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ANALYSIS OF GROUND WATER QUALITY OF KALIMATI AREA, KATHMANDU, NEPAL: A REVIEW

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ABSTRACT

Principles of Water Quality present the fundamental environmental processes that regulate the movement of materials in natural systems. Water quality is dependent on the type of the pollutant added and the nature of mineral found at particular zone of bore well. Monitoring of the water quality of ground water is done by collecting representative water samples and analysis of physicochemical characteristics of water samples at different locations of Indore City. Estimation of water quality index through formulation of appropriate using method and evaluate the quality of tube well water by statistical analysis for post and pre monsoon seasons. The seasonal values of WQI indicate that during summer season, lake water is more affected than during winter. This could be due to the fact that the microbial activity get reduced due to low temperature, thereby keeping DO level at a very satisfactory range during entire winter season. The suggested measures to improve the lake water quality includes total ban on the activities that causes pollution. Result of water quality assessment clearly showed that most of the water quality parameters slightly higher in the wet season than in the dry season. Water quality is dependent on the type of the pollutant added and the nature of self-purification of water. Groundwater is an essential and vital component of any life support system. It is not only the basic need for human existence but also a vital input for all development activities. Physico-chemical parameters such as pH, electrical conductivity, total dissolved solids, total hardness, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride are used to assess the suitability of groundwater for domestic purpose by comparing with the WHO and Nepalese standards.

KEYWORDS: Ground water, water quality standards, physico-chemical, Water Quality Index.

1. INTRODUCTION

Kathmandu valley is one of the historical cities containing many world heritage sites recognized by UNESCO. It is centrally located in the middle hills of Nepal. Within the valley are Kathmandu Metropolitan City, the Capital city of Nepal, Lalitpur sub metropolitan city & three municipalities namely Kirtipur, Bhaktapur & Madhyapur Thimi.[1] Kathmandu district has the largest population of 1,740,977 among the districts of Nepal.[2] (CBS, 2011). The study area (Kalimati) is on one of the 35 wards of Kathmandu metropolitan city, centrally located ward no.13.This ward comprises 213.3 hectares and its population in 2001 was 29,721& total number of households were 6429.[3] (KMC, 2012). Kalimati which lies approximately between 85°17'51''E and 85°18'12'' E and 27°41'48''N and 27°41'54''N. Altitude is about 1310 m asl. The study area is a part of Kathmandu valley, having main rivers Bagmati and Bishnumati and their tributaries. Bishnumati River separates Kalimati from Teku area in the east. Monsoon rain prevails during June to September during which about 80% of annual precipitation occurs. Soil of Kalimati is of histosol type & is known to be highly productive with higher organic matter content.[4] The Kathmandu Valley has a mild climate most of the year, situated at an altitude of 4,297 feet (1,310m). Summer temperatures range from 67-81°F (19-27°C), and in winter temperatures are between 36 and 68°F (2-20°C). During the rainy monsoon season between June and August, there is an average rainfall of between 7.8-14.7 inches (20-37 cm) in Kathmandu.[5] May and June can be very hot and humid until the monsoon rains bring relief. In spring (March to April) and autumn (October to November) the temperatures are pleasant with occasional short bursts of rain, while November to February are dry, but can be very cold, especially at night.[6]

Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life.[7] Groundwater is used for domestic and industrial water supply and also for irrigation purposes in all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization.[8] According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored back easily and to device ways and means to protect it. Ground water is an important source of water for the

inhabitants of the Kathmandu valley as majority of the residents depends on this source.[9] Due to overpopulation in the valley, overconsumption of water by the residents from ground water sources is increasing causing the reduction of the quality and quantity of groundwater. The concrete cover on the ground surface is preventing the normal ground water recharge.[10] The pollutants on soil and the leakage of sewage from the sewerage is also causing ground water pollution. As Kalimati lies near the Bishnumati River, which itself is severely polluted, the water that percolates downward can also contaminate ground water. So for these reasons Kalimati was selected for the study.

Water quality index (WQI) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater.[11] WQI is an important technique for demarcating groundwater quality and its suitability for drinking purpose. Water pollution is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses[12] (Miller, 2007). The water quality is assessed in term of physical, chemical & biological characteristics & its intended uses. Changes in water quality are reflected in its physical, biological, and chemical conditions and these in turn are influenced by physical 8 and anthropogenic activities.[13]

2. Assessment of Water Quality Parameters

2.1 Temperature

Temperature of water depends on the surrounding temperature of the water body. Temperature affects the other parameters of water quality by altering the reactions rate among chemicals present within water.

2.2 pH

It is defined as negative logarithm of H+ ions activity. Its value ranges from 0-14. pH is measured by a pH meter using a glass electrode which generates a potential varying linearly with the pH of solution in which it is immersed. Value range of pH from 7 t0 14 is alkaline, from 0 to 7 is acidic and 7 is neutral. Mainly drinking water pH lies from 4.4 to 8.5. The pH scale commonly ranges from 0 to 14.

2.3 Turbidity

Water may appear colored or turbid or both, color arise from the absorption of visible light by dissolved & undissolved substances. Suspension of particles in water interfering with passage of light is called turbidity. Turbidity is caused by wide variety of Suspended particles. Turbidity can be measured either by its effect on the transmission of light which is termed as Turbidity. Turbidity is caused by the scattering of light in all directions by an undissolved substance. Turbidity is an important parameter for characterizing the water quality & also helps to estimate the concentration of undissolved substances. The amount of scattered light & its angular distribution is governed not only by the quantity of the insoluble substance but also by their relative shape and refractive index.

2.4 Electrical Conductivity

Conductivity is the capacity of water to carry an electrical current and varies both with number and types of ions the solution contains. This conductivity depends on the presence of ions their total concentration, mobility, valence and relative concentration and on the temperature of the liquid. Solutions of most inorganic acids, bases, and salts are relatively good conductors. Electrical conductivity is a measure of the ability of a water sample to carry an electric current & it depends on its ionic strength. Conductivity is a reciprocal of the resistance. Conductivity is a measure of conductance of a conductor of length 1cm & area of $1cm^2$. Conductivity mostly depends upon the nature of the various dissolved ionized substances, their actual and relative concentrations & the temperature at which the measurement is made. Higher conductivity of water indicates the presence of pollutants in water.

2.5 Chloride

All type of natural and raw water contains chlorides. It comes from activities carried out in agricultural area, Industrial activities and from chloride stones. Its concentration is high because of human activities. Chloride in drinking water is relatively harmless, if present in amounts below 250 ppm. In natural fresh water high concentration of chloride is considered to be an indicator of pollution due to organic waste of animal origin (sewage) or some industrial wastes. The municipal and domestic wastewater contains higher amount of chlorides. It is due to the fact that the common salt consumed by the man and cattle eliminated out of body unutilized. A high chloride concentration corrodes metallic pipes & structures as well as harms agricultural plants due to soil salinity & water logging.

2.6 Dissolved oxygen (DO)

Oxygen dissolved in water is often referred as DO. In natural and waste waters, DO levels depend on the physical, chemical, & biological activities of the water body. The analysis of DO plays a key role in water pollution control activities & water treatment process control. There are two main sources of DO in water: diffusion from air & photosynthetic activity within water. Non polluted surface waters are normally saturated with DO while presence of oxygen demanding waste like organic wastes causes rapid depletion of DO from water. Oxygen is considered to be a most limiting factor for aquatic life. Low DO may prove lethal for many aquatic organisms.

2.7 Biochemical Oxygen Demand (BOD)

BOD is defined as the amount of oxygen required to microorganisms to degrade decomposable organic matter in a waste under aerobic conditions. Since the test is based on mainly bio-assay procedure measuring the amount of oxygen consumed by bacteria, it is necessary to provide suitable environment (temperature, pH, absence of toxic substances, etc.) for microorganisms. It is an index of organic pollution in water. The complete degradation of the organic matter completely takes about 20-30 days. Simple organic compounds like glucose are almost completely oxidized in 5 days, so the 5 days BOD measurement is in practice.

2.8 Chemical Oxygen Demand (COD)

The COD determines the amount of oxygen required for chemical oxidation of organic matter present in water, using a strong chemical oxidant, such as potassium dichromate under reflux conditions. The estimation of COD is of great significance for waters having unfavorable conditions for the growth of microorganisms, such as presence of toxic chemicals. The test is highly useful to find out the pollution strength of industrial effluents and sewage. BOD is the requirement of oxygen to degrade only the biodegradable organic matter, whereas COD is the requirement of oxygen for overall degradation of organic matter by oxidizing agents. So COD is always greater than BOD. The advantage of COD to BOD is that COD test can be performed in short time rather than 5 days for BOD.

2.9 Alkalinity

The alkalinity of water is its quantitative capacity to neutralize a strong acid to a designated pH. Since the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate & hydroxide ions, the alkalinity is taken as an indication of the concentration of

these constituents. The alkalinity of many natural & treated waters is due to only bicarbonates of calcium & magnesium. The pH of these waters does not exceed 8.3. Their total alkalinity is practically identical with their carbonate hardness & such samples do not have phenolphthalein alkalinity. Waters having a pH above 8.3 contain besides bicarbonate, normal carbonates & possibly hydroxide also. The alkalinity fraction equivalent to the amount of acid required to lower the pH of the sample to 8.3 is called Phenolphthalein alkalinity.

2.10 Hardness

Hardness in water is mainly due to calcium & magnesium ions. Though some other polyvalent ions such as aluminium, iron, manganese, strontium & zinc also contribute to hardness. In natural waters it is defined as sum of the calcium & magnesium ions expressed as calcium carbonate (CaCO3). Hardness in water poses problem of scale formation in boilers. It is also objectionable for laundry & domestic purposes. Hardness in water is due to the natural accumulation of salts from contact with soil and geological formations or it may enter from direct pollution by industrial effluents. There are two types of hardness: temporary & permanent hardness. Temporary hardness is caused by the presence of bicarbonates of calcium & magnesium, & it can be removed by boiling. Permanent hardness is caused by the presence of soluble salts of Ca & Mg, other than bicarbonates such as chlorides, sulphates and nitrates.

2.11 Ammonia

It is naturally present in surface water, ground water & domestic sewage. It is produced largely by the deamination of organic nitrogen containing compounds & hydrolysis of urea. In water bodies, it is produced naturally by the reduction of nitrates under anaerobic conditions. Chlorine added to drinking water supply, when encountered with ammonia gets neutralized and chloramines are formed. It is toxic to man at high pH, most of ammonia remains in the gaseous form. Deep well waters usually contain only traces of organic matter and ammonia. If an excess of ammonia and organic matter are present then it should be suspected of pollution through seepage.

2.12 Nitrate

These are usually monitored regularly in water supplies as they are deemed to be potentially hazardous to health if their maximum admissible concentration is exceeded. Nitrate is particularly dangerous to infants less than six months old causing child disease,

methemoglobinaemia. Nitrate generally occur in traces in surface water, but may obtain high values in some groundwater. Nitrate may occur in surface or ground waters as a result of agricultural runoff, which may reach to hazardous level. Nitrate is also one of the most important nutrients, limiting growth of autotrophs.

2.13 Phosphate

It occurs in natural & waste waters as inorganically and organically bound phosphate. Phosphate is largely used for laundry purpose, treatment of boiler water and agriculture. The runoffs from all these sources find their way into water bodies. Organic phosphates are formed primarily by biological processes, but are also contributed to by domestic sewage. Phosphates also occur in bottom sediments & in biological sludges, both in precipitated inorganic forms & incorporated into organic compounds. Phosphates play an important role in the eutrophication of lakes & reservoirs. Phosphate may occur in surface or groundwater as a result of leaching from minerals or ores, from agricultural runoff, as a result of industrial wastes & as a major element of municipal sewage due to the use of synthetic detergents. Though present in low concentration, phosphorus is one of the most important nutrients, limiting growth of autotrophs, but the high phosphorus content causes increased algal growth often as blooms.

2.14 Iron

Surface water generally contains less than 1 ppm of iron. Some ground waters & acid surface drainage may contain much higher levels of Iron. Water containing more than 2 ppm of iron causes staining of clothes (while washing) & imparts a bitter astringent taste. Iron is found both in oxidized (ferric) & reduced (ferrous) forms. Reduced iron is generally more soluble than oxidized iron. Iron has got little concern as a health hazard but it is still considered as a nuisance in excessive quantities.

3. Water Quality Index (WQI)

WQI is a dimensionless number that combines multiple water-quality factors into a single number by normalizing values to subjective rating curves. Factors to be included in WQI model could vary depending upon the designated water uses and local preferences. Some of these factors include DO, pH, BOD, COD, total coliform bacteria, temperature, and nutrients (nitrogen and phosphorus), etc. These parameters occur in different ranges and expressed in different units. The WQI takes the complex scientific information of these variables and synthesizes into a single number.

Calculation of WQI: The Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method. The quality rating scale for each parameter Qi was calculated by using this expression: Quality rating, Qi = 100 [(Vn -Vi) / (Vs -Vi)].

Where, Vn: actual amount of nth parameter, Vi : the ideal value of this parameter, Vi = 0 except for pH and D.O.; Vi = 7.0 for pH; Vi = 14.6 mg/L for D.O., Vs : recommended WHO standard of corresponding parameter.

Relative weight (Wi) was calculated by a value inversely proportional to the recommended standard (Si) of the corresponding parameter:

$Wi = 1 / Si$

Generally, WQI are discussed for a specific and intended use of water. In this study the WQI for human consumption is considered and permissible WQI for the drinking water is taken as 100. The overall WQI was calculated by using Equation:

$\text{Water Quality Index} = \sum(Qi)Wi / \sum Wi$

The WQI ranges have been defined as:

- 90-100 : Excellent
- 70-90 : Good
- 50-70 : Medium
- 25-50 : Bad
- 0-25 : Very Bad

By this way it defines water quality.

4. CONCLUSION

Water is a natural gift given to us by nature. Drinking water regularly in daily basis is the best way we can give to our bodies. Some of us drink it when we are thirsty and some of us drink it when we are fully hydrated. The surprising thing is that there are some people who don't like drinking water at all. In facts, we need water to keep our health no matter who we are. The importance of drinking water for our bodies is paramount to our health, because it makes up to 70 percent of our bodies' weight. There are four fulfilling benefits of drinking water to our bodies, such as it can speed up our metabolisms, make our skins healthier, lose our weight, and stay alert.

The first benefit of drinking water is it can speed up our metabolisms. Increased hydration levels have an effect of increasing the blood volume. The increased of blood volume helps the transport of oxygen to our bodies' cells. It also facilitates the transport of waste out the cells. If our cells are hydrated properly, our metabolisms will be optimal. The more water we consume, the more efficient our cells can work.

The next benefit is it can make our skins healthier. Drinking water can help our skins healthier, refreshed, and radiant for sure. Our skins will look unhealthy when the toxins are remained in our bodies. The role of water here is to flush the toxins away out of our bodies. Our skins need a lot of water to stay hydrated and supple, so we have to make sure that we drink enough water each day. We need to drink water for about 8 – 10 glasses in a day in order to keep our skins healthy.

The third benefit is water can lose our weight. When we are in a diet or fitness program, there is a suggestion that we have to drink a lot of water. Water can help us to suppress our appetite, so we don't eat as much as usual. Drinking water also helps our bodies to burn the fat in our bodies, and so our weight can be reduced. Some people say that drinking 15 liters of water in a day can help in losing our weight drastically. By the loss of our fat in our bodies, we can be healthier because some diseases caused by the fat will be avoided.

Finally, water can make us stay alert and focus. When we are properly hydrated, the circulation in our body will be good. By the fact, our brains are made up 85 percent of water, so we have to stay hydrated to help our brains. If our brains are properly hydrated, it will keep the mood fresh and active. People who drink less water often feel bored and less enthusiastic. Meanwhile, people who drink more water are really energetic and full of zeal. It also helps our bodies in relieving the fatigue of the body.

In conclusion, drinking water is a very important thing to our bodies' health. Not only human, but also all of the organisms need water to survive. The importance of drinking water for our bodies is paramount to our health, because it makes up to 70 percent of our bodies' weight. There are four fulfilling benefits of drinking water to our bodies, such as it can speed up our metabolisms, make our skins healthier, lose our weight, and stay alert. So, we have to consume water as much as we can to keep our body in a good condition.

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6. REFERENCES

1. Ghimire, M.K. 1996. Groundwater Quality Analysis in Patan Area, M. Sc. Dessertation submitted to the Central Department of Meteorology, Tribhuvan University, Kathmandu.
2. CBS, 2011. Preliminary Result of National Population Census 2011. Central Bureau of Statistics, Kathmandu.
3. Kathmandu metropolitan city website. http://www.kathmandu.gov.np (accessed on 06.05. 2012).
4. Joshi, D.R. and Baral, M.P. 2004. Chemical and Microbial Quality of Groundwater of Kathmandu valley. Abstracts of 4th National Conference on Science and Technology, March 23.
5. Shrestha, S. 2008. Water quality assessment of public wells of Madhyapur Thimi municipality, a dissertation submitted to Central Department of Environmental Science, Tribhuvan University, Kathmandu.
6. Raghunath, H.M. 2007. Groundwater, New Age International (P) Ltd., third Edition. Saras Graphics India.
7. Trivedy, R.K. & Goel, P.K. 1984. Chemical & biological methods for water pollution studies, Environmental publication, Karad, India.
8. JICA, 2005. Ground Water Quality Surveillance in Kathmandu and Lalitpur municipality areas, A joint study conducted by Japan International co operation agency and Environment and Public health Organization.
9. ENPHO, 1999. Monitoring of Groundwater Quality in the Kathmandu valley, Environment and Public health Organization, Nepal.
10. Diwakar et al. 2008. Assessment of drinking water of Bhaktapur municipality area in premonsoon season, Scientific World, July 2008; 6: 6.
11. De, A.K. 2006. Environmental chemistry, New Age International (P) Ltd, Sixth Edition. Daryaganj, New Delhi.
12. Gupta N. and et.al., Physico-Chemical Analysis of Drinking Water Quality from 32 locations in Delhi, Journal of Indian Water Works Association, (2010).
13. Shweta Tagy and et al, Water Quality Assessment in terms of Water Quality Index, American Journal of Water Resources, 2013; 1(3): 34-38.