
42.	Seychelles	88
43.	Sierra Leone	57
44.	Somalia	29
45.	South Africa	88
46.	Sudan	70
47.	Swaziland	62
48.	Tanzania	62
49.	Togo	52
50.	Tunisia	93
51.	Uganda	60
52.	Zambia	58
53.	Zimbabwe	81
Africa		**62**

Source: AfDB, 2007a

Judging by the statistics, only 4 African countries (Botswana, Egypt, Mauritius and Tunisia) had 91-100 % of their population with access to potable water. Ten countries (Algeria, Comoros, Cote d'Ivoire, Gabon, Gambia, Morocco, Namibia, Seychelles, South Africa and Zimbabwe) had 81-90 % of their population with access to potable water. Eleven of them (Burundi, Cape Verde, Central African Republic, Djibouti, Ghana, Lesotho, Libya, Malawi, Rwandi, Sao Tome and Precipe and Senegal) had 71-80 % of their population with access to potable water. Seven African countries (Benin, Burkina Faso, Cameroun, Liberia, Sudan, Swaziland and Tanzania) had 61-70 % of their population with access to potable water. Nine (Angola, Congo, Eritrea, Guniea Bissau, Kenya, Mauritania, Sierra Leone, Uganda and Zambia) had 51-60 % of their population with access to potable water. Six countries (Chad, Congo Democratic Republic, Guinea Equatorial, Mozambique, Niger and Nigeria) had 41-50 % of their population with access to potable water. Two of them (Ethiopia and Somalia) had 21-30 % of their population with access to potable water. Thus, as manay as 8 of the 53 African countries (15.1 %) had less than 50 % of their population with access to potable water in 2004.

Water contamination and treatment

Even when water is available, it may be a life threatening resource because of its contamination. Water dissolves many materials coming in contact with it, including naturally occurring microbiological and chemical contaminants arising from domestic and industrial activities amidst increasing urban population. In condensing, evaporated water dissolves rocks to become saline solution, particularly rich in sodium chloride. Faeces contaminate underground water. Fertilizers, seepages in groundwater, septic tanks and surface water run-offs form soil nitrates. Pesticides from agricultural activities pollute underground water. Chemicals and heavy metals from industrial activities and waste dumpsites can pollute both ground water and surface water. Although, nature has ways of annuling pollution, when concentrations of contaminants increase above the levels prescribed by local and global authotities, the water becomes unfit for human consumption [11, 12].

Naicker et al [13] reported that the concentrations of ammonia-N, phosphates, total coliforms and *E.coli* in effluent leaving the treatment system in South Africa were higher than those specified in the South African Effluent Standards, signaling risk to the receiving environment. Therefore the addition of post treatment processing, such as sub-surface irrigation, should be evaluated. Edema et al [14] reported that there was higher total petroleun hydrocarbon (TPH) in the domestic water around the petroleum flow station than other areas in Niger delta region of Nigeria.

Alani et al [15] reported that there was spatial distribution of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides (OCPs) in Lagos lagoon water and sediments. There is also bioaccumulation of these contaminants in invertebrates (shrimps and crabs) and eleven species of fish, including commercially important fish sold to local markets. This finding is significant because Lagos lagoon is one of Africa's largest urbanized estuarine ecosystems, which receives organic input from atmospheric, industrial, municipal and oil related activities, and is an important habitat for a wide array of fish and marine organisms, as well as the major source of seafood for the people of Lagos and its environs.

Mule et al [16] noted that organochlorinated pesticides (OCPs), which have been used for agricultural purposes for decades and are distributed widely across the globe even in tropical regions, pose a great danger to the environment due to their toxicity. Their residues were found in screened water and soil samples in Kimondi wetland, Kenya. Nzung'a [17] evaluated the physico-chemical and bacteriological qualities of drinking water sources in Kithimani location in Kenya and effective treatment options. Zaranyika et al [18] showed that the slime dams at a goldmine in Zimbabwe are a source of pollution of the stream and dam by Pb, Cu, Zn, Ni, Co, Mo, As, U and Cd.

The report of a study by Mdoe and Buchweishaija [7] showed that people, especially those living in squatters in Dar es Salaam, Tanzania resorted to the use of ground and surface water for domestic needs because of the inadequacy of treated water supply. Yet, the water from shallow wells was heavily polluted by both total and faecal coliforms. Pollution load increased during rainy season. The chemical status of the groundwater was generally high. The water could be hazardous if taken raw and in large quantities.

Madadi et al [19] investigated the occurrence and temporal variations of 17 organochlorine pesticides in water, sediments, weeds and fish of River Sio drainage basin of Lake Victoria. Most of the pesticides had levels below the maximum permitted for drinking water except for aldrin, dieldrin and heptachlor epoxide. Aldrin and dieldrin had higher concentrations for all the seasons above WHO permitted maximum residues, whereas higher residues of heptachlor epoxide were observed in the dry and heavy rain seasons. Presence of pesticide residue in the samples is an issue of concern due to associated biological effects to human and environment.

Abdelgader [20] reported that industrial chemical (tanneries) or biological (*E. coli*) pollution threats exist along the River Nile course. The Blue Nile water is relatively high in contamination with total coliform bacteria, compared with White Nile and the Main Nile. Samples from four different locations in Khartoum were found to be positive with coliform bacteria. Molasses (from sugar industry) could cause high concentration of organic matter, leading to fish deaths. Faecal contamination suggested discharge of domestic sewage into the Nile. High turbidity values were detectable in the Blue Nile water during the flood season accompanied by huge sediments load, and hence, high values of suspended solids. Pesticides also contaminate the water in Sudan. Since fresh water quality that satisfies different use guidelines is essential for proper socio-economic development, remediation is imperative.

Studies on the effect of supplementary feeding on water quality during cage culture practice of Oreochromis Niloticus in Lake Kuriftu, Ethiopia showed an insignificant difference in the abundance of zooplankton at the two sites studied, but a significant difference in abundance between sampling dates due to variations in contamination [21]. According to *Earthwatch* [12], leachates of heavy metals contaminate ground water.

Relating access to potable water to poverty, hunger and health/sanitation crisis in Africa

Too many Africans live in poverty and hunger because they have no access to adequate sanitation and safe water [3]. Inadequate water supply for agricultural activities leads to food insecurity and malnutrition, which is responsible for high rate of stunting (33.5 %), underweight (30.7 %) and wasting (15.6 %) among under-five children in Nigeria [5].

The African Development Bank [22], submitted that, in 2006, 32 African countries belonged to low income countries (LICs) with $785 or less per capita income, 14 belonged to the low middle income countries (LMCs) with per capita income range of $786-$3,115, and only 6 belonged to the upper middle income countries (UMCs) with per capita income range of $3,116-$9,636. Poverty in Nigeria, which constitutes one-quarter of Africa's population [6], is critical to Africa's development. Yet, the Nigeria's National Bureau of Statistics [23] revealed that poverty rose in Nigeria from 51.6 % in 2004 to 62.8 % in 2010 and 71.5 % in 2011. Table 2.2.1 shows relative poverty in Nigeria from 1980 to 2010. The proportion of non-poor dwindled from 72.8 % in 1980 to 31 % in 2010. On the other hand, moderately poor increased from 21 % in 1980 to 30.3 % in 2010, while extremely poor increased from 6.2 % in 1980 to 38.7 % in 2010.

Table 2.2.1*: Relative poverty in Nigeria: Non-poor, Moderately poor, and Extremely poor (%), 1980-2010*

Year	Non-poor	Moderately poor	Extremely poor
1980	72.8	21.0	6.2
1985	53.7	34.2	12.1
1992	57.3	28.9	13.9
1996	34.4	36.3	29.3
2004	43.3	32.4	22.0
2010	31.0	30.3	38.7

Source: NBS, Harmonised Nigeria Living Standard Survey (HNLSS) [24]

Table 2.2.2 shows the relative poverty headcount from 1980 to 2010. Poverty incidence increased from 27.2 % in 1980 to 69 % in 2010, when the estimated populations were 65 million and 163 million respectively for 1980 and 2010. On the other hand, population in poverty increased from 17.1 million in 1980 to 112.47 million in 2010.

Table 2.2.2*: Relative Poverty Headcount from 1980 to 2010*

Year	Poverty Incidence (%)	Estimated Population (million)	Population in Poverty (million)
1980	27.2	65	17.1
1985	46.3	75	34.7
1992	42.7	91.5	39.2
1996	65.6	102.3	67.1
2004	54.4	126.3	68.7
2010	69	163	112.47

Source: NBS, Harmonised Nigeria Living Standard Survey (HNLSS) [24]

Water is a common factor to Africa's food, fuel and water crises, to which good water management is basically the solution, and one of the main keys to sustainable development in Africa. About 94% of Africa's hydropower potential is unused. Harnessing this energy will create food through enough storage capacity to multiply irrigated farmland many times over. Access to water is a prerequisite to help Africans escape dehumanizing effects of mass poverty, to give them a future and to advance the development of the African continent [3].

For their domestic needs, many Africans helplessly fall back on contaminated water sources because they cannot afford the high cost of water treatment. Besides, across the continent, there is the common belief that water is not polluted enough to be lethal. Thus, ignorance plays a part here. The consequent water-related problems include miscarriages, birth defects, and infantile health challenges, such as methaemoglobinemia *(Blue baby syndrome)*, dehydration, and malnutrition. Other health maladies suffered by children as a result of water crisis are loss of work and school days equivalent to 3-5% GDP, loss of parents to high maternal mortality rate (MMR) and sanitation-related low life expectancy, which afflict children, leading to high mortality rate and morbidity of infants and under-five children [10]. The African Development Bank [9] reported that the MMR was greater than 100 per 1,000 for 17 African countries, between 11 and 99 per 1,000 for 35 African countries, and none of the countries had less than or equal to 9 per 1,000. Average MMR was 84 per 1000 for African countries in 2006.

Sixteen African countries had infant mortality rates (IMRs) above 100 per 1,000 in 2006. In the same year, nine other countries in the continent recorded IMR between 77.5 and 92.6 per 1,000, ten others recorded between 57 and 72.7 per 1000, eight others recorded between 31.4 and 52.4 per 1,000, and only four others recorded between 14 and 25.6 per 1,000. The average IMR was 83 per 1000 [9].

The average under-five mortality rate (U-5MR) for African countries in 2006 was 138 per 1,000. Two countries recorded 250 and above per 1000, four countries recorded between 200 and 249 per 1000, seventeen countries had between 150 and 199 per 1000, fourteen countries had between 100 and 149 per 1000, and another fourteen countries had 100 and below per 1000 [9].

The occurence of diarrhoea is a measure of water availability, sanitation and hygiene. In Nigeria – the most populaous African nation - there were 673,692 reported cases of diarrhoea in 2003. The appaling figure increased to 732,728 for the following year, to 800,611 in 2006 and to 1,069,133 in 2007. The corresponding deaths were 2,368 (2003), 2,116 (2004), 2,093 (2006) and 2,454 (2007). Between 2003 and 2007, there was highest number of deaths from diarrhoea (4,190), even when there were fewer reported cases of diarrhoea (682,828) than the previous year and the succeeding year [25]. Diarrhoeal diseases were second to malaria as the main cause of infant mortality and morbidity [26]. Since good sanitation practices, which require good water supply, are preventive measures for diarrhoeal diseases, these high figures are directly related to water and sanitation crisis in Africa.

There is also the danger of having dull skin during water crisis. Heavy water causes irritation and discolouration of the skin. It is also responsible for poor water penetration and hydration of the skin, which leads to poor skin glow, radiance and complexion beauty [10].

In some developing African countries, the health and economic consequences of poor water management include 4.6 million deaths from diarrhoeal disease and a sizeable number of casualties from ascariasis [27]. In the West African sub-region, there are estimated 4 million cases of guinea worm, while about 500 million cases of trachoma leads to blindness of about 8 million people each year [28].

Studies have shown that zoonotic diseases (transmitted from animals to humans) are yet to be eliminated or fully controlled in above 80 % of the public abattoirs in Nigeria. Some of the infectious diseases are tuberculosis, colibacillosis, samonellosis, brucellosis and helminthoses [29].

Patronage of hospitals and other health care facilities is on the increase because of water-borne diseases. There is high incidence of typhoid, cholera, dysentery, infectious hepatitis and guinea worm in urban settlements of Nigeria [30]. People suffering from illnesses related to poor sanitation occupy 50% of hospital beds in sub-Sahara Africa. And, these illnesses account for a massive 12% of the health budget. Work and schooldays are lost to these illnesses, leading to 3-5% losses in Gross Domestic Product (GDP) [4].

Water management in Africa: The way forward

Eneh [9, 31, 32] submitted that purifying drinking water involves boiling, disinfection, filtration, and analysis. Toit [33] reported that hot water was often seen as a luxury commodity in South Africa, but it was a prerequisite for improved levels of health and increased quality of life. At present, low-income households spend a significant portion of their income on electricity or paraffin to heat hot water for cooking, cleaning and bathing purposes. Beside straining already limited incomes, this resource use pattern also contributes to unsustainable energy usage in South Africa. Solar water heaters (SWHs) provide a possible sustainable solution to the dual challenges of energy shortage and the lack of hot water availability. By installing solar water heaters on new, low-income houses, the electricity capacity requirement for new developments would be significantly reduced, while poor households would gain access to hot water. The solar water heating industry could also contribute considerably to job creation amongst currently unemployed persons in the Stellenbosch area. By identifying these opportunities, the SWH industry can become a strategic leverage point for local economic development (LED). Unfortunately the South African Solar Water Heater industry is still in its infancy and largely unable to meet even the existing demand from middle-income households with the total national manufacturing capacity estimated at only 10 000 units per annum. The high capital costs of installing SWHs (between R7 000 and R20 000 per unit means that the technology remains totally beyond the reach of low-income consumers.

The CJTF-HOA Water Resources Programme (WRP) of Djibouti, Ethiopia and Kenya aims to develop the knowledge and skills necessary for Africans to more effectively manage their own water resources. It is being extended to Uganda and Tanzania. Only after surface and groundwater resources have been accurately and objectively identified, characterized, and quantified can truly good water policy decisions be made [34]. Chipompo et al [35] reported that regulatory bodies in the Water and Sanitation Sector in Zambia were not financially, functionally and institutionally independent.

Swaminathan [36] opined that water security is fundamental to food, livelihood and ecological security. All the sources of water should be harnessed and managed in an equitable manner. This will involve saving rain water, augmenting surface water, managing the aquifer, recycling of all industrial effluents and waste water, and harnessing sea water. Thus, there should be an integrated strategy for conserving and managing sustainably and equitably ground, surface, rain, waste and sea water. Local level water users' associations can ensure the sustainable and equitable use of the available water. Education (water literacy), social mobilization and regulation will be the three pillars of a sustainable water security system.

Ntifo [37] submitted that it is a failure to society that there is excess water through flooding and yet insufficient basic water supplies. Townsend [2] urged scientists, technologists and engineers to work together to develop not just ideas, but innovative technologies to provide sustainable solutions. Whole system approaches are required that cross some traditional, scientific, commercial, social and governmental boundaries.

Bunhu and Tichagwa [38] submitted that nanotechnology could play an important role in efficient, effective and low-cost removal of pollutants from water. An active emerging area of research is the development of novel nanomaterials with increased affinity, capacity, and selectivity for heavy metals, organic compounds and other contaminants. The benefits of using nanomaterials accrue from their enhanced reactivity, surface area and sequestration characteristics. Nanoadsorbents based on lignocellulosic materials (biomass), grafted polymer and nanoclay (montmorillonite clay), was used for removal of heavy metals and chlorinated organic pollutants from water. The chemical and physical properties of lignocellulose and montmorillonite clay, and also their wide availability make them attractive for the development of effective, efficient and lowcost adsorbents for water treatment and purification. Nanocomposites based on biomass and montmorillonite clay with smart adsorption properties were prepared via *in situ* intercalative graft polymerisation as well as solution blending. The prepared nanocomposite adsorbents were characterised and evaluated for their adsorption performance by carrying out batch adsorption experiments on selected heavy metals and chlorinated organic compounds. K'Owino et al [39] described the use of a palladium nanoparticles and sulphur mixture as a novel nanoremediation approach for the conversion of hexavalent chromium [Cr(VI)] to trivalent chromium [Cr(III)] to remove Cr(VI) from soil and water samples.

Gachanja et al [40] described the use of the root of *Maerua documbens* and seeds of *Moringa oleifera* in water treatment to remove pathogenic organisms and toxic substances making the water suitable for drinking, is of vital importance. The root of *M. documbens* reduced low turbid water (87 FTU) by 95% and very turbid water (137 FTU) by 50%, but was found to impart colour to the water after treatment. The seeds of *M. oleifera* reduced low turbid water (87 FTU) by 98%, very turbid water (121 FTU) by 77% and impacted no colour and odour on the treated water. In addition, the root of *M. documbens* and seeds of *M. oleifera* reduced pathogenic microbial count by 99% and 100% of the purified water respectively.

To address high levels of fluoride in drinking groundwater and cases of dental fluorosis caused by excess fluoride in drinking water, Kayira [41] reported on optimizing the use of bauxite for defluoridation of groundwater obtained from rural areas in Southern Malawi. Reduction of turbidity and removal of colour was done using sand and charcoal. The optimum bauxite dosage, retention time and combined dosage of sand/charcoal mixture were found to be 0.150 kg/L, 15.0 minutes and 0.720 kg/L respectively. The specific water yield was 6.68 L. At the optimized conditions fluoride is reduced from 6.17 ppm to 0.14 ppm, representing 97.67 % removal, and a defluoridating capacity of 0.034 mg F/ g bauxite. The high per cent removal is comparable to those reported elsewhere for materials of similar composition to bauxite though at lower dosages. The low defluoridation capacity may be attributed to high water pH which is unfavourable for fluoride removal, since the hydroxide ions compete with fluoride for adsorption. Turbidity is reduced from 9.42 NTU to 5.24 NTU using the combined dosage of sand/charcoal mixture and the red colour of treated water is removed. Other water quality parameters in the defluoridated water are below the WHO recommended guideline values. Therefore this work has established the feasibility of using raw bauxite in the designed defluoridator for abating high fluoride levels in groundwater in rural areas of Malawi.

Onindo et al [42] described the use of water hyacinth, *Eichhornia crassipes*, a weed of low economic value and abundant in inland water systems, for removal of lead (II) ions from aqueous solutions. The influence of various parameters such as effect of pH, contact time, adsorbent dose, and initial concentration of metal ions on the removal was evaluated by batch method. The sorption process was found to be relatively fast and the equilibrium was reached in about 100 minutes of contact for lead (II) ions. Uptake of lead (II) ions on the *Eichhornia crassipes* showed a pH-dependent profile with an optimal value at pH 5. The maximum metal uptake value was around 163 mg/g. The experimental sorption equilibrium data were fitted by both Langmuir and Freundlich models, with Langmuir providing the best fit (R2 > 0.99). The biosorption kinetics was determined by fitting first-order-Lagergren and Pseudo-second-order models to the experimental data, being better described by the pseudo- second- order model (R2 > 0.99). FTIR analysis confirmed the participation of carboxyl groups in metal uptake. Calcium and Magnesium nitrate salts were found to affect considerably the metal ion biosorption. A comparison of the maximum sorption capacity of several untreated biomaterial based residues showed that Eichhornia crassipes are suitable candidates for use as biosorbents in the removal of heavy metal ions from aqueous solutions.

Kofa et al [43] described the presence of arsenic in ground water exploitable for drinking purposes as a major concern in the world, particularly in some parts of Asia and Africa, owing to its adverse effects on human health, such as cancer, diabetes, hypertension and skin diseases. Among the technologies used for the removal of arsenic from water, adsorption on powder or granular material is very effective for moderate levels of contamination, and it is easily adaptable for well or borehole water, and local materials can be used. The most efficient adsorbents are oxides or hydroxides of tri- and tetra-valent metals, including aluminium and iron. Natural pozzolan is a low cost geomaterial available worldwide, especially in Africa, and is rich in aluminium and iron oxides. Two types (black, red) of natural pozzolan from Djoungo, Cameroon in powder form were used for the removal of arsenic as arsenate ion, As(V) from water. Adsorption was very fast, attaining equilibrium in 20 minutes and followed pseudo second-order kinetics. The maximum amount of As(V) adsorbed varied slightly (15 %) with pH between 5 and 9 in the absence of added electrolyte, but was strongly influenced by ionic strength above 10-3 M. The presence of calcium improved adsorption while sulphate depressed adsorption. The adsorption isotherms fitted the Langmuir equation. Both types of pozzolan gave similar results. It was ascertained that pozzolan can be used to purify water containing Arsenic, for example, at a pozzolan concentration of 10 g/L, and initial As(V) concentration of 50 μg/L, As(V) residual in water was lowered to below 5 μg/L, whereas the WHO allowed limit is 10 μg/L.

Reommendations

To effectively address the challenges of poor access to potable water, poor water management and their ugly consequences in Africa, the following recommendations are proferred:

1. Since preventive healthcare is ten times cheaper than curative care, sustained access to potable water should become a public priority as the best conceivable preventive healthcare. This will help decongest 50% of hospital beds in sub-Sahara Africa, save 12% of the health budget, and regain 3-5% losses in Gross Domestic Product (GDP) due to work and school days lost to water-related illnesses.
2. For attaining the MDG 7 target for water and sanitation in Africa, the current rate of 15 million Africans that annually gain access to improved drinking water source must be more than doubled, and the current rate of 10 million people that annually gain access to improved sanitation facilities must be increased five-folds.
3. Pro-poor health policies and increased health budgets are imperative.
4. To assure the quality and availability of safe water in Africa, individual, family, corporate and governmental efforts must be stepped up in urgently addressing the challenge of poor water management.
5. The people must be first sensitized and enlightened on appropriate responses to corruption and lack of governance in the water sector in Africa.

Conclusion

It is indeed a failure to the African society that there is excess water everywhere in the continent, and yet insufficient potable water supplies. Poor access, poor management and corruption in the water sector network to exacerbate health maladies through poor sanitation and malnutrition in Africa. Beside the appalling lot of the present generation, inter-generational factors point to unsustainable development and heartless strides toward achieving the MDG No. 7 for water and sanitation in 2015. Politicians and academics ought to work together to develop ideas and innovative technologies to provide sustainable solutions. Whole system approaches are required that cross some traditional, scientific, commercial, social and governmental boundaries.

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