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A review of Ghana's water resource management and the future prospect

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Abstract: Water covers about 70% of the earth's surface and it exists naturally in the earth in all the three physical states of matter and it is always moving around because the water flows with the current. Out of the earth's percentage of water covering the surface, only about 2.5% is fresh water and due to the fact that most are stored in deep groundwater, a small amount is readily available for human use. Water scarcity is becoming a major concern for people around the world and the need to protect the existing ones and find ways or means to provide safe water for individuals around the globe in adequate quantities with keeping the needs of future generations in mind. Water is life, and it is linked with lots of services either directly or indirectly, such as; human health and welfare and social and economic development of a community or country. The need to delve into Ghana's water resources management is essential. The study reviewed existing literature on the various members of the Water Resource Commission (WRC) in Ghana; the various basins in the country; the existing measures that the WRC authorities have in place to deal with water resources management issues; the challenges that hinder the progress of their achievements and some suggestions that if considered can improve the current water resources management situations in Ghana.

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PUBLIC INTEREST STATEMENT

Ghana as a country has a standing history with small scale mining of gold, it existed as far back as the eighth century as a household economic activity. In spite of these influences, the industry has a number of negative effects on the environment and most significantly water bodies. River bodies that were the main source of water for drinking, household chores and other activities have been destroyed by these activities of illegal small scale mining of gold. The paper reviewed existing literature on the basins in Ghana, the existing measures put in place by Ghana Water Commission to deal with water resources management issues and the challenges that hinder the progress of their achievement. Recommendations are made to ensure the efficient use of water across all the sectors that ensures sustainable water withdrawals, the demand and supply of freshwater in order to address water scarcity in the future prospects.

Subjects: Civil, Environmental and Geotechnical Engineering; Pollution; Water Engineering; Water Science

Keywords: water resources management; Ghana; basins; illegal mining; water weeds; renewable energy; climate change; groundwater; environmental sustainability engineering

1. Introduction

Water resource management refers to the skilful and efficient planning of the scarce fresh water resources available for the consumption of the entire human population. These water resources are composed of all surface water and underground water that can be treated for human use. In water resource engineering the focus is mainly turned towards the conception planning design tendering construction and operation of the water resource systems such as dams, water treatment systems, water supply systems waste water collection and removal systems among others (Yanmaz, 2013).

Proper management of water resources is necessary for quality control operation and treatment of water resource systems. According to Pahl-Wostl (2007), having an uncontrolled urbanization in developing and threshold countries will lead to excessive pressure on the available water resources. Water has to be controlled in order to prevent loss of lives, excessive damage to private and public properties. As such the branches of urban hydrology and hydraulics in civil engineering deals with the design and proper planning of every kind of control facilities which includes storm drainage systems, measures of flood mitigation like dams and diversion weirs, design of main road culvert systems among others (Yanmaz, 2013).

The bio-assimilation strategy which involves the use of physical and biological processes that are employed to reduce, convert and store pollutants on land before they are released to the aquatic system is considered to be the most ecological, sound sustainable and cost effective approach that can be used to restore water quality conditions in the low lying streams (Osborne & Kovacic, 1993). This helps a great deal in making sure that river basins and streams are protected from pollution and can be effectively used for various purpose.

Water is all around us yet not every individual or country has access to potable water that meets their basic needs (health, sanitation and recreational activities) and development. The earth's surface is covered with about 70% of water and it is the only substance that exist naturally on earth in all the three physical states of matter (solid, liquid and gas) and it is always on the move. With all the water on earth only about 2.5% is fresh water and because most of the water is stored in deep groundwater, only a small amount is easily available for human use. Therefore, ensuring that adequate supply of water is available for human use is essential (Oki & Kanae, 2006). The aim of the study is to review existing literature on the various members of the Water Resource Commission (WRC) in Ghana; the various basins in the country; the existing measures that the WRC authorities have in place to deal with water resources management issues; the challenges that hinder the progress of their achievements and some suggestions that if considered can improve the current water resources management situations in Ghana. In essence, the study will inform the public on the importance of improving water quality by reducing natural and artificial pollution and inform Government on the need to protect the water ecosystems towards achieving equitable access to safe and affordable drinking water.

The increasing number of population around the globe, especially in developing countries poses a threat to the water resource and whether it would be sustained for future generations hence the need to manage the resource. As water moves with time and space steadily with the hydrologic cycle, the term 'water management' extends over a wide variety of activities and discipline. Water management can be divided into three classifications: managing the resource, managing water services, and managing the trade-offs needed to balance supply and demand (United Nations, 2014). Water resource management is of great importance to countries and the world at large of which Ghana is no exception.

The management of water resources in Ghana is regulated by the WRC of Ghana. The WRC of Ghana was established by an Act of Parliament (Act 522 of 1996) with the obligation to regulate and manage Ghana's water resources and co-ordinate government policies in relation to them. Act 522 of 1996 specifies that ownership and control of all waters are vested in the President on behalf of the people, and plainly defines the WRC as the overall body responsible for the management of water resources in Ghana (WRC Ghana, 2015a).

The aim of the study is to review Ghana's water resource management in order to create awareness on water conservation and the efficient use of water across all the sectors that ensures sustainable water withdrawals, the demand and supply of freshwater in order to address water scarcity in the future prospects.

1.1. Members of the WRC

The WRC, Ghana is made up of 15 members, including the Chairperson, the Executive Secretary, a Chief and two other persons, of whom one shall be a woman (WRC Ghana, 2015a). The rest of the representative institutions are depicted in Figure 1.

1.2. Basins in Ghana

According to the WRC of Ghana, Ghana has five basins namely (Figure 2): the Densu River basin, Ankobra basin, Pra basin, Tano basin and White Volta basin (WRC Ghana, 2015c).

1.2.1. Densu River basin

The Densu basin is located in the south-eastern part of Ghana and lies within longitude 10° 30'W–10° 45'W and latitude 5° 45'N–6° 15'N. It shares its catchment boundary with the Odaw and Volta basins to the east and north, the Birim in the north-west and Ayensu and Okrudu in the west. The basin

Figure 1. Representative institutions of Ghana's water resource management.



Figure 2. The main basins in Ghana.



has an area of about 2,490 km² and spans eleven local government assemblies in the three regions, namely; Greater Accra, eastern and central regions respectively. There are about 200 settlements in the basin and the total population is over 600,000 equivalent to 240 individuals per kilometer square. The soils are mainly well drained, friable, leaky, loamy savanna mostly reddish brown.

1.2.2. Ankobra basin

The Ankobra basin is bounded to the east, west and south by the Pra basin, Tano basin and the Gulf of Guinea respectively. It is located within latitudes 4° 52'N and 6° 27'N and longitudes 1° 42'W and 2° 33'W (WRC Ghana, 2015d). According to WRC Ghana (2015b), the basin has an area of about 8,403 km² covering eleven districts in the area of Wassa Amenfi, Wassa West and Nzema East Districts. The Ankobra basin falls under the south-western equatorial and the wet semi-equatorial climatic regions. The south-western equatorial is the wettest climatic region in Ghana with an annual mean rainfall above 1,900 mm and vegetation consists of rainforest as well as semi deciduous forest.

1.2.3. Pra basin

The Pra basin is located between latitudes 5° N and 7° 30'N and longitudes 2° 30'W, and 0° 30'W in the south central of Ghana. The drainage network comprises the main Pra and its major tributaries of Birim, Anum and Offin rivers and their tributaries with a drainage area of about 22,106 km², with an average elevation of about 300 m and generally less than 600 m above sea level. It features Lake Bosomtwe, which is a natural lake that stands out as prominent protected area (WRC Ghana, 2015e).

1.2.4. White Volta basin

The White Volta river system extends through Togo, Burkina Faso and Ghana. It spans three administrative regions in Ghana, i.e. all the upper east region, 70% of the upper west region, and 50% of the northern region. The White Volta River basin in Ghana is located between latitudes 7° 30'N and longitudes 0° 0'W. The drainage area within Ghana is about 44% of the total area of the White Volta river system.

The White Volta River and its main tributaries in the northern part, the Red Volta (Nazinon) and the Kulpawn/Sissili rivers, take their sources in the central and north-eastern portions of Burkina Faso. It contributes on an annual basis, on average some 20% of the inflow to the Volta Lake and hence is

an essential element of the hydropower generated at Akosombo Dam and Kpong power stations in the lower Volta (WRC Ghana, 2015c).

1.2.5. Tano basin

The landscape of the Tano basin, ranges between 0 and 700 m above sea level. The climate of the basin falls partly under the wet, semi-equatorial and partly under south-western equatorial climate zones of Ghana, thus characterized by double rainfall maxima (USAID, 2011). The Basin is located in the south western part of Ghana and lies amid latitudes 50°N and 70° 40'N and longitudes 20° 00'W and 30° 15'N. Arable lands occupy the highest percentage of the total land mass, which is 50%. There is commercial farming of cocoa, plantain and other food crops. About 10% of the land mass is used for human settlement and the remaining 40% of it is covered by forests which are principally protected (WRC Ghana, 2015c).

2. Water resource management

Water is essential to all forms of life and needed in sufficient quantity and quality to sustain life. With the increasing human population around the globe, with a current population of about over seven billion people and the growth of technology require human society to devote more and more attention to protection of adequate supplies of water. Degradation of water resources has long been a concern of human society (Karr, 1991). Water can be managed in various number of ways provided there is a joint effort to achieve the goal of protecting the fresh water resources available.

2.1. Water resource management in Ghana

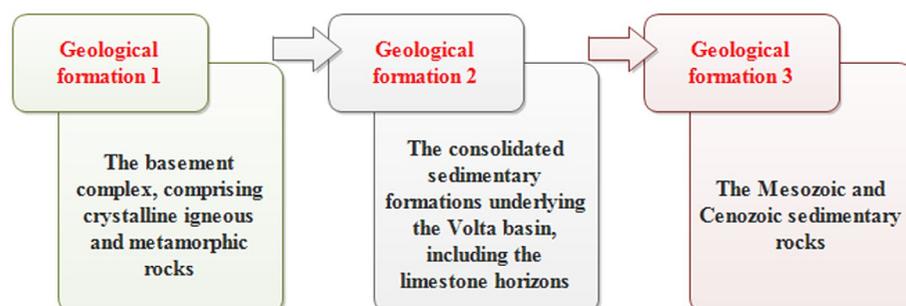
Ghana is privileged to have adequate water supply for its indigenous if managed properly. According to USAID (2011), the occurrence of groundwater in Ghana is related with three main geological formations as showed in Figure 3.

One percent is obtained from the Mesozoic and Cenozoic sediments, 54% in the basement complex and 45% over the Volta in the formation of the country. The aquifer depths of the country are normally between 10 and 60 m, and yields seldom surpass 6 m³/h. In the Mesozoic and Cenozoic formations occurring in the extreme south-eastern and western part of the country, the aquifer depths vary amid 6–120 m. There are as well limestone aquifers some of which are 120–300 m in depth, with an average yield as high as 180 m³/h. Groundwater resource in Ghana is generally good except for some cases of localized pollution and areas with high levels of iron, fluoride and other minerals (USAID, 2011). Some coastal aquifers especially have their groundwater being salinized (WRC Ghana, 2015f).

2.1.1. Activities undertaken to manage Ghana's groundwater resource

There are a lot of activities the regulators of water resources in Ghana put in place to ensure a sustainable water resource for the country and future generations. These are as follows (WRC Ghana, 2011);

Figure 3. Geological formation of the occurrence of groundwater in Ghana.



- Awareness creation, education and training of stakeholders through radio and television programs, newspaper articles, community Durbar's, etc.
- Carry out field operations to control pollution.
- Check illegal mining activities which of late has become a challenge to regulators because lots of water bodies are being destroyed.
- Stop encroachments around water bodies.
- Dredge sections of the river to prevent flooding where necessary.
- Running of ecological and water quality monitoring.
- Initiating establishment of regulated buffer areas to protect the quality of open water bodies (rivers and lakes).
- Adopting programs targeting the management of water resources, such as Integrated water resources management (IWRM) and ensuring its completion.
- Strengthen policies and regulations for the protection and long-term sustainability of Ghana's groundwater resources.

2.1.2. Usage of water resources in Ghana

In Ghana, the major consumptive uses of the water resources are water consumption, irrigation and livestock watering. Domestic and industrial urban water supplies are based almost entirely on surface water, either lock up behind small dams or diverted by levees in rivers. Water supplies in rural areas, however, are obtained almost entirely from groundwater sources. The various groundwater development programs have resulted in the drilling of more than 10,000 boreholes nationwide (UNFCC, 2011).

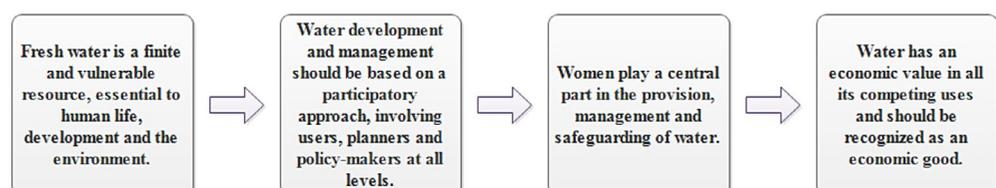
The main non-consumptive uses are hydropower generation, inland fisheries and water navigation. In Akosombo, is the Akosombo Dam, located 100 km from the mouth of the Volta, the first Volta hydroelectric dam which was constructed in 1964, which created one of the largest man-made lakes in the world, covering an average area of about 8,300 km² (Mensah, 2010). Another hydroelectric dam was constructed in 1981 with an area covering about 40 km² and it is located 20 km downstream of Akosombo. Rainwater harvesting has also become common and has a great potential to increase water availability in certain localized areas (WRC Ghana, 2015f).

2.2. Integrated water resources management

The basic ideas of IWRM emerged decades ago. According to Giordano and Shah (2014), they are a call to consider water holistically, to manage it across sectors, and to ensure a broader participation in decision making. It is to bring to an end the fragmentary approaches to water resource management and other development decisions made for the benefit of a single group or section. These concepts an exceptional point of considering the improvement in water management and governance, and they have been formalized as what has now become in capitals, IWRM, with specific prescriptive principles whose is operated frequently sustained by donor funding and international advocacy.

The roots of IWRM can be traced back to the establishment of the Tennessee Valley Authority in 1933 (Stålnacke & Gooch, 2010). The next major landmark in the development of the concept was in 1977 at the International Water Conference in Mal del Plata. The emphasis of the conference was on coordination between different water sectors, primarily at the national level. The issues were given further attention at the 1992 Dublin conference, preparing for the Earth Summit in Rio de Janeiro (Stålnacke & Gooch, 2010). The Dublin statement included the following principles showed in Figure 4.

Figure 4. Principles of IWRM.



2.2.1. Implementation of IWRM in Ghana

Ghana is primarily rural; about 56.6% of its population live in rural areas. These rural people are the most deprived in terms of access to safe drinking water and other socio-economic infrastructure. According to Anokye and Gupta (2012), elements of the IWRM include a holistic, integrated approach and the main principles of public participation, the role of gender and the notion of recognizing the economic value of water.

Ghana as a country is keen on protecting its water resources, with traditional authorities in the primitive years used to give regulations and taboos in order to protect these water bodies. Even before the WRC was given the sole mandate in 1996 of managing water resources in Ghana, a policy was launched in 1994—The National Community Water and Sanitation Program to ensure that water resources were protected. The WRC of Ghana adopting the IWRM in its approach to manage its water resources was a good decision made.

As the IWRM stresses the significance of involving all stakeholders; authorities, organizations, the public and private sectors, non-state actors and civil society in the management of water resources, Ghana is doing same with the WRC decentralizing its roles by the generation of boards in the various major basins in the country, involving municipal authorities and district authorities as well as equipping them with appropriate tools to aid their work, to explain to the community stakeholders their roles as well as members of the community and particularly the involvement of women at all stages.

It also creates awareness of the importance of water among policy-makers and the public (Lonergan & Brooks, 1994), also involving users of water in the planning and implementation of water projects, as decisions arrived at might cater more for the needs of the public. It also in cooperates members of the community in the management, operation and maintenance of facilities (Anokye & Gupta, 2012; WRC Ghana, 2015c).

3. Challenges in the management of water resources in Ghana

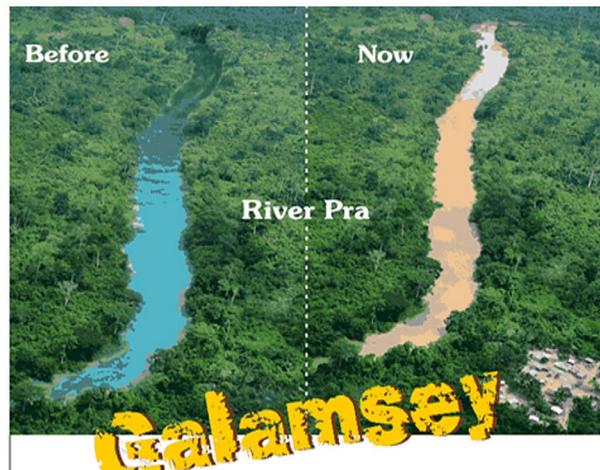
During this search, there were a number of challenges identified to be hampering the progress of water resource management and sustainability in Ghana by the WRC and its affiliated bodies. This paper would like to focus on these; illegal mining activities, pollution, improper agricultural activities, climate change and proliferation of water weeds or otherwise known as seaweeds.

3.1. Illegal mining activities

Ghana as a country has a standing history with small scale mining of gold, it existed as far back as the eighth century as a household economic activity. It was legalized when the Small Scale Mining Law (PNDCL 218) 1989 was passed and public policies formulated to ease the implementation of the law (Kessey & Arko, 2013). Since then, the industry has become a major contributor to the total quantity of gold Ghana produced and an employer to a lot of the rural labor force. The household name for small scale illegal gold mining is “Galamsey”.

In spite of these influences, the industry has a number of negative effects on the environment and most significantly water bodies. River bodies that were the main source of water for drinking, household chores and other activities have all been destroyed by these activities of illegal small scale mining of gold. Subsequently, the small scale mining industry of gold is getting more damaging as a second largest pollution after agriculture in Africa (Kessey & Arko, 2013) and in Ghana causing more deaths each day as well as destroying the water resource available making the work of the WRC more challenging dealing with. All the chemicals, especially mercury that is from the mercury-gold amalgamation process is dumped back into the river bodies as well as the washing of their gold dust and oils from the generators used for drilling. Figure 5 shows a pictorial view of the extent of damage done to water bodies in Ghana.

Figure 5. Illegal mining activities destroys river body (MyJoy, 2015).



Aside illegal mining activities of gold, sand winning in and around water bodies is also destroying water bodies in Ghana. In the sea it enhances sea erosion and disrupts aquatic life which are essential in the management of water resources. Figure 6 shows a pictorial view of illegal sand winning along the coastal shores of Ghana.

3.2. Waste and chemical pollution

Water is in limited amount all over the world and without water, the rest of our earthly habitat could not have sustained us; almost everywhere, increasing amounts of organic waste and industrial pollutants threaten water resources quality and availability (Karr & Chu, 2000). At Ghana indiscriminate disposal of organic waste from homes and chemical waste from industries been dumped into water pollutes the water bodies a lot.

The Korle Lagoon in Accra, Ghana, has become one of the most polluted water bodies in Ghana. It is the main outlet through which all major drainage channels in the city empty their waste into the sea (Asumadu-Sarkodie, Owusu, & Jayaweera, 2015; Asumadu-Sarkodie, Owusu, & Rufangura, 2015). Large quantities of untreated industrial waste emptied into open drains has led to severe pollution in the lagoon and disrupted its natural ecology. This has made it challenging for the authorities to manage the situation, but efforts are still being made. The net effect of these activities is that, at the slightest rainfall observed, the lagoon overflows causing flooding in its environs (Owusu Boadi & Kuitunen, 2002).

Figure 6. Illegal sand winning activity (GNA, 2015).



3.3. Improper agricultural activities

In Ghana, most of the occupation of the rural communities are crop production or livestock rearing and most of Ghana's water resources are located in these rural areas and the improper activities such as improper application of fertilizers, livestock's going out to graze and drink by themselves in water bodies, chemical such as DDT used for fishing, high intensity lights for fishing and the cultivation crops along river banks ends up polluting these bodies.

Research in the Densu River basin by Karikari and Ansa-Asare (2006), concluded in their results that the poor microbial activity observed might be due to contamination caused by human and livestock. With the humans, it was a common practice for people living along the catchment to discharge their domestic and agricultural waste into the river and the livestock's defecating and urinating in the river bodies. The high turbidity also observed by the group in the basin was attributed to poor farming activities such as intensive agriculture, resulting in large quantities of top soil ending up in the river after a heavy rainfall.

3.4. Climate change

Climate change a known situation in the 21st century has taken the centre stage in the development agenda of both developed and developing countries. Its main cause is credited to the increasing emissions of Carbon dioxide and other greenhouse gases (Nitrous Oxide, Nitric acid, Methane, Chlorofluorocarbons, etc.) and subsequently increasing temperatures in the atmosphere (Asumadu-Sarkodie & Owusu, 2016b, 2016c, 2016f; Asumadu-Sarkodie, Rufangura, Jayaweera, & Owusu, 2015; Kankam-Yeboah, Amisigo, & Obuobi, 2011).

There is a known fact that the climate in Ghana has changed significantly with impacts being felt everywhere in the country, especially on water resource management; with research showing that there is increased evaporation, decreased and highly variable rainfall pattern, and frequent pronounced flood and drought situations (Asumadu-Sarkodie, Owusu, & Jayaweera, 2015; Asumadu-Sarkodie, Owusu, & Rufangura, 2015). The impacts of the rising temperature are during the dry season (December–March). Also, there have been intensive rainfall events causing flood situations such as the recent event one, on the 3rd June 2015 in Accra, Ghana's capital, together with an explosion at a Goil fuel oil filling station that resulted in a death toll of over 152 lives and the loss of properties worth millions of Cedi's and the pollution of water bodies around the catchment area, affecting the freshwater quality (Asumadu-Sarkodie, Owusu, & Rufangura, 2015).

A research conducted by the Council for Scientific and Industrial Research-Water Research Institute (CSIR-WRI) showed that aside climate change considerations, Ghana is predicted to become a water stress country by 2025. In the aspect of increases in the frequency and severity of extreme weather events, it is most likely that the climate change scenario will worsen future water scarcity in many places in the country (Asumadu-Sarkodie, Owusu, & Rufangura, 2015; Kankam-Yeboah et al., 2011).

3.5. Proliferation of water weeds

Aquatic weeds are sophisticated plants that grow in water or in wet soils, which are mostly not desired. They grow in profusion and usually occur along the shores of water bodies like dams, lakes, along rivers and river mouths. The menace of water weeds is reaching worrying extents in many parts of the world, particularly in tropical water bodies where they have led to ecological, economic losses and the challenge of managing water resources efficiently and Ghana is no exception (Aloo, Ojwang, Omondi, Njiru, & Oyugi, 2013).

In Ghana the most affected area is the Tano/Abby/Ehy Lagoon complex as well as along 25 km of the river from the convergence of the Tano river with the Lagoon complex, which poses a threat to the aquatic life, the quality of the water and the management of the water body for the authorities (WRC Ghana, 2015c).

4. The future prospect

Section 4 outlines possible solutions towards water resource management in Ghana.

4.1. Incorporating customary water management

Prior to the colonial era traditional leaders used to manage water resources and they did a good job to maintain and manage these resources. This was achieved by the leaders by ploughing, contouring, clay pots in storing water, wells being dug, homestead ponds, rainwater harvesting, taboos/totems, etc. Some examples of taboos/totems are: in some communities' water bodies are not to be visited or, so to speak disturbed on a particular day within a week, because water bodies are termed to be "spirits"; also livestock were not to be found around or graze along streams and river bodies; No cutting of trees along the river banks as well as the pollution of river bodies; Fishing activities were not allowed in any river bodies, etc.

These methods and practices epitomized the practices of ethnic groups. It helped to minimize deforestation, soil erosion and also was to allow the ecosystem replenish itself (Atampugre, Botchway, Esia-Donkoh, & Kendie, 2015). If these are incorporated into the governments' management it would go a long way in improving and sustaining water resources in Ghana.

4.2. Increasing awareness of the dangers of illegal mining and education

In dealing with the problem of illegal mining destroying a lot of water bodies in Ghana, the governments with their task force going to around these sites, arresting the culprits but still after the raid people would still go back. Even though the pits they dug for the mining ended up killing some of their members they would still go back, this is evident that all the measures in place to stop these illegal miners so far it has not been assisting in the combating of this act.

An increased awareness of the dangers of illegal mining to these miners and also to their environment in relation to the future of generations yet to be born. Behaviour change cannot happen overnight, but with proper advocacy and well planned awareness creation as well as behaviour change communications to these miners in the affected areas can go a long way to help improve the situation.

Education on the license being given for small scale mining should be intensified and after giving the miners the license, they should be educated on how cover their pits to avoid dangers posed to their lives as well as others and also how it should be away from water bodies and they not destroy these bodies.

4.3. Renewable energy resource for mitigating climate change

Climate change has become a global phenomenon and of interest to all parties involved around the world. Even if a particular country is not emitting most of these greenhouse gases, they have been affected since the atmosphere is a unit. In Ghana, if there is a contribution to this, it would be the felling of trees for timber and burning some to be used as a source of fuel (charcoal) for cooking (Asumadu-Sarkodie & Owusu, 2016a; Owusu & Asumadu-Sarkodie, 2016). Also, liquid fuels used in cars with bad engines, ending up producing fumes from the exhaust pipes of these vehicles which are mainly Carbon monoxide gases.

To address the above, the use of the charcoal must be minimized and replaced with Liquefied Petroleum Gas which the government of Ghana is trying to achieve by giving out some cylinders to some rural areas since they use a lot of wood in cooking and also with stricter measures by the Forestry Commission of Ghana to the indiscriminate felling of trees.

All round the world today there is an advocate for the use of renewable sources of energy to mitigate climate change and is proven to help. Ghana can also go into new emerging, renewable sources of energy such as Solar and Wind and also increase investments in hydropower, which is already present in Ghana but facing challenges (Asumadu-Sarkodie & Owusu, 2016d, 2016e).

4.4. Stakeholder specific responsibilities

In Ghana most of the water bodies and resources are mostly in the rural areas. In this, assigning specific duties to stakeholders of small communities as to how they can help protect and restore their water resources and its related ecosystems by these roles, as well as equipping them with the adequate materials needed to do so. In addition to this, improving sanitation in communities would also help protect water resources, which should also be added to their responsibilities.

4.5. Investment in wastewater treatment

In Ghana a lot of untreated waste-water is likely to end-up in storm water drains or gutters, lakes, streams, etc. Which intern pollutes some good drinking water bodies in case of flood situations or disruptions in drainage pathways. Total waste-water production annually in Ghana is yet to be evaluated, because there is little or no data on industrial and commercial production except that from domestic sources and out of this only about 8% of it (Waste-water – Domestic) undergo some degree of treatment in Ghana (Gyampo, 2012).

If a lot of research goes into the treatment of waste-water in Ghana and invested in it, as well as the assurance given to the population that it is safe and can be used. In attaining this it would go a long way to minimize shortages of water and improve groundwater recharge since a lot are used for irrigation purposes, which in turn will improve the management of water situations in Ghana.

5. Conclusion

Water covers about 70% of the earth's surface and it exists naturally in the earth in all the three physical states of matter and it is always moving around because the water flows with the current. Out of the earth's percentage of water covering the surface, only about 2.5% is fresh water and due to the fact that most are stored in deep groundwater, a small amount is readily available for human use. Hence, the goal of ensuring sufficient supply of water is available for everyone in our world at present and considering the future generations.

The paper aimed at considering the whole picture of water resource management in Ghana. A qualitative research was employed by reviewing papers and some credible web pages in the area of study. The study looked at the available water resources in Ghana (Basins-Ankobra, Densu, Pra, Tano and Volta), Water resource management in Ghana, Incorporating IWRM in Ghana, Challenges that the Ghana Water Commission is facing in the management of water and some recommendations that can help improve the management of water resources in Ghana.

IWRM adoption by Ghana is a good decision, but other measures or recommendations are needed to be considered to better the measures already put in place by the WRC. The Challenges identified during the study, that tends to hinder the work of the WRC of Ghana are as follows; illegal mining activities, waste and chemical pollution, improper agricultural activities, climate change and proliferation of water weeds.

Moreover, adopting scientific planning and strategies that reduces the factors that affect water loss such as rainfall harvesting, drip irrigation, landscape water use, soil improvements (soil moisture monitoring), furrow diking, metering and sub-metering are efficient measures of promoting water conservation in Ghana.

The aforementioned challenges can be addressed by taking these recommendations into consideration; incorporating customary water management, renewable energy resource for mitigating climate change, investment in waste-water treatment, stakeholder specific responsibilities and increasing awareness of the dangers of illegal mining and education.

In putting the above suggestions into account and implemented, the achievements of the WRC would improve a lot more and water resources protected and kept in adequate quantities for the populace and future generations to come.

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