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Groundwater Resource Management: A Way to Reduce Poverty in Africa

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Abstract: Groundwater accounts for a major percentage of the world's fresh water and it is fairly distributed all over the world. It has always been considered to be a readily available source of water for domestic, agricultural and industrial use. Various strategies have been adopted for the development and management of groundwater resource because of its importance to life. This presentation enumerated some of the factors affecting groundwater quality and its diminishing quantity. It also highlighted the effect of these on the economy, health and the environment. It was concluded that poverty can be reduced if conscious effort is made to develop and manage groundwater resource.

Key words: Groundwater, economy, health, environment, management

INTRODUCTION

The poor management of groundwater resource is one of the major causes of poverty in Africa and the poor level of education of the people on the importance of managing this resource makes the situation almost hopeless. Groundwater is a vital resource in theworld; it is a major driver of socio-economic development (Nwankwoala, 2011). It accounts for about 95% of the world's fresh water and it is fairly distributed throughout the world. It provides a reasonable constant supply which is not completely susceptible to drying up under natural conditions like surface water. Groundwater has always been considered to be a readily available source of water for domestic, agricultural and industrial use (Acharyya, 2014). Groundwater can be found almost everywhere. The water table may be deep or shallow and may rise or fall depending on many factors. Heavy rains or snow may cause the water table to rise or fall (Geissen *et al*., 2015). Groundwater is stored in and moves slowly through layers of soil, sand and rocks called aquifers. The speed of groundwater flows depends on the size of the spaces in the soil or rock and how well the space is connected. Groundwater is brought to the surface naturally through a spring or can be discharged into lakes and streams. This water can also be extracted through a well drilled into the aquifers. Groundwater supplies are replenished or recharged by rain and snow melt. In some areas of the world, people face serious water shortages because groundwater is used faster than it is naturally replenished. In other area groundwater is polluted by human activities. Aliewi and Khatib (2015) assessed the hazard and risk associated with the pollution of groundwater resources and the health of the people that depended directly on this sources for water supply.

In many parts of the world, groundwater management and development have contributed greatly to the improvement of the social and economic circumstances of human beings because it supplies various domestic, agricultural and industrial water needs. Therefore how to manage this all important resource has always been a problem that requires an urgent solution. Management strategies have been targeted on the development of groundwater resource while projects of various type and scales have been developed and managed in response to the increasing demand for water by communities and industries. Despite, the various benefits with the increasing demand, this resource is being over exploited in many areas resulting in a permanent depletion of the aquifer system and some other associated environmental and social consequences like land subsidence and water quality deterioration, water borne illnesses, affecting the productivity of labour, financial hardship due to personal water treatment, waste of productive time in search of potable water among others. Moreover, due to changes in land use and increase in the quantities and types of industrial, agricultural and domestic gases entering the hydrological cycle, a gradual decline in water quality resulted due to surface and subsurface pollution. Based on the above, it can be seen that poverty can be eradicated or reduced if groundwater resources are properly managed.

MATERIALS AND METHODS

Factors affecting groundwater quality and quantity: Sustainable groundwater resource development is the efficient management of existing groundwater resources as a source of water supply to meet the needs of the people and also to sustain its quality (Raghavendra and

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Deka, 2015). The quality of groundwater is affected by a number of factors ranging from chemical, soil properties and site conditions. Each of these factors is discussed as follows.

Chemical factor: The contribution of chemical components to water quality and quantity ranges from solubility, adsorption, degradation and volatility. As water seeps through the soil, it carries with it soluble chemicals, this process is called leaching. The more water soluble a chemical is the more likely it is to leach. The type of soil and the amount of organic matter present in it determines the rate of binding of chemical particles to the surface. Also, chemical compounds such as pesticides are broken down by heat, sunlight, micro organisms and a variety of physical and chemical properties. The longer these compounds stay in the soil, the longer they are available to seep into the groundwater. Furthermore, compounds that vaporize readily are said to be volatile. Highly volatile compounds may contaminate groundwater if they are also highly soluble in water.

Soil factors: This ranges from soil texture, soil permeability and the organic matter content. The relative proportion of sand, silt and clay determine the texture of a soil. This has effects on the movement of water through the soil and thus, the movements of dissolved chemical substances like pesticides. Soils that allow water to move down through them are said to be highly permeable. Therefore, dissolved chemical substances are carried along with water and as a result get to the groundwater. Also, the amount of organic matter in a soil affects the adsorption capacity of the soil and the amount of water the soil can retain. Soils with high organic matter content tend to hold the water and dissolved chemicals in the root zone where they will be available to plant and to eventual degradation.

Site conditions: This ranges from depth to groundwater, rainfall, geologic conditions and crop removal. The shallower the depth to groundwater, the less soil there is to act as a filter and the fewer opportunities there are for degradation and adsorption of chemicals. Also, if rainfall is high and soils are permeable, water carrying dissolved chemicals may take only a few days to percolate downward to the groundwater. The permeability of the geologic layers between the soil and groundwater also affects the possibility of contamination. Finally when crops are harvested, pesticides and their deposits that are absorbed within the plant are subjected to washing and processing procedures that remove or degrade much of the remaining pesticide residue.

Groundwater resource management: The groundwater management practice is often done to facilitate usage and development. As development progresses with more wells drilled and scattered over the basin then the challenges such as over exploitation, equitable sharing of water and degradation of water quality become apparent in many basins (Molobela and Sinha, 2011). A sustainable groundwater resource development depends on the understanding of processes in the aquifer system, quantitative and qualitative monitoring of the resource and the interaction with land and surface water development. For groundwater development to be sustainable, then the rate of extraction should be equal to or less than the rate of recharge. Jahromi *et al*. (2014) suggested that smart energy and water meter could be of great assistance in the monitoring and management of groundwater. In the same vein, Srinivas *et al*. (2015) was of the opinion that inference tool could be used to develop a model for groundwater quality assessment. Jianfei *et al*. (2012) suggested the importance of studying the utilization of groundwater resources for its sustainability. In situations where the rate of extraction is higher than the rate of recharge, it will result in continual lowering of water level or potentiometric level. A continual lowering of the water table will steadily increase the pumping cost and then it would not be economical to pump for many uses such as agricultural production. Therefore, groundwater resources development requires an assessment of the natural recharge process. Senanayake *et al*. (2016) came up with an approach to delineate groundwater recharge potential sites in order to address the challenge of scarcity of water. The quality of groundwater in aquifers can be affected by natural and human activities while the extent to which the quantity is affected varies with hydro geological and climatic conditions (Shekhar *et al*., 2015). A deterioration of groundwater quality is detected where there is a characteristic odour, colour or taste in consumed water or when the presence of polltant has an immediate effect on users of water. It is difficult to establish a simple cause of water contamination due to the possibility of contamination from various sources. One major strategy of addressing groundwater contamination is by land use planning.

By this, the producers of hazardous wastes are kept away from the areas overlying groundwater resources so that in the event of an accidental leakage, little damage will occur and once the contamination of a local groundwater supply has occurred, action must be taken to find and eliminate the sources. By making changes to the groundwater system, changes in the broader context of the water system may result. On the other hand, by making changes in the environment of other components of the water cycle, changes in the groundwater system can result. This is particularly evident where the groundwater system has hydraulic links with the surface water systems such as rivers, lakes, springs and swamps. A continual lowering of water table or pontentiometric level can result in land subsidence due to formation compaction in some hydrogeological environments. Many associated and potential problems like flooding, loss of property and human lives, severe deterioration of infrastructural facilities, groundwater pollution and health hazards have been attributed to the effects of excessive groundwater withdrawal and land subsidence. Shamir *et al*. (2015) pointed out the effect of change in climate on the availability of groundwater resources and its management. The impact of this was simulated by Lemieux *et al*. (2015). Policy options were drawn on groundwater and its relation to climate change and sustainable well-being of the less privileged (Acharyya, 2014).

The water content of living organisms ranges from 60-95%. Humans by composition are about 60% water. In order to sustain health, a human should drink from 1.5-2.5 litres of water daily (Molobela and Sinha, 2011; Pimentel *et al*., 2004) which is about 547.5-912.5 litres annually. If this is multiplied by the entire world population per year, the figure will be alarming. That is between $3.8325\text{-}6.3875\times10^{12}$ L, if the world population is taken to be 7 billion. This volume is just the amount consumed by drinking only, so it is obvious that life of man depends on water for maintenance and sustenance. Therefore, conservation of the world's water must be a priority of every individual, community and nation.

As much as our lives depend on groundwater, groundwater also depends on us. Therefore, to manage groundwater effectively, appropriate and consistent policies must be put in place and enforced (Omer, 2010; Glasser *et al*., 2007). Policies on the amount of water drawn from the subsurface per time or per annum must be in place so as to control groundwater usage. This will help solve the problem of groundwater overuse or depletion and this can be regulated by the number of boreholes drilled in a community and the number of artesian wells sunk. Also there must be policies on proper waste management so as to avoid the leaching of hazardous or contaminants into the subsurface. Also agricultural practises must be done with the safety of groundwater in mind so as to prevent contamination. Fertilizers and pesticide application must be reduced to the barest minimum especially in a well recharged area. There should be institutions and regulatory agencies that will be saddled with the responsibility to ensure compliance with these policies (Gesicki and Sindico, 2014; Acharyya, 2014). This institution will still oversee the maintenance and protection of water related infrastructures from vandalisation, obtain data and information for planning, recruit, train and re-train manpower, enlighten and orientate the public on the importance of managing groundwater resource, obtain adequate funding from the government (Omole, 2013).

RESULTS AND DISSCUSION

Various sources of groundwater contamination: One way to define water quality is based on the biological, chemical and physical conditions of water. Contamination on the other hand can be defined as the introduction of substance into the hydrological environment that can adversely affect water quality (Shekar *et al*., 2015). This is more often than not a result of human activities especially land use (Glasser *et al*., 2007). The quality of groundwater is affected by some activities that are industrial, domestic, agricultural and natural in sources. Some of these are as enumerated; subsurface percolation (septic tanks), industrial hazardous waste, open dumps, residential waste, surface impoundments, Grave yards, animal burial, open burning and detonation sites, radioactive disposal sites, pesticides applications, fertilizer applications, animal feeding operation, de-icing salts application, percolation of atmospheric pollutants, mining and mine drainage, Oil and gas wells and so on.

Effects of groundwater contamination

Health impacts: Good health begins with access to clean water. Studies have shown that half of the world's hospital beds are filled with people suffering from a water related disease. Contamination in groundwater could be due to biological, chemical or radioactive substances. Many naturally occurring and synthetic substances can cause biological injury, disease or death under certain conditions of exposure. Whether injury or illness occurs depends on many factors, including properties of the substance, dosage of the substance and exposure to the substance and characteristics of the individuals exposed. The various methods through which water contamination can be contacted include the following: Direct ingestion through drinking, inhalation of contaminants (during showering), skin absorption from water, ingestion of contaminated food and skin absorption from contaminated soil. Also, some chemicals are of high toxicity and can affect the liver, kidney. Pathogenic biological organisms that are present in groundwater include bacteria which are responsible for typhoid, bacillary dysentery, cholera gastroenteritis and tuberculosis then, we also have viruses and parasites which are equally dangerous to man. Finally, most groundwater contains trace levels of naturally occurring radioactive substances or their by-products. The types and levels vary from area to area depending principally on subsurface materials (Omer, 2010; Pimentel *et al*., 2004).

Economic impacts: As earlier stated the absence of potable water is a major factor contributor to poverty in the developing nations of the world. Just as the saying that health is wealth, so whatever tampers with the state of our health will also affect us economically because the resources that would have been used to improve on our livelihood would be channelled to some other directions. In the light of the above, we shall highlight the economic impact of inadequate potable water or groundwater resource on our industries, agriculture and households. We shall also see how this affects our environment. The economic impacts of inadequate water resource development are the following. Lack of potable water leads to higher operation and capital costs for industries, it causes degradation in the value of machines used for production, it affects the revenue generated by decrease in the quantity of products that are produced due to breakdown of machines. It also leads to decrease in farm produce due to damage to productivity of land, it leads to loss of revenue from discarding of food products unsuitable for consumption, it also leads to loss of output due to injury or total destruction to perennial plants and trees. It causes decrease in livestock productivity due to illness and even death. It results in unemployment due to decrease in production. Furthermore, household maintenance increases due to frequent cleaning and replacement of damaged pipes, plumbing and appliances. Finally, it brings about loss of income due to sickness (Nwankwoala, 2011; Pimentel *et al*., 2004).

Environmental impacts: Poor water resource management often produces unfriendly odour, bad taste and poor appearance which affect the environment and the residents due to air pollution and soil contamination. It also results in damage to vegetation, aquatic life, wild life and contamination of fish. Poor groundwater management can result in ground collapse often called land subsidence (Bovolo *et al*., 2009). This occurs when there is a loss of support below the ground due to the overuse of groundwater. Also excessive pumping of water in the coastal region can cause saltwater to move in land and upward, leading to saline water intrusion. Major change of land use such as the removal of vegetation can also lead to waterlogging and salinisation problems (Punithavathi *et al*., 2011; Omer, 2010) and this can be prevented by making provisions for adequate soil drainage system so that excess water and salts are drained from the soil (Pimentel *et al*., 2004).

CONCLUSION

The problem of groundwater affects everyone. As there is no alternative to potable water, then collective efforts should be made by all to develop and mange groundwater resources. The impact on individuals, population and the government cannot be over emphasized. Therefore, good quality water will not only keep us healthy and productive, it will also improve our lives, save our resources, protect our environment from degradation and improve the quality of our farm products thereby giving us more profits and reducing poverty in our world.

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