

Research Article



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Evaluation of the effects of human activities on water resources in Masaba North, Nyamira County

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Abstract

Water is essential to sustain life and a satisfactory supply must be available to all. But, access to sufficient amounts of clean water has been recognized as the critical resource problem in the 21st century. This study aimed to evaluate the effects of human activities on water resources in Masaba North, Nyamira County. This study adopted a descriptive research design with both quantitative and qualitative approaches. The target population was 27913 households that live on catchment areas in Masaba North namely: Kiabonyoru, Keroka and Kianungu and along valleys of main rivers namely Gucha, Kenyamuchwachwa and Kenyamware. The study also targeted the department water officials of Nyamira County. The sample size of the study was 381 household heads. The study used interview schedules, questionnaires, observation and photography to collect primary data. Data collected by the use of questionnaires and interview schedules was analyzed using thematic analysis. The results were presented using line and bar graphs, tables and pie charts. Photographs taken were displayed and explanations given. The findings showed that all households unanimously agreed that sand harvesting along river and stream banks makes the waters turbid and murky, discharge of untreated waste domestic water, washing and bathing in rivers and streams, pollutes water. The findings of the study will be beneficial to the Nyamira residents and water department in Kenya.

Keywords: Anthropogenic Activities, Catchment area, Water Conservation, Water resource, water cycle.

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Public Interest Statement

In Nyamira County, the demand for water has become so high that the residents do not have enough to use. The water springs and streams that used to flow throughout the past years portray a different scenario today. Some of the water holes (wells), springs, streams or rivers have either dried up or have very little water than they used to. A lot of human activities are taking place on the catchment areas and along river valleys. In the recent past, residents of Nyamira County would travel to distant places from various destinations to look for water for their domestic use where particular streams have some little left. Therefore, this study examined the effects of human activities on catchment areas and along river valleys of river Gucha and its tributaries.

1. Introduction

Water is key to health care and adequate access (sufficient, secure and available) should be made accessible to all. But access to clean water is progressively being acknowledged as a major resource crisis in the 21st century (World Bank 2005). Boosting access to secure drinking water can lead to substantial health satisfaction. Therefore, this calls for efforts to be put in place to achieve the required standards for safe drinking as much as possible (Kithiia, 2010). Groundwater exists naturally, in different ways and in different places: on the surface of the earth and underground. There are freshwater and fresh water resources (UNESCO, 2017). Water on the surface of the earth covers seventy one percent of the total surface area and without it, only a quarter are fresh water. In this freshwater, less than 2.5% is contained in rivers and lakes (Huang, Zhang & Wu, 2018; Nitasha and Sanjiv, 2015).

It is clear that, on a global and regional scale, biodiversity of freshwater species is at greater risk than terrestrial or aquatic. (DellaSala, 2013; Palaniappan et al., 2012; Jay and Tom Le Quesne, 2009). Clean water services and their reliability are critical to human survival because they are used for domestic purposes, fishing, transport, agriculture, recreational, tourism, and energy generation among others. (World Bank, 2008). It has been observed that anthropogenic activities in many countries around the world such agricultural use and urbanization affect water resources in various ways on temporary and local scales (Helmens, 2008). In the United States, anthropogenic activities are estimated to affect rivers by 98 percent (Wohl, 2005; 2005a). It has been recognized that drainage in rivers and groundwater during a drought can reduce river flow, causing drying of rivers (Holmes 1999; Palmer et al. 2009). Also, climate change and climate change exacerbate the situation by increasing the frequency of droughts in many areas of the globe (Meehl et al. 2007). This increases the amount of time and the location of the dry rivers.

Water availability in recent times has become scarce and worse due to human pressure that has led to the loss of wetlands and wetlands and the effects of climate change and diversity (Trenberth et al. 2003; Giorgi et al. 2004; Raisanen, 2004). Also, human action such as landslides, pollution, deforestation, land reform, and urban growth threaten water resources (WWDR, 2018). It has been noted that the rivers of the Huang-Huai-Hai Plains, China, are strongly affected by a various anthropogenic activity including artificial impacts on water catchment areas, changes in the gradient of the plains, and alterations made on the ecosystem of rivers and lakes (Gong & Xu, 2017). Further research into the Yellow and Yangtze rivers in China, from 1950 to 2008 revealed that the runoff increased significantly in the wet and humid region due to land reclamation, deforestation and urbanization which reduced evaporation and land penetration leading to river collapse (Wang, Ding, Ye, Liu & Wang, 2013)

A study conducted in the Vaal Catchment area of South Africa has shown that various

anthropogenic activities such as extraction of minerals, industrialization, urban and rural agriculture have led to environmental degradation of the river system (Gyedu-Ababio & Van 2010). Degradation occurs through deforestation, the conversion of natural fields into farms, urban growth, road construction, and surface mining. Every type of human activity changes the appearance of the earth that directly or indirectly affects the natural environment that directly or indirectly affects the earth's water resources. In Uganda, a study conducted by Tera (2011) on water resources in the Kisoro region found that population growth and poor soil systems were the only causes of water pollution in rivers. In Kenya, water resources have been constrained as a result of discharges from agricultural effluents such as fertilizers, pesticides, city and industrial spills, as well as the use of renewable energy. Thus, the increasing demand for diversified freshwater resources creates many challenges that lead to contamination of existing water resources. A study by Twesigye, Onywere, Getenga, Mwakalia and Nakirinda (2011) on the physiological and chemical analysis carried out on the Nzoia River found that water with high levels of nitrates and phosphates was associated with agricultural activities near the Nzoia Basin. Water contamination from towns and commercial waste creates another environmental problem. In Kenya, freshwater sources are about 20.2 cubic metres with seventy six percent used in agricultural activities and four percent in industrial use. Only about forty-two of the population lives in rural areas and eighty eight percent of the people living in urban areas have access to safe water for drinking. The situation is worse in slums in urban areas due to the lack of proper sanitation and sanitation systems. These settlements are located near or above the river road that absorbs the city of Nairobi and add up to notable pollution and declining quality of the waters. Further, Kenya's water bodies are highly contaminated by biological, inorganic and biological (Kithiia, 1992 & 1997). The impact of pollution on water resources is reflected in low water levels that cause water poisoning in animals and aquatic lives; improper deprivation of the gorgeous value in fun and games, high cost of water supply as wastewater costs treatment, eutrophication, deoxygenation, acid rain and habitat conversion. This is evident in urban areas and other areas in the city of Nairobi.

A study by Mirona (2006) found out that in Kisii County, 90 percent of the wetlands have been reclaimed and no longer exist. In Nyamira County, wetlands that are sources of springs and streams have also been destroyed. It is on this ground that this research was conducted to assess the effects of human activities on catchment areas and along river resources.

2. Literature Review

2.1 Effects of Human Activities on Water Resources

Anthropogenic activities have affected fluxes of water, sediments and vegetation alongside the river corridors. This has brought about temporal and spatial fluctuations of those fluxes which have reduced (Poff et al., 2007; Wohl et al. 2015). Similarly, these changes have brought about reductions inside the lateral mobility of river channels that lessen spatial heterogeneity of river systems and lateral connectivity between channels and flood plains (Florsheim et al. 2008; Florsheim & Mount, 2002). UNEP, (2008) has stated that human activities are the main assets of water infection globally. some of the leading sports consist of farming growth in population, boom of industries and cities (Angelidis, Markantonatos & Bacalis, 1995; UNEP, 2002).

It has been opined that globally positive inland lakes and seas may also dry due to over withdrawals of water for human use from their feeding tributaries. further in underground recharges, water has been withdrawn faster than it could regain (UNESCO, 2017). similarly, research has proven that within the Mediterranean climates, changes in land use along with deforestation

has stronger improved dry seasons, and pollution due to erosion from naked fields. The has led to upward thrust in temperatures and diminished the river's sum of dissolved oxygen (Cooper, Lake, Sabater et al. 2013).

In Europe huge quantities of water drawn for era of energy and cooling has altered river regimes. It has also been noted that shortage of water has been skilled in many European river basins with different water stress ranges affecting approximately 15 to twenty-five percentage of total European territory (european environment company, EEA, 2019; United nations, UN, 2014). It's been within the center East, valuable Asia and the Indian Sub-continent, water in some rivers have skilled a decrease of greater than 15 percentage due to water overconsumption within the river basin (Haddeland *et al.*, 2014). Inappropriate irrigation methods additionally pollute the water our bodies. In arid and semi- arid regions, evaporation on irrigated fields leads to over concentration of salts at the top soils. When torrential rains fall, they erode and transport minerals, metals discovered in the soil and chemical substances used inside the farms to the streams and floor water our bodies as a consequence polluting the waters. This enhances the boom of algal blooms and decrease oxygen in the water our bodies (UNEP, 2009).

Deposition of erodes particles makes the water murky and turbid. in line with Bonareri, (2017), turbidity is the readability of water. when the waters are turbid, they become cloudy. substances such as eroded clay, silt and algae are a number of the components that make the water to grow to be turbid. In Sangamner vicinity, Ahmednagar District in India a observe carried on the effect of anthropogenic sports on the best of ground water located out that floor water salinization, nitrate pollution, modifications in alkalinity, hardness of groundwater changed into due to human activities inside the location (Deshmukh, 2013), those activities blanketed use of chemical insecticides, addition of industrial wastes, home and agricultural waste to water our bodies (Ajibade *et al* 2008).

It's been noted that China the most not unusual hazard inside the coastal regions is land based resources of pollution which includes discharge of untreated commercial effluents, sewage and agricultural run offs has polluted rivers and streams (Zhou, 1994). Agricultural runoff causes sparkling water frame's eutrophication. it's been cited those anthropogenic activities have led to accelerated attention of minerals and nutrients in coastal waters. This has led to accelerated prevalence of harmful algal blooms on the coastal waters. Okaichi and Yamada (1997) have proven that within the Seto Inland Sea the increase of vitamins is due to run offs of nitrogenous and phosphorus compounds and effluents from industries and houses discharged into the sea.

In keeping with Hooda et al (2000); Lovell and Sullivan, (2006) animal farming is the major source of deposition of phosphorus and nitrogen into rivers which ends up in eutrophication of rivers. it has been referred to that half of lakes in US are eutrophic. those agricultural contaminants are a prime primary contributor to eutrophication as excessive attention promotes Cyanobacteria and Algae boom which in the long run reduces dissolved oxygen in water (Oladele et al. 2011). Perry et al (2007) notes that nitrogen and phosphorus, purpose aquatic organic productivity to boom, resulting in low dissolved oxygen and eutrophication of lakes, rivers, estuaries, and marine waters. dangerous pollution which collect in food chain are produced with the aid of cyanobacterial blooms (Chaudhry & Malik, 2017). A observe accomplished in South Africa revealed that raw and sick-dealt with wastewater has negatively impacted freshwater resources which in flip has brought about eutrophication (Edokpayi, et al., 2017). In Kenya a look at via Bonareri (2017), discovered that agriculture contributed to river pollutants through erosion of fertilizers washed to the rivers, use of herbicides and pesticides.

Van Grinsven et al., (2002) have stated that loss of oxygen in water bodies consisting of rivers, lakes and seas is as a result of the presence of nitrogenous compounds inside the water which has affected aquatic existence. all through the rainy season or on irrigated fields nitrogenous compounds dissolve in water consequently polluting floor and underground waters (Rosen & Horgan 2009; Singh, Singh & Sekhon, 2006). further, chemical substances used to govern pests, weeds and sicknesses are washed via rain water into the streams and rivers therefore polluting the waters. a few are leached into the underground hence polluting floor water (Environmental destiny of pesticides, 2015; McBride, 1989). it's been cited those soils contain a loose happening metal referred to as selenium, but on irrigated fields, this steel accumulates in the soils. when the soils containing these metals are washed to streams and rivers the metal is deposited, inflicting a chance to human and animal lifestyles (Ganje,1966). it has been stated that during Africa eighty percent of the raw sewage from settlements is released into streams, rivers and lakes, consequently polluting and degradating the available water sources besides waste water from agriculture and business sports (longe et al., 2010; UN WWAP, 2014; UNEP, 2009; Hopkins et al., 2009).

It has been opined that discount of flowers cowl along river banks because of overgrazing leaves the ground naked subsequently exposing the soils to erosion. this can in addition result into habitat retrogradation, destruction of riverbanks and flora on the flood undeniable. those results in water pollution and destruction of the surroundings (Patric & Helvey, 1986). in addition, people have an effect on streams via flow channelization. according to Keller (2002) people modify rivers with an purpose of controlling erosion and floods via straightening, deepening, widening and lining the banks with concrete. this will negatively have an effect on water exceptional and aquatic lives in general (Hahn, 1982)

It has been referred to that during developing international, greater than 90 percent of sewage is discharged directly into rivers, lakes and coastal waters without any sort of treatment (Bjorklund, 2001). bad sewage disposal leads to underground water infection through the seepage of beverages from pit latrines and soakage pit machine. A record from Kilifi County reveal that underground water ways were polluted by means of sewage structures from slaughter homes and latrines (hi-Sang & Nguta, 1994; Allan, 2004)

Growing urbanization in particular developing countries is increasing call for water (Bjorklund, 2001). Urbanization also ends in water pollution and shortage as a great deal water is withdrawn from rivers for industrial and domestic uses. it's been mentioned in the African cities and cities there was a steep increase in population which has also caused increased city, industrial growth and agricultural land use. This has expanded water pollutants thru discharge of effluents to the water our bodies (Fakayode, 2005; Blanchard & Lerch, 2000). Industries are the predominant resources of water sources depending on the type. Hardoy et al., (2001) in his study found out that pollution of rivers as a result of discharge of industrial effluents from towns and raw sewage caused huge human health issues to humans discovered in the downstream. This is in agreement with an observation accomplished on Nairobi River is extraordinarily polluted as a result improved launch of untreated effluents from business, industrial and domestic areas to rivers and streams (Wanjiru, 2011). It has also been mentioned that urbanization associated activities have improved nitrogen, phosphorus, alkalinity and total dissolved solids on floor waters (Boyer et al., 2002; Gergel, 2005). This causes the trouble of water fine which is articulated through Jordan et al. (1993) as causing a superb strain on water supply structures, mainly in cities along river courses.

It has additionally been cited that over-extraction of water from rivers, mistaken strategies of cultivation, soil degradation along water catchment regions and riparian areas reason flash

floods that makes the waters murky and purpose siltation in rivers. This has to brought about critical degradation in the amount and pleasant of the water bodies (MWI, 2006; ROK, 2012). regular launch of untreated sewage, run off from farms has impacted negatively on water great. studies has proven that the intensity of lake Baringo reduced from 15 metres in 1921 to at least one.8 metres presently due to reduced inflows and improved deposition of sediments eroded from the encircling water catchment regions (MWI, 2006).

Similarly, Kithiia (1992&1997 have mentioned that during Kenya, organic and inorganic substnces are the primary assets of water pollutants which affects human and aquatic life as evidenced in most city areas specially Nairobi city. This makes the surface water bodies to lose its suitability to be used as a result insufficient smooth water to be used. In Nyamira County, human sports have polluted and affect the down ward drift hence inflicting water to be scarce.

3. Methodology

3.1 Research Design

A research design is an outline of collecting, measuring and analyzing data (Kothari, 1990). This study adopted a descriptive research design with the use of both quantitative and qualitative approaches. Descriptive design answers question such as “why”, “what” and “where”. This design will systematically describe the activities that take place at the catchment areas and along the rivers and streams.

3.2 Target Population

The study targeted 27,913 households who live within Masaba North Sub-County who live within three catchment areas of Kiabonyoru, Keroka and Kianungu. The study also targeted three rivers, namely: Gucha, Kenyamuchwachwa and Kenyamware and the Nyamira County water department officials.

3.3 Sample Size and Sampling Techniques

Mugenda and Mugenda (2003) defines sampling as a procedure of choosing a small group of elements to be a representative of a larger group in any given inquiry. This study used predetermined sample size by Krejcie and Morgan (1970). Out of a population of 27,913 households, the sample was 381 calculated at 95% confidence level. The study conveniently sampled three catchment areas, Kiabonyoru, Manga and Kianungu. A pilot study that was conducted on the number of households who live in the three catchment areas established that there were 55 households at Manga catchment area; 74 households at Kiabonyoru catchment area and; 37 households at Kianungu catchment area. In total, there are 166 households. All these households were considered to participate in the study. In this case, all household heads from the 166 households were purposively sampled because they engage in all types of activities that affect the water resources in one way or another. The household head used in this study were any adult above 18 years who were available during the time of study to provide information on activities that take place at the catchment areas. The other 215 household heads who live along the three river valleys for a distance including twenty kilometers from the source were randomly sampled to participate in the study.

3.4 Data Collection Instruments

3.4.1 Interview Schedule

An interview schedule is a framework that contains a set of structured questionnaires, to serve as a

guide for interviewers and investigators to gather information on a particular topic. During the actual field study, the interviewer fills answers given by the interviewees in the schedule (Luenendonk, 2016). Open ended and structured questions were used to collect data on whether there were water policies and if they are ever implemented. Interview schedules allow the interviewers and researchers to get more information since they can ask follow-up questions and clarifications to the questions asked. The interviews schedules were issued to Nyamira County water department officials.

3.4.2 Questionnaires

A questionnaire is a data collection tool containing a series of questions and other activities for the purpose of collecting information from respondents. According to Kothari (2004), the use of questionnaires is the most commonly used method in collecting data in many field studies. Questionnaires are widely used to gather information on current situations, practices, ideas and attitudes quickly and precisely (Orodho, 2008). They offer a cheaper way to get information (Mugenda & Mugenda, 2003). The questionnaires were administered to the household representatives.

3.4.3 Observation

Observing is a method of data collection, in which the researcher collects information about the object that was researched by performing observations, as is the case and when it occurs. The researcher aims to look at human behavior, substance use, and human interactions associated with that event (Morgan, et al., 2017). The researcher observed a variety of phenomena occurring along streams and rivers and how they have been interfered with by human activities.

3.4.4 Photography

In photography, the researcher uses a camera to record the happenings in the environment in relation to the topic of study (Kaoru, 2008). During the actual field study, the researcher took photographs depicting human activities done on the catchment areas and along rivers. This gave the real picture of what was taking place and supplemented to the responses given by the respondents.

3.5 Methods of Data Analysis

Data collected by the use of questionnaires and interview schedules will be analyzed using thematic analysis. The results will be presented using line and bar graphs, tables and pie charts. Photographs taken will be displayed and their explanations given.

4. Findings and Discussion

4.1 Effects of Human Activities on Water Resources in Masaba North, Nyamira County

The study sought to evaluate the effects of human activities on water resources in Masaba North, Nyamira County. The findings are represented in table 1

Table 1: Effects of Human Activities on Water Resources

Activities		Strongly agree	Agree	Disagree	Strongly disagree
Clearance of vegetative cover bares the land surface leading to erosion leading siltation of rivers and streams	N	90	215	28	07
	%	26.5	63.2	8.2	2.1
Destruction of catchment areas leads to reduction of water levels in rivers and streams	N	30	123	170	10
	%	8.8	36.2	50	2.9
Sand harvesting along river and stream banks makes the waters turbid and murky	N	201	139	00	00
	%	59.1	40.9	0	0
Agricultural run-off transports fertilizers and pesticides into rivers resulting to pollution, growth of algae and de-oxygenation of water which kills other aquatic organisms	N	120	189	30	01
	%	35.3	55.6	8.8	0.3
Discharge of untreated waste domestic water into rivers and streams pollute water	N	251	89	00	00
	%	73.8	26.2	0	0
Livestock grazing along the river valleys and on catchment areas exposes soil to water erosion which destroys rivers and stream banks	N	166	157	14	03
	%	48.8	46.2	4.1	0.8
Widening and deepening of river and stream channel during sand harvesting reduces the amount of water flowing down stream	N	200	115	20	05
	%	58.8	33.8	5.9	1.5
Human settlements along rivers and streams results to raw sewage disposal into river making it unhealthy for use	N	233	105	02	00
	%	68.5	31	0.5	0
Increased population on the catchment areas and along rivers and streams leads to over-extraction of water leading to downstream reduction	N	92	67	170	11
	%	27.1	19.7	50	3.2
Planting of blue gum trees along banks of streams/rivers reduces the amount of water flowing down stream	N	105	220	10	05
	%	30.9	64.7	2.9	1.5
Washing and bathing in rivers and streams pollutes water	N	285	55	00	00
	%	83.8	16.2	0	0

Source: *Field research, 2021*

Based on table 1, all households (100%) unanimously agreed that sand harvesting along river and stream banks makes the waters turbid and murky, discharge of untreated waste domestic water, washing and bathing in rivers and streams, pollutes water. 99.5% (338) household heads agreed that human settlements along rivers and streams results to raw sewage disposal into river making it unhealthy for use, 89.7% (305) agreed that clearance of vegetative cover bares the land surface leading to erosion leading siltation of rivers and streams while 10.3% (35) disagreed. On livestock

grazing along the river valleys and on catchment areas, 95 % (323) were in agreement that it exposes soil to water erosion which destroys rivers and stream banks. Further 90.9% were in agreement that agricultural run-off transports fertilizers and pesticides into rivers resulting to growth of algae and de-oxygenation of water which kills other aquatic organisms, 92.6% (315) agreed that widening and deepening of river and stream channel during sand harvesting reduces the amount of water flowing down stream. Photographs taken support these findings as shown below.



Plate 1: Murky water in Ekenyamuchwachwa river as a result of sand harvesting

Source: *Field research, 2021*



Plate 2: Brick making along entono stream makes river Gucha's waters murky The arrow shows the confluence of entono stream and river Gucha, Kiabonyoru Catchment area

Source: *Field research, 2021*



Plate 3: Cleared vegetation deposited in the river channel of Ekenyamwachwachwa, Keroka Catchment area

Source: *Field research, 2021*

A key informant from the Nyamira County water department observed that indeed water catchment areas in the most recent times have been widely planted eucalyptus trees right at the sources of rivers Gucha and Ekenyamochwechwe. The end result especially in the months of February, July, August and September experience low stream water flows unlike in the early 1980s to mid-1990s when the water volumes were always high. He said:

The human activities taking place at our catchment areas really worry this department. Land has been so much fragmented into very small pieces and those people who were allocated portions at the river sources have opted to planting eucalyptus trees and this consume so much water that they have resulted to low quantities at the rivers Gucha and Kenyamochwachwa.

The officer further observed that water in rivers Gucha, Kenyamware and Kenyamochwachwa have been victims of siltation from sand harvesting along their banks; waters become murky downstream and becomes a challenge for persons who depend on it for domestic use. Additionally, peasant farming has polluted the water as fertilizers used for planting are also find their way into these rivers hence contaminating it. He observed:

Our main rivers especially Gucha, Kenyamochwachwa and Kenyamware will soon dry out because of the unchecked eucalyptus tree planting, there is water pollution especially from farm inputs such as fertilizers that are washed into rivers from shambas which are close to the rivers. The river waters also become very dirty during sand harvesting...

The above findings agree with Khatri, & S Tyagi (2014) who found out that the human activities affecting the quality of surface water include farming, clearance of vegetation, discharge of untreated sewage into the water bodies. This also agrees with Chetty & Pillay (2019) who noted that human activities such as agriculture and industrialization have played a crucial role in heavy metal precipitation and transport in the Palmiet and Sezela Rivers. In Kenya, Wakhungu (2019) found that increase in population leads to increased production of waste water that is discharged as effluents to river systems thus degrading downstream ecosystems and posing a threat to human

health. Also, the findings agree with Mulwa, Li, & Fangninou, (2021) who found that water pollution in Kenya was majorly from the agricultural sector, industrial and sewage plants. Agrochemicals used in the agricultural sector are eroded during the rainy season landing into water sources. Also, sewage plants release untreated effluents into the surface waters hence polluting the waters. They also found out that human activities like poor agricultural practices such as digging along the contours, deforestation led to increased surface run-off to the water bodies thus increasing the turbidity and siltation of the surface waters. These findings further agree with a study done on the water quality of Nairobi River and riparian zones of river Ruaka which found that effluents from car wash and garage, run off from farms polluted the waters (Mugambi, 2010; Mbui, Chebet, Kamau & Kibet (2016).

5. Conclusion

Based on the findings, the main effects of human activities reported were sand harvesting along river and stream banks which made the water to be unsuitable for human consumption because the waters were turbid and murky; discharge of untreated waste domestic water, washing and bathing in rivers and streams, did pollute waters of the rivers that under study; the catchments which had been settled by man along rivers and streams resulted to raw sewage disposal into rivers making them unsafe and unhealthy for man to use.

Recommendations

There is need to examine the adverse effects that unregulated human activities may pose to unsuspecting water users and to a larger extent the water catchment areas and the health of the members of the households who depend on this natural resource.

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