Chemical Response Of Some Forest Water Sources Vs. The Quality Effects To Plants And Animals

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Abstract

The Taita Hills were once covered with extensive montane cloud forests. Ngangao is the second largest forest in the Taita Hills. There is a wide gap in knowledge concerning chemical concentration in the water under study. The objective of this study was to determine the water chemical composition of the streams flowing from some of the sources at Ngangao forests. A CRD comprising with five treatments and three replicates was used. Probeware was used to quantify conductivity, salinity, pH, Turbidity, DOC, temperature and nitrate. Phosphate tablate was used to determine the amount of phosphate. The data were subjected to One way ANOVA. conductivity had no significant difference ($p>0.05$) in both cases. pH. had a C.V 0.15% within treatments. DOC had a significant difference ($p<0.05$) with a CV 3.55 % within treatments. Temperature had significant difference ($p<0.05$) with a mean of 22.59^{0}C. Phosphate had no significant difference ($p>0.05$) with a CV 47.11% within treatments. Rivers or drainage ditches dominated by subsurface agricultural return flows greatly affect water in the study area. The drinking water under study was aesthetically unappealing, and may also represent a health concern. Less temperatures assumes less oxygen concentration to reduce microbial respiration. The water is recommended to be safe considering its conductivity, salinity, and pH range that has a close relationship. Therefore it's that Regional boards are recommended to be formed in order to detect changes chemical time after time in these areas with concern to microbial breeding in near future since, Microbial breeding might affect much on health status of human beings.

Keywords: *Chemical quality, Agro economic activities, Ngangao forests, Probeware, Phosphate tablate*

Introduction

Kenya, an independent country since 1963, is located in Eastern Africa between 4º21′ N and 4º28′ S and between 34º and 42º E. Kenya is dominated by land types that can be classified as Arid or Semi-Arid Lands (ASAL), as they comprise about 88% of the land area in the country this indicates less water availability to plants. Moreover, a quarter of Kenya's population and half of its livestock live in these areas. According to Wass (1995), bush land, wooded grassland, grassland and desert occupy over three quarters of Kenya's land cover. In these areas, productivity varies significantly, subject to the area and time. Isolated hills and river floodplains are the most productive areas in the regions where dry land cover types dominate like Taita in which the study area falls.

Population growth in the medium- and high-potential areas has led more and more people to move to urban centres, as well as to the ASAL. This has caused the ASAL areas to suffer problems such as intensified cultivation, overgrazing, deforestation, acute water shortages, loss of biological diversity and soil erosion (Mwagore 2002). The little water available should then be determined for its safety to human consumption. Erosion Leads to ultrafiltration and mineral sippage into the rivers and streams flowing in such areas like Taita. In the drier regions in Kenya, malnutrition affects over a quarter of the population. The droughts make matters even worse (Mwagore, 2002).

The study was done within Taita Hills which are located in south-eastern Kenya at 03º20′ S, 38º15′ E, approximately 150 km inland from the coast and 25 km west of Voi in the Taita-Taveta district (Figure 2). The district covers an area of 16,959 km² and has six divisions: Voi, Mwatate, Wundanyi, Tausa, Taveta and Mwambirwa (Taita Taveta district development plan 2002–2008).

As the hills are the first barrier for moisture-laden air masses that blow in from the coast, orographic rains are also of great significance to the area. The eastern and southeastern slopes receive more rain from these humid southeast trade winds than do the western and northern slopes that are in the rain shadow area (Vogt & Wiesenhutter, 2000). Altitude also has an influence on the rainfall pattern: higher areas get more rain than lower areas. The average annual rainfall ranges from 500 mm in the plains to 1,500 mm in the upper mountainous area (Vogt & Wiesenhutter, 2000). Rain water may affect greatly the water quality parameters as measured in this study.

The Taita Hills were once covered with extensive montane cloud forests. However, today only small forest fragments remain on the highest peaks of the hills. In the midlands of the Taita Hills (<1,200 m a.s.l.), woodland and dry forests occur with *Acacia-Euphorbia* species (Krhoda, 1998). The lowlands are mostly covered with bushland and thicket, with some sparsely scattered trees. In addition, woodlands, wooded grasslands, grasslands and riverine forests, as well as swamps, can be found in the plains (Were & Soper, 1986), these will affect water quality. Loss of natural vegetation in the Taita Hills area, among other reasons, has caused considerable gully erosion on the hillslopes and the foothills (Sirviö et al., 2004). This affects water chemical characters in term of nutrients.

The scarcity of arable land and other natural resources has forced people to move further up into the hills or to the nearby urban centers. However, more and more people are moving to the lowlands in search of land (Soini, 2005). A restricting factor, when it comes to this need for land, is the location of the Tsavo National Parks. They almost surround the Taita Hills, thus restricting the spread of settlement to the lowlands. This shows that the water flowing from the forest is greatly used for human consumption and plant irrigation. Its therefore important to know the amounts of different mineral ion composition among other chemical composition.

The gazettement situation of the Taita Hills forests is difficult to trace hence difficult to justify the trend in the water quality. What is known is that the Kenyan Forest Department started to get involved with the forests in the 1950s (Brooks et al., 1998). In 1973 the County Council of Taita-Taveta began the process of transferring the forests from the Council to government ownership by approving 22 forest areas for gazettement. Several of these areas were plantation forests. A year later additional 10 forest areas were added. This addition, proposed to be gazetted, included the forest areas of Ngangao (139 ha), Mbololo (370 ha), Sagalla (1,280 ha) and Chawia (86 ha) (Beentje 1988). According to Tetlow (1987, cit. Brooks et al. 1998) a total of 43 forests had been approved for gazettement by 1984. However, it was not until 1991 when the first Taita Hills forests were gazetted under the legal notice 235/1991 (Matiru, 2000), although Collins & Clifton stated already in 1984 that Chawia had been gazetted as a national forest. The list of forests gazetted in the Taita Hills varies a lot in different sources: according to Wass (1995), none of the forests is gazetted while Hodgson (1992) list a number of gazetted forests

Ngangao forests where the study was carried is the second largest forest in the Taita Hills. Its at location of Ngangao 03º22′ S, 38º20′ E. It is situated quite in the middle of the main hill complex between 1,700 m and 1,952 m a.s.l. The extent of the forest differs in different sources. According to Bytebier (2001), it comprises 92 ha, while Run (1995) claims it to consist of 113 ha of indigenous forest, 29 ha of forest plantation and 5 ha of bare rock. The forest is surrounded by agricultural land and to the west, by steep cliffs. Outside the main forest, there are also very small patches of natural and planted forest intermixed with agricultural land. Ngangao has suffered an intermediate level of disturbance, although it is choosen as the study area since it is one of the best forests in the Taita Hills. There are lots of old pit-saw sites, which were used to saw the logged trees. Most of the logging stopped after the Presidential Ban of 1977 which prohibited the cutting of indigenous trees without a licence (Tetlow 1987). Nowadays even collecting of wood waste is controlled by the forest guard (Mwandoe 2004). According to the forest guard of Ngangao Mr. Mwandoe (2004), one of the greatest threats to the Ngangao forest in these days is fire, although there have not been any big fires in recent years. Furthermore, the collection of firewood and timber, both under licence and illegally, continues on a small scale in Ngangao as in other forests too (Brooks et al., 1998).

Plantations in Ngangao began in 1955, when 0.78 ha of pines were planted on the western edge of the forest. Since then, there has been several plantations including *Cupressus lusitanica* and *Pinus patula* in 1971 and 1973 to prevent erosion, and *Acacia* and *Maesopsis eminii* in 1976 (Tetlow, 1987). Most of the plantations in Ngangao have been accomplished in areas that had already been cleared before or where no forest had been growing (Mwan'gombe, 2004). Furthermore, these plantations replaced the original forest where it has disappeared due to forest fires (Beentje, 1988). An exception is an area near the local Mwarangu Youth Polytechnic, which was cleared for exotic plantations in mid-1980s (Brooks et al., 1998; Beentje, 1988). The plantations separate a small indigenous forest area in the north; the plantations in the central part almost cut the main part of the forest into two. There has been an intention to replace the exotic species with indigenous species but this action has never been put into effect (Mwan'gombe, 2004). Ngangao has a wide range of trees from pioneer species to forest interior ones. Common pioneer species include *Phoenix* sp., *Bridelia micrantha*, *Maesa lanceolata*, *Celtis* sp. And *Ficus* sp. (Imboma, 1997). Two of these, *Tabernaemontana stapfiana* and *Albizia gummifera* are broadly distributed species that are known to occur in disturbed forests it is therefore probably to cause a difference in the water quality due to its humas. *Podocarpus latifolia* and *Ocotea usambaresis* are reported to have been common but are now almost absent as a result of extraction (Bytebier, 2001). There are lots of trees that are quite small but Ngangao holds some very large trees too (Wilder et al., 1998). In 1993 Mwangangi & Mwaura estimated that Ngangao forest had an upper canopy of 40%, a middle canopy of 50%, a lower canopy of 60%, a shrub cover of 75% and an herb cover of 40%.

The main economy in Taita is agricultural, producing coffee, mango, tomatoes, maize, bananas, beans, vegetables, and cassava for local and commercial trade. To minimize the event of crop failure due to the range in moisture levels, the typical Taita farmer cultivates small plots in the dry lowlands as well as small plots in the upper moist elevations. Forest streams as these under study are utilized in simple, small-scale irrigation systems (Milla, 2007). In addition to agricultural clearing, other human activities, such as planting of exotics, firewood collection and tree poaching, have been integral in the subsistence of the local villagers. The obvious result of these human activities has been the reduction of forested land area hence reduced water supply with time. Tropical forests are of special interest. Deforestation of these forests can have both local and global consequences. Forests provide foundations for life on earth through various means. Their ecological function cannot be underestimated, nor can their significance in biodiversity. Moreover, their importance for water balance and weather patterns and their role as regulators of the environment is increasingly valued in a world struggling with climate change (FAO 2004).

The major positively charged ions are sodium, (Na^{+}) calcium (Ca^{+2}), potassium (K^{+}) and magnesium (Mg^{+2}). The major negatively charged ions are chloride (Cl^{-}), sulphate (SO_4^{-2}), carbonate (CO_3^{-2}), and bicarbonate (HCO_3^{-}). Nitrates (NO_3^{-2}) and phosphates (PO_4^{-3}) are minor contributors to conductivity, although they are very important biologically (Wu and Koch, 1991). It is therefore important to determine conductivity level in order to clarify how this ions affects water in the streams. The salts in sea water are primarily sodium chloride (NaCl). However, other saline waters owe their high salinity to a combination of dissolved ions including sodium, chloride, carbonate and sulphate. Therefore the streams and reservoirs under study are affected greatly by these dissolved ions. If a daily water consumption of 2 litres and an average chloride level in drinking-water of 10 mg/litre are assumed. The average daily intake of chloride from drinking-water would be approximately 20 mg per person. An approximate figure of 100 mg/day has also been suggested (Yung, 1995). This shows that it was important to determine salinity in this water used for living organism's consumption.

If rain water flows on hard water soil and rocks in Ngangao forests, it`s pH raises due to bicarbonate ions (HCO_3^-) that cause water to produce OH^- , this is common in this area under study. The most frequently reported waterborne disease in the United States is acute gastrointestinal illness, or gastroenteritis (Niemenski, 1992). These diseases are associated with turbidity which is character in drinking water that needs to be determined. Measuring dissolved oxygen and temperature, scientists can gauge the overall condition of water bodies. Aquatic organisms need dissolved oxygen for their survival. Water temperature also directly influences aquatic organisms. The DO concentration within a water body can experience large daily fluctuations and this needs to be studied. Forest fertilization which happens in Ngangao commonly increases nutrient concentrations in stream water. Excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child`s blood. This state reasons clearly why nitrates were determined.

Soil and rocks in this area under study as shown in figure above, release ions into the waters that flow through or over them, but the salinity level or the conductivity of the water flowing out of the forest is not known. Water quality change over time but the trend of this change is never stated. There is a wide gap in chemical concentration in terms of pH, phosphate, and temperature, dissolved oxygen concentration in the water under study and their effects to human, plants and other organisms. It was necessary to know the concentrations in this water since the ecological requirements of the organisms we try to protect are not known. Safe levels of chemicals in drinking water which do or may cause health problems is not known within Ngangao. Information on maximum contamination level in drinking water within the study area is not available.

Conductivity will vary with water source: ground water, water drained from agricultural fields, municipal waste water, rainfall. Therefore, conductivity found can be used to indicate groundwater seepage or a sewage leak. Agro economic activities in Taita have with time posed a change on the water being used in by locals. Therefore, information on the average composition of some of the water chemical characters used for human and plant will be available. Understanding turbidity, its causes and sources, and the significance to human health will provide the background on which new turbidity standards can be best. Once considered as a mostly aesthetic characteristic of drinking water, significant evidence will exist that controlling turbidity is competent safeguard against pathogens in drinking water. Through this process, microbial, chemical and radiological aspects of drinking-water will be subjected to periodic review, and documentation related to aspects of protection and control of public drinking water quality. The objective of the study was to determine the water chemical composition of the streams flowing from some of the sources at Ngangao forests.

Materials and methods

Field site characteristics; The research was carried out within the month of March-April 2014 in Ngangao Forests,Wundanyi, Taita Kenya. Ngangao Forests are located in Taita Hills and form the northernmost part of the Eastern Arcs. They are located in the Taita-Taveta District, southeast Kenya (03°15′- 3°30′S and 38°15′- 38°30′E), approximately 165 km inland from the Indian Ocean. The altitudinal range of the forested area is from 1500 m to 2,140 m. (Burgess et al., 2007). Annual rainfall ranges from 500 mm in the lower elevations to 1500 mm in the mountains, and can vary widely from year to year. Peak precipitation months are April and November, but moist weather conditions prevail throughout the year (Books et al., 1998). Temperature range during the month of study was 7-28^0 C.

Treatments and replications; A Completely Randomized Design (CRD) comprising of five treatments with three replicates as follows: 1st treatment; water at one of the source and used in Kitumbi High school, 2nd treatment; tank containing water piped directly from the source plus water harvested from iron sheets and used in Kitumbi High school**,** 3rd treatment; water piped from the source and used directly from the tap and serving the kitchen, 4th treatment; Water flowing from the ground put at a collection point and used by the community surrounding Kitumbi High school and 5th treatment; Water from various sources converging to form a dam and used by the community for watering plants and piped to some homesteads for home consumption.

Measurement of parameters; Probeware connected to the LabQuest was used to quantify conductivity (low, medium and high conductivity) in µs/cm, chloride/salinity in mg/l, pH, Dissolved oxygen concentration (mg/l), temperature (^{0} c) and nitrate (mg/l).

Labeled Sachi discs were used to determine turbidity of water (JTU).

Phosphate tablet was used to determine the amount of phosphate (ppm) in water.

Statistical data analysis; The data were subjected to one way ANOVA using SAS statistical computer package (Steel *et al*., 2006). Duncan`s multiple range test at 5% level was used to separate and to compare the treatment means.

Results

Table to Summarize of all results for parameters measured. Showing 1st treatment; water from one of the sources and used in Kitumbi High school: 2nd treatment tank containing water piped directly from the source and water harvested from the iron sheets and used in Kitumbi High school: 3rd; water piped from the source and used directly from the tap to serve the kitchen of Kitumbi High school; 4th; water flowing on the ground but settled at a collection point and used by the community surrounding the school: 5th; water from various sources converging to form a small minor dam.

Treatments / meanParameters	1	2	3	4	5	Grand mean	C.V in %	P values
Temperature(^{0}c)	23.50	19.20	21.4	24.57	24.27	22.59	1.04	0.0001
Std error	0.06	0.06	0.25	0.15	0.03	0.54		
pH	5.98	6.26	6.21	6.13	6.21	6.16	1.70	0.06
Std error	0.08	0.07	0.03	0.08	0.03	0.04		
Turbidity(JTU)	100	100	100	100	100	100	0.00	-
Std error	0.00	0.00	0.00	0.00	0.00	0.00		
DOC	0.70	0.73	0.80	0.70	0.70	0.73	3.55	0.0029
Std error	0.00	0.03	0.00	0.03	0.03	0.01		
Phosphate (ppm)	2.33	1.33	1.33	1.67	2.00	1.73	47.12	0.5251
Std error	0.88	0.33	0.33	0.33	0.00	0.21		
Nitrate(mg/l)	1.00	1.00	1.00	1.00	1.00	1.00	0.00	-
Std error	0.00	0.00	0.00	0.00	0.00	0.00		
Chloride or salinity (mg/l)	1.00	1.00	1.00	1.00	1.00	1.00	0.00	-
Std error	0.00	0.00	0.00	0.00	0.00	0.00		
Low conductivity (µs/cm)	74.97	95.47	72.80	108.50	76.37	85.62	13.8	0.015
Std error	6.67	13.62	1.10	0.57	1.07	4.55		
Medium conductivity (µs/cm)	86.33	111.33	83.33	127.67	87.33	99.20	14.44	0.0129
Std error	7.33	16.84	1.31	0.88	1.45	5.61		
High conductivity (µs/cm)	91.00	114.33	86.00	131.0	88.00	102.07	15.97	0.0258
Std error	11.00	0.58	0.58	0.58	1.53	5.92		

Conductivity; Low conductivity had no significant difference ($p>0.05$) with a mean of 85.62 µs/cm and a C.V 13.8% within treatments. Critical range value for five means was 23.39 while Treatments 4, 2, 5, 1 and 3 had means of 108.5, 95.47, 76.37, 74.97 and 72.8 respectively. Medium conductivity had no significant difference ($p>0.05$) with a mean of 99.2µs/cm and a C.V 14.44% within treatments. Critical range value for five means was 28.36 while Treatments 4, 2, 5, 1 and 3 had means of 127.67, 111.3, 87.33, 86.33 and 83.33 respectively. High conductivity had non significant difference ($p>0.05$) with a mean of 102.07 µs/cm and a C.V 15.97% within treatments. Critical range value for five means was 32.27 while Treatments 4, 2, 1, 5 and 3 had means of 131.00, 114.33, 91.00, 88.00 and 86.00 respectively.

Salinity; Chloride/ salinity had no p value with a mean of 1mg/l and a C.V of 0 % within treatments. Critical range value for five means was 0.00 while while all treatments had a mean of 1.

pH; pH had no significant difference ($p>0.05$) with a mean of 6.16 and a C.V 0.15% within treatments. Critical range value for five means was 0.21 while Treatments 2, 5, 3, 4 and 1 had means of 6.26, 6.21, 6.2, 6.13 and 5.98 respectively.

Turbidity; Turbidity had no p value with a mean of 100 JTU and a C.V 0% within treatments. Critical range value for five means was 0.00 while All treatments had means of 100.

Dissolved oxygen concentration; Dissolved oxygen concentration (mg/l) had a significant difference ($p<0.05$) with a mean of 0.73 mg/l with a CV 3.55 % within treatments. Critical range value for five means was 0.05 while Treatments 3, 2, 1, 4 and 5 had means of 0.8, 0.73, 0.7, 0.7 and 0.7 respectively.

Temperature; Temperature had significant difference ($p<0.05$) with a mean of 22.59^{0}c and a C.V 1.04% within treatments. Critical range value for five means was 0.47 while Treatments 4, 5, 1, 3 and 2 had means of 24.57, 24.27, 23.5, 21.4 and 19.2 respectively.

Nitrate; Nitrate had no p value with a mean of 1mg/l and a C.V 0% within treatments. Critical range value for five means was 1.62 while All treatments had a mean of 1.00.

Phosphate; Phosphate had no significant difference ($p>0.05$) with a mean of 1.73 ppm and a CV 47.11% within treatments. Critical range value for five means was 0.00 while Treatments 1, 5, 4, 2 and 3 had means of 2.33, 2.00, 1.67, 1.33 and 1.33 respectively.

Discussion

Conductivity; Rivers or drainage ditches dominated by subsurface agricultural return flows seem to greatly affect conductivity of water in the study area as found by Yung et al. (1995). The current is carried by ions; therefore, the conductivity increases with the number in ions present in solution and their mobility (Yung and Daula, 1995). In both low, medium and high conductivity as measured in this parameter in the study showed a non significant difference.

This indicates that almost all the water at different points of treatment had no much difference in conducting ion concentration. Positively and negatively charged ions that might have contributed to conductivity in these water collection points in the experiment might include Na^{+}, Ca^{+2}, K^{+}, Mg^{+2}, Cl^{-}, SO_4^{-2}, CO_3^{-2}, HCO_3^{-}, NO_3^{-2} and PO_4^{-3} as indicated by Wu and Koch (1991) in their research. In California, each of the Regional Water Quality Control Boards develops a Basin Plan that keeps on updating on water over time. This should be taken in as suggestion and implemented here in Kenya.

Salinity; Chlorides are leached from various rocks into soil and water by weathering since they are highly mobile and are transported to closed basin at the source in the first treatment. They are then moved to streams. Taste thresholds for sodium chloride and calcium chloride in water are in the range 200–300 mg/litre as postulated by (IOS, 1989). The mean chloride concentration in several rivers in the United Kingdom was found to have a far much smaller range of 11–42 mg/litre during 1974–81 (Gregory, 1990) as compared to this of IOS, 1989. In this study, the chloride concentration in water had a mean of 1 mg/l in all treatments. These low figures may have been contributed to low rate of application of fertilizers which might have led to low seepage of potassium into streams under this study. Chloride levels in unpolluted waters are often below 10 mg/litre and sometimes below 1 mg/litre (Gregory, 1990). Chloride in water may be considerably increased by treatment processes in which chlorine or chloride is used. For example, treatment with 40 g of chlorine per m^3 and 0.6 mol of iron chloride per litre, required for the purification of groundwater containing large amounts of iron (II), or surface water polluted with colloids, has been reported to result in chloride concentrations of 40 and 63 mg/litre (Gelbs and Anderson, 1981). In the studied area, there has been no chloride treatment of water.

The average daily intake of chloride from drinking-water would be approximately 20 mg per person. In humans, 88% of chloride is extracellular and contributes to the osmotic activity of body fluids. The electrolyte balance in the body is maintained by adjusting total dietary intake and by excretion via the kidneys and gastrointestinal tract. Chloride is almost completely absorbed in normal individuals, mostly from the proximal half of the small intestine. Normal fluid loss amounts to about 1.5–2 litres/day, together with about 4 g of chloride per day. Most (90– 95%) is excreted in the urine, with minor amounts in faeces (4–8%) and sweat (2%) (Wu and Koch, 1991). Basing on this information, the toxicity of Chloride found in the study treatments might be less minimal or absent. It`s also important to note that the toxicity of chloride salts depends on the cation present; that of chloride itself is unknown. Although excessive intake of drinking-water containing sodium chloride at concentrations above 2.5 g/litre has been reported to produce hypertension (Yung and Daula, 1995), which is an effect that is believed to be related to the sodium ion concentration. This might not be the case in people taking water from the area in this study. Water qualities therefore change over time as we learn more about the effects of each parameter and the ecological requirements of the organisms we are trying to protect. This implies that different and inconsistent data might be found with time. Therefore, continuity in research is very vital.

pH; The pH here suggested that the water had concentration of OH^- exceeding that of H^+. Rainfall might have been the major influence on the pH of the streams and collection water point in the study since a pH range of 5-6.5 is found in rain water. There is CO_2, and air pollutants such as Sulphur dioxide which are acidic (USEP, 1997). If rain water in these areas flows on hard water soil which might also lead to pH raise due to bicarbonate ions (HCO_3^-) that cause water to produce OH^- through the process below;-

$$HCO_3^- + H_2O \longrightarrow H_2CO_3 + OH^-$$

This phenomena leads to the streams and water collection points under the study range from 5.98 at the source which was the first treatment to 6.26 second treatment (water piped from the source and water harvested from the iron sheets). Small change in pH can endanger many kinds of plants and animals. Water pH may have also been affected by algal blooms, levels of hard water minerals, effluents from industrial process, carbonic acid from respiration or decomposition and oxidation of sulphides in sediments. In most of the drinking water, the pH should range between 6.5- 8.5 (Campbell and Wildberger 1992), and with these values water used by members of the community under study was safe. These areas might be having low concentrations of Mg^{2+}, Ca and HCO_3^-, since the high concentration raises pH values to 7.5-8.5.

Turbidity;It was caused by suspended matter or impurities that interfered with the clarity of the water such that light was scattered and absorbed by: particles and molecules rather than transmitted in straight lines. This study found a turbidity mean of 100JTU and C.V 0.15% for all the treatments, which might be caused by; divided inorganic and organic matter, soluble coloured organic compounds, planktons and other microscopic organisms as suggested by CDC (1996).

The turbidity or cloudiness was high in this study, meaning that the drinking water was aesthetically unappealing, and may also represent a health concern. It could be providing food and shelter for pathogens hence regrowth in their distribution systems leading to waterborne disease outbreaks as stated by USEP (1997). Significant cases of gastroenteritis may come to exist if this turbity is not removed (Fox et al., 1999). The particles of turbidity provided shelter for microbes by reducing their exposure to attack by disinfectants. The material aids in microbe survival (Lechevallier et al., 1992 and 1991). Turbidity over 1.0 NTU was occurring in finished water during the outbreaks of diseases.

Dissolved Oxygen concentration; Dissolved oxygen and temperature are fundamental variables in rivers and pond ecology that was used to gauge the overall condition of the water. Aquatic organisms need dissolved oxygen for their survival. While water temperature also directly influences aquatic organisms; it regulated dissolved oxygen concentrations within the treatments. All organisms in this study area; fish, insects, microscopic zooplankton, need oxygen for respiration. During respiration, organisms might have had need to consume oxygen and gave off carbon dioxide while absorbing food molecules to obtain energy for growth and maintenance (Caduto 1990). Some organisms may live in environments where oxygen levels fluctuate significantly, water with less oxygen of 0.75 mg/l seemed to be unfit for human consumption at the same time, oxygen might have been consumed most by micro-organisms housed in this water under study. Plants respire at night when there is lack of sunlight which prevents photosynthesis which may have distributed to low oxygen in these water bodies under study. Decomposition of dead plant and animal material also requires DO making levels low and lower.

The amount of oxygen dissolved in a water body is affected by salinity, altitude, groundwater inflow, and water temperature. Salinity is how much salt is in the water. Although it is generally not a concern in most freshwater lakes, salinity can greatly affect oxygen solubility in estuaries, brackish waters, bogs, and water bodies in agricultural areas (Campbell and Wildberger 1992). Higher salinity reduces the amount of oxygen that can dissolve in the water. Due to lower atmospheric pressure, lakes in higher altitudes usually have lower levels of DO. Groundwater, which does not have contact with the atmosphere, typically has lower levels of DO than surface waters. When groundwater enters a lake, DO concentrations are initially reduced near the spring (Caduto, 1990). However, groundwater is generally colder than surface waters (Caduto, 1990). Colder water holds more oxygen than warmer water. By reducing lake water temperature, groundwater inputs increase the ability of a water body to hold oxygen in the long term. Of these variables, temperature mostly directly affects DO in lakes and ponds.

Temperature; Seasonal air temperature might have caused low water temperatures of a mean of 22.59^0 C as found in this study. The temperatures are often very low in the regions that the study was carried. Migration, spawning, egg incubation, growth, and metabolism of aquatic organisms might have been possible in these water bodies. Warmer water promotes higher metabolism and respiration rates hence indirectly influencing DO concentrations. Warm water holds less oxygen in solution than cold water. Therefore, these low temperatures may have contributed to low DO found in this study. Water temperatures can range from 0^oC in winter to above 30^oC in summer as found by Adams et al. (1997). Cooler water as found in the streams under study is generally healthier than warmer water, although there are no definitive standards.

Nitrogen; The drinking-water quality of stream water in forests is typically very good, exceeding the quality of water in areas with other types of land use. Streams draining on agricultural lands in the United States average about nine times greater concentrations of nitrates and phosphate than streams draining in forested areas (Dan et al., 1998). Depending on this information, a low mean of 1mg/l and C.V 0 % was found at every treatment in this study. These concentrations might have been contributed by forest fertilization and agricultural fertilizer application along the flowing water. Peak concentrations of nitrate-N in stream water increase after forest fertilization, with a few studies reporting concentrations as high as 10 mg/l as nitrate as reported by Dan et al. (1998). High levels of nitrate have been linked to methemoglobinemia (blue-baby) syndrome in human infants which have been very rare in the areas under study. The USEPA, 1986 has set a drinking water guideline of 10 mg/l for nitrates, and this standard is also used in Canada (CCREM, 1990). The World Health Organization and European Community use a standard of 50 mg/l nitrate. In North America, major river systems average <1 mg/l as nitrate, with many systems substantially below this concentration. Europe has higher nitrate concentrations in rivers, which averages as high as 4 mg/l. The high values in Europe are attributed largely to fertilization practices in agriculture. Though, high rates of atmospheric deposition of N may also play a role (GEMS, 1997). Increased N due to fertilization may provide an opportunity for increased productivity of aquatic ecosystems. But the available studies suggest little if any response in stream productivity following fertilization. Perrin et al. (1984) found that fertilization of a watershed (with and without buffer strips along some streams) and a lake within the watershed increased lake chlorophyll concentrations by about threefold.

Substantial increases in concentrations of nitrate-N in deep soil solutions following fertilization may indicate a potential for increased stream water concentrations. High concentrations of nitrate-N in soil water may, or may not, lead to stream water impacts, depending on factors such as nitrate retention in the stream biota, nitrate removal (denitrification), and nitrate dilution from mixing with other water.

Excessive levels of nitrate in drinking water have caused serious illnesses and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child`s blood.

Phosphorus; Fertilization with phosphates can lead to increased peak concentrations of >1 mg P/l (Dan et al., 1998) as found at the source which had 2.33 ppm since there was high biological fertilization from cypress trees to the collection points. No evidence has been reported of detectable effects of forest P fertilization on the composition or productivity of stream communities, but more detailed studies should be warranted. Phosphate is not toxic, and concerns on extremely high concentrations of phosphate on increase in the productivity of aquatic ecosystems has been raised. MacDonald et al. (1991) noted that the USEPA has set no standard for P in freshwaters, but a variety of suggested guidelines may relate to avoiding major effects on aquatic ecosystems. Suggested guidelines range from 0.025 to 0.1 mg /l as in Binkley et al. (1999) 191±213 total-P. The P concentration of streams draining into lakes or reservoirs may be more critical than the P concentrations in other streams as in this study. Concentrations of P in river waters in Europe are generally higher than in North America, ranging from 0.05 to 0.5 mg /l (GEMS, 1997). In addition to the issues that relate to human health, degradation of water quality through increased concentrations of limiting nutrients could impact the productivity and species composition of aquatic ecosystems. A variety of studies has examined the effects of fertilizer application directly into streams (Bisson et al., 1992). As reported by Bisson et al. (1992) found evidence of any detrimental effect of direct application of fertilizer to streams. Studies on the effects of forest application of fertilizers on stream ecosystems have shown no effects; background variation along stream ridges are typically too large relative to any minor and transient effects of elevated stream water nutrient concentrations to allow detection of any impacts on the biota (GoÈthe et al., 1993).

We expect that the transient timing of increased in P concentration, coupled with P removal and dilution downstream, probably result in little overall effect on aquatic ecosystems, but this expectation may warrant direct examination

Conclusion

Less ions in water studied was indicated by non significant difference in conductivity. There was no chloride addition in water as a water treatment method in the study area. This led to less chloride concentration in these streams. This means less risk of hypertension. The water flows on hard soils of bicarbonate probably raising pH to 5.98 or 6.26. The water is recommended to be safe for human consumption and plant irrigation considering its conductivity, salinity, and pH range. In future studies, conductivity, salinity and pH can be done several times within the year to check their threshold in accumulation within seasonal variation since the study was carried out during cold and rainy season.

A mean temperature of 22.5^0 c was healthier for organisms and human consumption. These less temperatures assume less oxygen concentration to reduce microbial respiration thus small number of microbes as much as turbidity had high value in this study. Temperatures, DOC and turbidity have a close relationship concerning microbial breeding. Therefore it’s recommended that regional boards to be formed in order to detect changes in these parameters time after time in the areas under study. Future studies can concentrate much on faecal caliform in addition to temperature, DOC and turbidity since they determine much on microbial infestation in water. This might affect much on health status of human beings.

There was high P concentration of 2.33ppm at the source compared to other treatments although phosphorous concentration have been found to have no detectable bad effects on humans. Nitrate concentration of 1mg/l was low as most recommended. This water suggested it is safe for consumption. Excessive levels of nitrate in drinking water cause illness and sometimes death. This death in infants is due to conversion of nitrate to nitrite by the body which interferes with oxygen carrying capacity of a child`s blood. Agricultural firms are recommended to carry more research and carry mass education on farming to members in these areas since phosphate and Nitrate are sipped into the rivers as people do a lot of farming along streams. Future studies should concentrate much on nitrate concentration, since it's much lethal to human life in high concentration. This should be done in other areas around these forests.

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