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Assessing the Environmental Impact of Water Borehole Drilling

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Abstract

Making a hole in the earth involves a technique called drilling. This study aims to explore groundwater and categorize different sorts of rocks. This information will be used to assess the aquifer, water level, pollution brought on by the dumping of solid wastes in the nearby settlements, influence on local species and ecosystems, and effect on vegetation. The gathered information will be used in models to evaluate common pollutants, groundwater movement and flow, and short-term and long-term effects on environmental quality. It is hoped that the results of this study will have a significant impact on how policies are created in the field of study as a whole.

Introduction

Water is necessary for human life, and its significance for both the health of a person and the welfare of a country cannot be overstated. The primary sources of safe water for domestic use, sustainable development, and human life are fresh water. It takes up roughly 70% of the planet's surface. A little over 97% of the earth's surface water is found in the oceans, 21% in polar ice and glaciers, 0.3-0.8% underground, 0.009% in inland freshwaters like lakes, and 0.00009% in rivers. Water is often thought of as a universal solvent that can dissolve a wide variety of substances, whether they are good for people or the environment. Nonetheless, it is necessary for all living creatures and the ecosystem. Around 52% of its inhabitants are thought to lack access to potable water as a result of governments' low water supply investments. The local population's access to fresh water sources is either dangerous or challenging. In some cases, women and children may walk for hours to gather simple drinking water; as a result, ground water has proliferated in many regions of the world.

ICRC (International Committee of the Red Cross), autonomous and impartial humanitarian organisation, its goal is to safeguard the lives and dignity of war victims and internal strife, as well as to offer them support. The ICRC offers water and sanitation through its Water and Habitat unit in numerous nations and crisis zones throughout the world. Millions of people's needs are being met by the world; the Hundreds of holes have been bored or restored by the Water and Habitat unit. The proliferation of boreholes may lead to a long-term environmental hazard and as well as pose a potential serious public health concern. The objective of this study is to elucidate the effect of the drilling of boreholes on environment [1, 2].

Methodology

Groundwater

A basic human requirement is to have easy access to safe, drinking water, essential to wellbeing and quality of life. A declaration like this Is now thought to be somewhat of a cliché, Though It must be noted that despite the increasing use of water Despite global shortages, there is still a need for a steady supply of water. Taken for granted with little consideration for sustainability and calibre. The places where this mentality is most glaringly apparent Where borehole water is used frequently, which, It is presumable that production will continue, at the same pace. Perpetually and continuously. There is no visible groundwater, and thus, it is generally out of sight but one of the richest sources of Bottled water that humans have developed.

Exploiting ground water

Rainfall is the main source of inland groundwater. Aran that falls on the ground will percolate in part If the circumstances are ideal, downward into an aquifer. A superb significant amount of rainwater runs off into streams and rivers, however Even here, a direct hydraulic connection to an is frequently present. Aquifer nearby. In fact, in arid regions with transient streams, high Depending on groundwater levels, surface flow along Drainages. A hole drilled or bored into a saturated "sponge" is evident Will release the stored water. You can suction or drain this water. If all goes well, more water will enter the hole after being pumped out to replace what has been removed. This is the basic Principle behind a water borehole. Hydrogeology is the science of groundwater, and it is the Job of a hydrogeologist to assess the groundwater resources in any given area. This is accomplished using maps (topographic, geological), satellite images, aerial Photos, field observations (geological mapping, vegetation Surveys, etc.), desk studies (literature, field reports, etc.) and Ground geophysics. Ground geophysical surveys are now quite effective in locating water-bearing formations at depths Down to around 100 metres. Methods include resistivity (vertical electrical profiling), natural-source self-potential and Electromagnetic methods (such as VLF), magnetic methods, and micro-gravity surveying [3].

Groundwater extraction

A water borehole is more than simply a simple earth hole. It must be expertly crafted, thoroughly conceived, and created Drilled. Water-extracting boreholes mostly include an upright hole with a sturdy liner to prevent Walls collapsing, with a method for allowing clean entry. Water entering the borehole, surface defence, and a technique for drawing water. Machine-driven drilling is Borehole drilling is an expensive process that calls for expertise. Expertise in both their construction and design. The process of drawing water from the earth is known as groundwater abstraction. Source, either in the long or short term. It is possible to abstract manually, employing rotary drilling

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equipment, typically where the water table is high or mechanized which can access deep aquifers of several hundred meters. A borehole is a narrow shaft bored in the ground, either vertically or horizontally.

Borehole

A borehole may be built for a variety of uses, such as the extraction of gases, other liquids (such as petroleum), or water (drilled water wells and tube wells) (such as natural gas).As a pilot hole for pier installation or underground utility installation, for geothermal installations, or for the underground storage of unwanted substances, such as in carbon capture and storage, it may also be used in geotechnical investigations, environmental site assessments, mineral exploration, temperature measurements, or for geothermal installations e.g. in carbon capture and storage. A water borehole is a ground hole that has been particularly constructed to provide a hole that allows water to flow into it and space for a pump to be installed into the opening to enable water absorption. The two most popular techniques for drilling boreholes are rotary and air Methods of percussion (Aqua Earth, 2011). A drill bit developed specifically for rotary drilling. A length of linked drill is attached to a robust metal made of tungsten. Pipe and the rotating drill bit break up the rock [4, 5].

Aerobic percussion: A down-hole air hammer is used in this technique on the drill string's end, which aids in breaking up the rock formation. The crushed rock fragments out of the hole to the surface along with any Water that flows into the hole during drilling. Typically, a Borehole is completed by installing a vertical pipe (casing) and well screen to Keep the borehole from caving and help prevent surface contaminants from entering the borehole and protect any installed pump from drawing in sand and sediment. The consequences of climate change have less of an impact on groundwater. Especially when compared to other water sources, surface water. Therefore, the countries' primary water source option will be groundwater abstraction. Climate change-related water shortage adaptation. The government is promoting people, organisations, and communities. The creation of pertinent policies and the providing of financial support to Use groundwater, particularly in ASAL regions where surface water is present, Limited, or unavailable.

Surface water boreholes are a promising engineering solution for water scarcity. Despite many benefits of water boreholes, a major concern is the potential negative impacts on the groundwater and environment. Therefore, the aim of this study was to investigate the impact of not regulating the siting of boreholes on the quality of groundwater resource and environmental impacts. This has been the case with developing countries such as Nigeria, where boreholes are drilled indiscriminately without observing the standard separation distances approved by the World Health Organization (WHO) and similar bodies. There are numerous standards, rules, and laws that can protect the public's health regarding the quality of drinking water. Potable water intended for human consumption is what is referred to as drinking water. For sustainable development and human health, clean water is essential. Access to dependable and secure water for inhabitants is a problem in many developing nations. In locations without access to surface water, groundwater is frequently used as a backup water source. More than 30% of the fresh water on Earth is contained in the ground. This makes its significance in the water cycle quite clear. Recent years have seen a vast drilling of water boreholes of varying depths and capacities to suit human requirements due to the development of technologies to harness groundwater and changes in human views of groundwater quality. The general population is less aware of how human activities, such as the unauthorised excavation of boreholes, affect groundwater resources [6].

A borehole is a hole made to intercept an aquifer with the use of a machine or a hand auger. The dimensions of the aquifer, as well as the quantity and quality of the water, affect its diameter and depth. Its quality may change depending on whether it is used for agricultural, industrial, or human or animal consumption, among other things. Drilling of borehole in different geological formations require different technical approach. These approaches are designed models to manage drilling activities to sooth the underlying aquifer bearing rock, manage soil structure, reduce environmental impact, and manage groundwater contamination. As a result of the differential settling of disturbed soil structures, the effect on soil structure is typically instantaneous and causes distortion of buildings, roadways, and even mild tremors. Artificial sinkholes are created when silty layers become cavernous. This causes the adjacent engineering structures' boreholes to collapse. The placement of boreholes also necessitates expert guidance because environmental geoscientists have demonstrated that groundwater interacts heavily with the environment, particularly with municipal dump sites, agricultural waste, industrial effluents, oil spills, and even household garbage. Borehole drilling companies both local and foreign owned spring up daily, managed buy pure businessmen whose motive is profit and no consideration on the environmental impact of their activities or efforts to conserve this threatened resource. This has led to high depletion of shallow aquifers especially those within the overburden/weathered layer of basement complex.90% of these boreholes were drilled without proper recognizance surveys of the environment Vis a Vis an impact assessment. They are drilled with uncalibrated equipment, unapproved methods, and no submission of borehole report for record purposes, research, and development. Around landfills, septic tanks, animal pens, storm water canals, and even sewage lines, boreholes are dug. This has a significant impact on groundwater quality. Fecalcolli form was found in the samples that were collected. This shows a significant connection between human and animal waste in our groundwater, which is alarming and requires immediate attention [7-9].

Effect of proliferation of boreholes

As much as boreholes provide fast and cost-effective access to portable water, the effect of its proliferation can be devastating such as:

Lack of standards in drilling boreholes

Many borehole drillers are skilled craftsmen who learned how to drill holes; they lack official training and adhere to no standards, which put consumers' health at risk by allowing groundwater to become significantly contaminated. According to UNICEF's research, the average PH of the water samples taken from boreholes in the Owerri Zone of Imo State in southern-east Nigeria is between 6.0 and 6.5. It indicates that the local water is somewhat acidic, making it unsafe to drink. Unfortunately, the government, whose responsibility it is to provide the people with potable water, ignores the negative effects of having a lot of boreholes concentrated in one area.

Groundwater reduction level

The effect of pumping out ground water from much water borehole point will lead to a reduction in the level of ground water. This means that people must drill farther down to get enough water to sustain pumping. Those that have shallow wells will no longer get water unless they go deep into the aquifer. It will therefore cost more in future to drill to a realistic sustainable depth in the aquifer if one desires to have a borehole in other words recharge will be low [10].

Reduction of flow

The net flow of subsurface water is reduced when a borehole is dug at random and water is gathered from numerous locations at once, which can have a substantial impact on the water cycle.

Saline intrusion risk

In addition to increasing strain on subsurface water, the proliferation of boreholes can also lead to salt water intrusion, especially if the location in issue is close to an ocean or seacoast. It also indicates that something needs to be installed there to take its place, or else there is a chance that landslides or other disasters could occur in the future and impact nearby structures and infrastructure. Further development of these holes could result in earth faults by way of fractures.

Pollution and contamination

The growth of boreholes contributes to the spread of contamination and pollution. Government permits the indiscriminate emergence of mechanic villages workshops and trash collection and disposal sites all over the town, especially in elevated topography, due to a lack of planning and the implementation of profession procedures. Heavy metals and other dangerous materials can be found in some of their trash. These compounds break down when it rains and seep into shallow aquifers by penetrating the soil layers. The rains will undoubtedly wash these harmful contaminants into the city's waterways and other low-lying areas, where many people live and inadvertently drill water boreholes that could potentially be contaminated. Boreholes stand the chance of being polluted by seepage from septic tanks around the borehole. Other domestic wastes are also sources of pollution of boreholes.

Effect on vegetation

Groundwater recedes as a result of frequent water withdrawal from numerous boreholes, which changes the saturation level of moisture. It is most likely that as a result of this recession, water in the top layer of soil will only stay at the capillary level, where it may not be highly accessible to plants and other soil creatures. This Draw Down effect will negatively impact soil moisture availability, which will then negatively impact vegetation.

Contamination of water resources

One could classify drilling as a wild (uncontrolled) activity. There is little control over drilling, the effectiveness of borehole sealing, or well management. On a local, municipal, provincial, national, or global level. It appears that digging holes in the earth is now acceptable without anyone having to face the repercussions. Every time a borehole is dug into the soil, a channel of vulnerability is formed, increasing the risk of groundwater resource contamination and deterioration. Hydraulic connections between tainted surface water and the pure underground water can be made by drilling into the subsurface. When surface toxins infiltrate deeper (cleaner) aquifers, this process is known as cross-contamination and these linkages become preferred channels for it.

Impact of water bore hole drilling on local wildlife and ecosystem

Excessive extraction of underground water through borehole drilling causes numerous adverse effects on ground hydrology and ecology. It causes depletion of the water table and this in turn negatively impacts the local biodiversity and ecology.

Wildlife and their habitats must be considered when drilling because it has increased significantly on a global scale in order to prevent catastrophic long-term repercussions.

Despite being a significant resource, borehole groundwater extraction can have negative environmental effects.

Habitat loss

The construction and land disturbance that is necessary typically has the biggest impact because it alters land use, damages local ecosystems, fragments wildlife habitats, and interferes with migration patterns. Dirt, minerals, and contaminants may erode into neighbouring water bodies during construction. If drilling lowers groundwater levels, streams and ponds may also be impacted. When buildings or roads, boreholes are built, habitat may be lost directly. Wildlife may be impacted by the project's loss of critical habitats like vernal pools or breeding grounds.

Behavioural disturbance

Drilling and exploration activities may disrupt wildlife to the point where their behaviour alters even without direct habitat degradation. Deer and other sensitive creatures could stay away from regions with a lot of people around, noise, and lighting. Numerous night-migrating bird species may suffer negative effects from light pollution. Because of the lights' attraction, birds run the risk of getting lost or hitting buildings. During the breeding and nesting seasons, noise can also impair songbird communication and change the dynamics between predators and prey. Predators can sneak up on their prey while remaining undetected by using the cover of noise brought on by humans.

Disruption of migratory routes

Mule deer, pronghorn antelope, and predators that require a sizable home range all depend on migration patterns that are disrupted by traffic, noise, human activity, and fencing at drilling sites. Studies suggest that planned energy and resource developments could lessen or even end migrations in the western United States. One such study was carried out by Joel Berger of the Wildlife Conservation Society and published in Ecological Society of America. Loss of habitat occurs as a result of cutting off migration pathways.

Direct injury or mortality

Wildlife may be injured or killed during construction, or during operations through collisions with vehicle and aircraft traffic, or collisions with buildings, communication towers, or other lighted structures. Wildlife may also be attracted to human structures by improperly stored waste, which could lead to them being removed or harmed for human safety reasons.

Introduction of non-nativeinvasives species

The release of invasive species is known to occur from land removal and vehicle use. Drilling operations could result in the introduction of invasive plant species, which could then spread into nearby habitat, decreasing the value of that area for wildlife. Invasive species have the potential to displace native plant species, which are more valuable to wildlife.

Extinction of species

Loss of habitat is currently the main factor contributing to extinction. When a habitat is destroyed, the plants, animals, and other species that live there have a lower carrying capacity or ability to survive, which leads to declining populations and eventual extinction. Many species, including orangutans, tigers, elephants, deer, antelope

and rhinos and other plant and animal species inhabiting the drilling site, are becoming more and more isolated, and their access to food and shelter is decreasing. Without enough natural habitat, many creatures come into touch with people and are frequently killed or captured, which escalates human-wildlife conflict.

Erosion

Reduced nutrient levels and increased erosion are two effects of habitat loss on terrestrial ecosystems. This can consequently result in lower agricultural productivity. Also, when erosion increase bore wells silt and pollution levels rises lowering the quality of the water.

Result and discussion

Common contaminants found in the groundwater

Some substances found naturally in rocks or soils, such as iron, manganese, arsenic, chlorides, fluorides, sulphates, or radionuclides, can become dissolved in ground water. Other naturally occurring Substances, such as decaying organic matter, can move in ground water as particles. Whether any of these substances appears in ground water depends on local conditions. Some substances may pose a health threat if consumed in excessive Quantities; others may produce an undesirable Odour, taste, or colour. Ground water that contains Unacceptable concentrations of these substances is not used for drinking water or other domestic (Figure 1).

Nitrate: It comes mainly from fertilizers which are added in fields. The excess of Nitrate cause Contamination of groundwater and result in causing a disease in infants known as methemoglobinemia (blue baby syndrome). Applying good agriculture practices can reduce nitrate level in the groundwater others are Synthetic compounds like POP (Persistent Organic pollutant) are most harmful for human Health, Pesticides causes contamination of groundwater. Chemicals in drinking water introduced naturally or by human's cause's serious health problems.

Fluoride: in water helps in protecting against dental carries and bone weakening higher level of fluoride in Groundwater causes adverse effect on health. It can damage teeth may give dental fluorosis at a drinking Water concentration between (0-9 to 1.2 mg/l) (Dean 1942) (4) Skeletal fluorosis which causes change in Bone structure is observed in people drinking water between 3 to 6mg/l of Fluoride per litre (WHO Guidelines of water quality) (WHO.int)

Arsenic: Exposure to arsenic for a long time in drinking water causes cancer and skin lesions. It can also Cause cardiovascular disease and diabetes it can damage liver and nervous system also. Arsenic is used in industries especially in glass processing, textile, metal adhesive industry, paper industry in wood Preservative industry and ammunition industry. This usage of arsenic in industries which leads to be a cause of groundwater contamination.

Figure 1: Common contaminants found in the groundwater.

Poorly Constructed Irrigation Wells

These wells can allow contaminants to enter Ground water. Often pesticides and fertilizers are applied in the immediate vicinity of wells on agricultural land (Figure 2).

Groundwater levels have dropped as a result of excessive consumption, and the relentless digging of water boreholes demanded greater plant clearing, which disturbed the habitats of several species and resulted in their extinction (Figure 3).

Drilling can have number of environmental effects; boreholes can significantly lower the water table which can lead to a reduction in the availability of water for both human use and for Environment. Additionally, borehole can create pathways for pollutants to migrate into the ground water which can contaminate the water supply also, drilling and construction activities associated with boreholes can disrupt local ecosystems wildlife.

Conclusion

The Earth's crust has often been compared to a sponge, in that It can soak up and hold water in pore spaces, fractures and Cavities. This ability to store water depends very much upon Geological conditions and on the host formation. For example, Fresh, unfractured, massive granite – a crystalline rock – has Virtually no space available for water, whereas unconsolidated, or loose, river gravel and highly weathered cavernous limestone Can store large quantities of groundwater and are capable of Releasing it relatively freely. In general, groundwater gets purer the deeper it is. For instance, boreholes in Tanzania are divided into shallow (under 30 metres), medium (between 31 and 50 metres), deep (between 51 and 80 metres), and extremely deep (beyond 80 metres), contamination will be more challenging to occur the farther away the borehole is from a potential source of pollution. To ensure the

Figure 2: Poorly constructed irrigation wells.

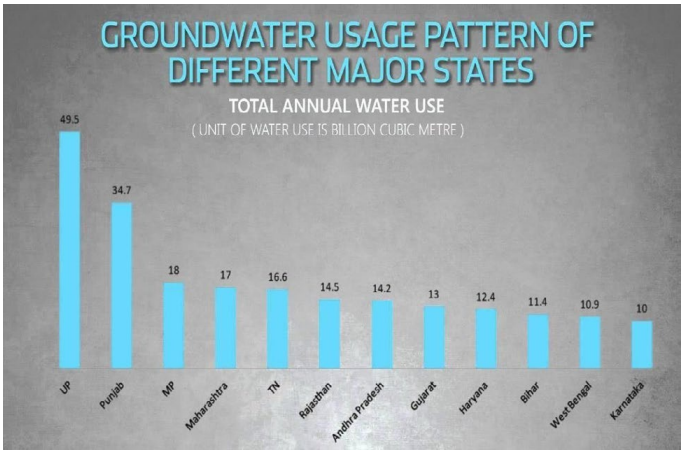

Figure 3: Groundwater usage patterns.

production of high-quality water, there are guidelines, specifications, and regulations that must be strictly followed and observed when drilling water boreholes. These standards include those set forth by the NIS.

I believe a balance between resource use and wildlife conservation is possible with careful planning, however if done improperly and without regard for wildlife, resource extraction can lead to reduction in wildlife populations.

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