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Physico-chemical analysis and assessment of water and ground water quality parameters in Nepal: A review

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Abstract
Nepal is the second richest country in water resources in the world. We can see many rivers, rivulares, brooks, streams, fall, lakes and small springs. Among them, rivers are the most important water resources. But rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Water is one of the most important compounds that profoundly influence life. The quality of water usually described according to its physical, chemical and biological characteristics. 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. Due to use of contaminated water, human population suffers from water borne diseases. It is therefore necessary to check the water quality at regular interval of time. Parameters that may be tested include temperature, pH, conductivity, total dissolved solids (TDS), total hardness, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride, sodium adsorption ratio (SAR), and permeability index can be used for irrigation suitability assessment. These parameters were used to assess the suitability of groundwater for domestic purpose by comparing with the WHO and Nepalese standards. Based on the total hardness and TDS, 96% of groundwater samples are found suitable for drinking purpose. Thus the analysis of the water quality is very important to preserve and prefect the natural eco system.

Keywords: ground water, pH, temperature, BOD, COD, water quality index (WQI)

1. Introduction
Nepal is the second richest country in water resources in the world. Nepal is rich in natural resources and it is second richest having highly potential in term of water resources. 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 [1]. 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 [2]. 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. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers [3]. It, thus, becomes an important parameter for the assessment and management of groundwater. Water quality standards are needed to determine whether ground water of a certain quality is suitable for its intended use. There are mainly two types of water resources [4]. They are: Surface water resources and Underground water resources. The source of water on the surface is called surface water resources like the river, rainfall, pond, etc. The water resources which implies underground sources like well, tube well, piped water under the ground. There are more than 6000 rivers and rivulets including big and small. The economic development of the country depends on how water has been utilized [5].

Water is a chief natural resource essential for the existence of life and is a basic human entity. Water resources are harnessed for various purposes like drinking, agricultural, industrial, household, recreational, and environmental activities, etc. Groundwater is one of the major sources of drinking water all over the world [6] (Bear 1979). Of the 37 Mkm^3 of freshwater estimated to be present on the earth, about 22% exists as groundwater, which constitutes about 97% of all liquid freshwater potentially available for human use [7] (Foster 1998). There has been tremendous increase in the demand for fresh water due to over exploitation and growth in population. Since groundwater is a renewable natural resource and a valuable component of the ecosystem, it is vulnerable to natural and human impacts. It is estimated that approximately one-third of the world's population use groundwater for drinking [8] (Nickson *et al*. 2005) and about one million people are directly dependent upon the groundwater resources in Asia alone [9] (Foster 1995).

In most parts of country, groundwater forms the major source of water supply for drinking and agricultural purposes. Quality of groundwater is equally important to its quantity owing to the suitability of water for various purposes. Groundwater quality data give important clues to the geologic history or rocks and indications of groundwater recharge, discharge and storage [10] (Walton 1970). Variation in groundwater quality in an area is a function of physical and chemical parameters that

are greatly influenced by geological formations and anthropogenic activities (Krishna Kumar *et al*. 2011) [11]. According to Babiker *et al*. (2007) [12], the chemistry of groundwater is not only related to the lithology of the area and the residence time the water is in contact with rock material, but also reflects inputs from the atmosphere, from soil and weathering as well as from pollutant sources such as mining, land clearance, saline intrusion, industrial and domestic wastes [13]. Excessive irrigation activities also resulted in groundwater pollution in Nepal [14].

2. Drinking Water in Nepal

"*Water, water everywhere, but not a drop to drink*" In most of the remote and rural areas, people drink directly from the sources like rivers, spring, ponds etc. These open sources of water are polluted and contaminated. Many of these water sources dry up in winter [15]. Such polluted water is the main cause for water-borne diseases like dysentery, typhoid and cholera. Every year many infants, children and adults become victims of these diseases [16]. There is an acute problem of rapid population growth in urban areas. The demand of drinking water is very high but difficult to fulfill. Most of water-pipes laid down during the time of Ranas have little or no maintenances [17]. Due to the carelessness of the people, water goes wasted as taps are let open event after use. People have to wake up early in the morning, and have to stand in the queue for long time just to get a bucket of water [18]. Often people have to fulfill their needs by buying water from the private sector.

In the past, people used to drink water directly from the source. The first piped water for drinking purpose was launched in Kathmandu during the time of Bir Shamsher. Water was brought through pipes from Shivapuri area, and stored in a reservoir in Bansbari, Maharajgung. From the reservoir, water was supplied to different parts in the valley. Similarly, during the time of Bhim Shumsher, water was brought through pipes from Sangle Khola and stored in the reservoir at Balaju and distributed to different places in Kathmandu [19]. In the context of Nepal, during the ruling period of Bir Shamsher the first piped water was launched in Kathmandu for the drinking purpose [20]. It was brought from Shivapuri area in Bansbari, Maharajgung. This water was supplied in the Kathmandu Valley. Similarly, during the time of Bhim Shumsher, water was brought through pipes from Sangle Khola and stored in the reservoir at Balaju and distributed to different places in Kathmandu [21].

3. Assessment of Water Quality

Now days due to increase in population, industrialization, agricultural activities and urbanization, large quantities of sewage and industrial wastewater are discharged into water bodies has significantly contributed to the pollution of the surface and ground water. Therefore, it is required to additional sources for fulfill the requirement of water. Because the ground water sources are safe and potable for drinking and other useful purposes of human being. Hence studies of physic-chemical characteristics of underground water to find out whether it is fit for drinking or some other beneficial uses. For the assessment of ground water quality of the bore well of the Indore city, Taking in view the following drinking water parameters are analyzed (1) pH (2)Turbidity (3) Total Dissolved Solids (4) Elec. Conductivity (5)Total hardness(6) Calcium(7) Magnesium,(8) Sulphates (9) Nitrate (10) M.P.N. (11) Total alkalinity (12) Chloride (13) Fluoride,(14) Boron (15) Phosphate (16) C.O.D.(17) Iron (18) Cadmium (19) Chromium (20) Nickel(21) Zinc (22) Manganese (23) Sodium and (24) Temperature [22].

The pH is important parameter of water, which determines the suitability of water for various purposes such as drinking, bathing, cooking, washing and agriculture etc. The pH level of water having desirable limit is 6.5 to 8.5 as specified by the BIS. Pure water is said to be neutral, with a pH of 7. Water with a pH below 7.0 is considered acidic while water with pH greater than 7.0 is considered as basic or alkaline. Electrical conductivity is the capacity of electrical current that passes through the water. It is directly related to concentration of ionized substances in water and may also be related to problems of excessive hardness. According to ICMR the desirable limit of Conductivity is 600 μm/cm. The standard desirable limit of alkalinity of potable water is 120 mg/l. The maximum Permissible level is 600 mg/l. Excessive alkalinity may cause eye irritation in human and chlorosis in plants [23]. It is measured by titration with standardized acid to a pH value of 4.5 and is expressed commonly as milligrams per liter as calcium carbonate. TDS in groundwater can also be due to natural sources such as sewage, urban runoff and industrial waste. The turbidity of water was 28 to 42 NTU which is higher as per the APHA limit. The limit of total hardness value for drinking water is to be within 300 mg/l of CaCO3.Higher concentration of hardness was found may be due to natural accumulation of salt, or surface runoff, water enter from direct pollution by human activities [24]. Chloride is one of the most important parameter in assessing the water quality and higher concentration of chloride indicates higher degree of organic pollution [25]. According to BIS and ICMR the permissible limit of chloride in drinking water is 250 mg/l. High concentration of chloride was observed may be due to natural processes such as the passage of water through natural salt formations in the earth or it may be an indication of pollution from industrial or domestic use [26]. In drinking water, high chloride content may lead to laxative effects [27] [28]. Nephelometer instrument measures the intensity of scattered light by turbid particles at right angle to the incident beam of light in comparison with the intensity of light passing through the sample. Scattering of light is a function of Tyndall effect exhibited by colloidal suspended particles. Turbidity of samples is measured by Nephelometer based on this principle [29]. The maximum Permissible level is 5 NTU. The temperature is measured with help of Digital Thermometer. The thermometer is immersed in sample and temperature is recorded.

4. Conclusion

Water resources are sources of water that are useful or potentially useful to humans. It is important because it is needed for life to exist. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses

require fresh water. Only 2.5% of water on the Earth is fresh water, and over two thirds of this is frozen in glaciers and polar ice caps [30]. Water demand already exceeds supply in many parts of the world, and many more areas are expected to experience this imbalance in the near future. It is estimated that 70% of world-wide water use is for irrigation in agriculture. Climate change will have significant impacts on water resources around the world because of the close connections between the climate and hydrologic cycle. Due to the expanding human population competition for water is growing such that many of the world's major aquifers are becoming depleted [31]. Many pollutants threaten water supplies, but the most widespread, especially in underdeveloped countries, is the discharge of raw sewage into natural waters. Groundwater is an important source of drinking water for many people around the world. Contamination of groundwater generally results in poor drinking water quality, loss of water supply, high cleanup costs, high-cost alternative water supplies and potential health problem.

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