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# Soil Quality Assessment Posed by Industrial Effluents in Bansbari Industrial Area of Morang District, Nepal

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**ABSTRACT**

The menace of industrial pollution has been haunting the human world in the past several decades by causing different types of pollution. Agricultural sector in Nepal is severely affected by the direct discharge of untreated effluents on the agriculture land. This paper focuses to analyze the effect of industrial effluents on soil by measuring different physico-chemical parameters. Discharge of industrial effluents into the soil causes to change the physico-chemical and biological profile of the soil. Physico-chemical parameters like pH, electrical conductivity, alkalinity, acidity, moisture, organic matter, water holding capacity, specific gravity, texture, nitrogen, phosphorus and potassium were analyzed. The study revealed the negative impact of industrial effluents in the soil. Various parameters were found badly affected, which were different from the normal range of the fertile soil. Excessive accumulation of organic matters has changed the alkalinity of the soil. The alkalinity was found maximum in the soil near to soap industries. Irregular distribution of micronutrients (nitrogen, phosphorus, and potassium) was found in the present study.



## Introduction

Nepal is a small developing country in the south Asia, bordered by China to the north and India to the south, east and west. The Nepal Living Standard Survey (NLSS) data forecasts that approximately 25% Nepalese people are below the absolute poverty line [1]. Majority of the people here have agricultural occupation as their primary livelihood. It is only the occupation where poor people can earn some cash. About 80% of the country population lives in rural areas [2]. In the past few decades, the pollution problem in Nepal is rapidly increasing due to unexpected industrial revolution and rapid population growth [3]. Industrial establishment has provided a large number of benefits to the society but its development without proper attention on pollution control measure have resulted adverse impact on the local environment of urban areas [4]. Despite more than three decades of industrial development, Nepal is still in the early stage of industrialization. However, the rate of industrial development is increasing. There have been growing environmental concerns, due to unplanned urbanization and the establishment of industries without considering pollution control measures [5]. In Nepal, there is a common practice to discharge untreated or partially treated industrial effluents directly into the river or agricultural land. And also due to the absence of better alternatives many farmers in urban areas are compelled to irrigate their cropland by polluted river water or even industrial effluent [6][7]. The disposal of effluents has become a global concern as the industries are associated with the generation of high volumes of effluents, limited space of land needed for the treatment technologies. Effluents from almost all the industries is being discharged untreated either on land or into water sources [8]. Even at the places where some treatment facilities exist, these are not being operated properly. Soil and environment are under tremendous pressure due to industrial expansion and discharge of effluents [9][10]. In the production process of these industries, a lot of solid, semi-solid and liquid wastes are generated that may contain substantial amount of toxic organic and inorganic pollutants, and if dumped in the environment without treatment then this may lead to serious environmental consequences [9]. Resultantly, these industrial wastes pollute the water resources and ultimately the agriculture land. It has been found that the growth, yield and soil health gets reduced when farmers use the effluents for irrigation on the cultivated land. No works have been conducted in this site about the impact of industrial effluent on quality of soil in agricultural land. Industries are creating several environmental problems to the local people adjoining this area. Thus, in present study an attempt has been made to analyze the quality of soil due to impact of industrial effluent on agricultural land.

## Materials and Methods

### Study site

Bansbari is located in Morang district about 7 km north from Biratnagar along the Koshi highway. It is in between the Ithari Biratnagar industrial corridor. This area is mainly populated by soap and steel industries. Although being the industrial corridor, there are some agricultural lands, where farmers use to grow crops. During rainy seasons, the overflow of effluents from the canal reaches the agricultural land and farmers use the effluent for irrigation. Thus the quality of soil in such area is decreasing rapidly.

### Sample collection

Three soil samples ($S_1$, $S_2$ and $S_3$) were collected from different agricultural site of this area. The sampling locations were selected approximately 200 m from the effluent releasing site.

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The first sampling point for $S_1$ was 200 m south to the Kamala steel industry, the second sampling point for $S_2$ was 300 m south to the Himalayan soap industry and the third sampling point for $S_3$ was 100 m south to the Moti Soap industry. To determine the nutrient status and physico-chemical characteristics of soil, the entire field was sampled and analyzed. Non uniformity within a field is reduced by using composite sample. The soil samples were collected from the location on depth of 0-15cm by digging a V- shaped cut. The samples were collected in clean and dry polythene bags, using sterilized spatula for reducing the chance of contamination as far as possible, and were carried to the laboratory for further experimental work.

Physico-chemical Measurements

All the chemicals used for the preparation of reagents and solution were of the highest purity analytical reagent grade available. Triple distilled water was used throughout the analysis. pH values of the samples were recorded on Elico EI 613 pH meter. Electrical conductivity was measured on Labtronics auto digital conductivity meter (LT-16 model). Alkalinity was measured by titration technique [11][12]. Nitrogen and phosphorus present in the samples were measured by Kjeldahl and Olsen method, respectively [13][14][15]. Potassium content was analyzed by flame photometric technique. The organic matter was determined by Walkley and Black method [12][16]. The whole experimental work for this study was conducted in Bio-inorganic and Materials Chemistry Research Laboratory of Mahendra Morang Adarsh Multiple Campus Biratnagar, Nepal. Part of the experimental work was conducted in Regional Soil Test Laboratory, Jhumka, Sunsari.

**Results and discussion**

The results of the physico-chemical parameters of the soil are presented in the Table 1. The colour of all the soil samples was faint black, indicating the presence of organic matters. The temperature of the soil samples during analysis was in the range of 24 - 28 $^0$C.

pH

The pH of soil is one of the most important physico-chemical parameter. It affects mineral nutrient soil quality. Under the decreased soil pH, most desirable crop nutrient become less available while others, often undesirable, become more available and can reach toxic levels. An examination of soil samples (Table 1) shows that the pH value ranges from 7.75 - 8.32. The sample ($S_2$) has greater pH value which means that the sample is slightly more alkaline than $S_1$ and $S_3$. All the samples were found alkaline due to the presence of organic matters.

Alkalinity

The alkalinity of the samples ranged between 90- 240 mg/l. Previous study reveals that the higher amount of alkalinity is harmful for the proper growth of cultivated species [17]. From the table we conclude that the alkalinity of sample $S_2$ is high and that of sample $S_1$ is low.

Electrical conductivity (EC)

The electrical conductivity is the measure of soluble electrolytes present in the soil samples. The measurement of conductivity is for measuring the current that gives a clear idea of soluble salt present in the soil. The electrical conductivity ranged from 0.239-0.365 mS/cm. The electricl conductivity for $S_2$ is highest and that of sample $S_1$ is lowest.

Moisture present

Soil moisture determination is of major significance, as moisture affects biological activity in the soil. The moisture presents in samples ranged from 22.24% - 32%. Sample $S_2$ contained low moisture % whereas sample $S_3$ contained high moisture %.

Texture

The texture variation of different types of soil samples is given in Figure 1. Soil contains mixture of sand, silt, and clay and it is unusual to find a soil containing only one of these. Soil textural classes denote the average or combined effect of the soil particle sizes in a given sample. The texture of the soil sample is composed of sand, silt and clay and there are more clay particles in all samples and it is followed by sand in sample $S_1$ and $S_2$ but in sample $S_3$ the value of clay particles was followed by silt.

Water holding capacity

From above result (Table 1) we can say that the water holding capacity is in the range of 15 - 19 percent thus the value of water holding capacity of sample $S_2$ is highest and that of sample $S_1$ is lowest.

**Table 1. Physicochemical parameters of soil samples.**

| Soil parameters | Units | Samples | | |
|---|---|---|---|---|
| | | $S_1$ | $S_2$ | $S_3$ |
| Colour | - | Faint black | Faint black | Faint black |
| Odour | - | Normal | Normal | Normal |
| Temperature | °C | 26.2 | 28.1 | 24 |
| pH | - | 7.91 | 8.32 | 7.75 |
| Alkalinity | mg/L | 90 | 240 | 120 |
| Electrical Conductivity | mS/cm | 0.239 | 0.365 | 0.249 |
| Moisture Present | % | 22.24 | 18.82 | 32 |
| Texture:<br>Clay<br>Silt<br>Sand | % | Clay<br>45.6<br>12.7<br>41.7 | Clay<br>42.6<br>19.7<br>37.7 | Clay loam<br>54<br>37.53<br>8.47 |
| Water holding capacity | % | 15 | 19 | 17.4 |
| Specific Gravity | - | 2.32 | 2.17 | 2.25 |
| Organic Matter present | % | 6.3 | 9.6 | 5.5 |
| Nitrogen (N) | % | 0.18 | 0.16 | 0.18 |
| Phosphorous (P) | Kg/ha | >100 | >100 | 48 |
| Potassium (K) | Kg/ha | 302 | 362 | 132 |

**Table 2. Range of major nutrients in soil.**

| Nutrient status | Nitrogen (N) % | Phosphorous (P) kg/ha | Potassium (K) kg/ha |
|---|---|---|---|
| Level in poor soil | <0.1 | <26 | <112 |
| Level in medium soil | 0.1 – 0.2 | 26 – 56 | 112 – 280 |
| Level in fertile soil | >0.2 | >56 | > 280 |

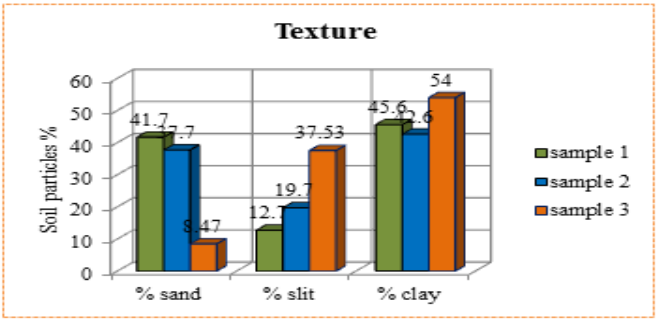


**Figure 1.Variation in texture of soil samples.**

Specific gravity

Specific gravity of a solid substance is the ratio of the weight of a given volume of materials to the weight of an equal volume of water (at 20°C). In effect, it tells how much heavier/lighter the material is than water. Specific gravity of samples ranges from 2.17 - 2.32. Sample $S_1$ has the highest specific gravity whereas sample $S_2$ has the lowest specific gravity.

Organic matter present

The best type of soil for agriculture production contained a generous amount of organic matter. Organic matter can be native to the soils or added through the application of additives such as compost and manure. Here in our study sample $S_2$ has high amount of organic matter whereas sample $S_3$ has low amount of organic matter.

Nitrogen (N)

Nitrogen is the most mobile nutrient in the soil. The percentage of nitrogen ranges from 0.16 - 0.18 %. The percentage of nitrogen is equal in sample $S_1$ and $S_3$ and the percentage is also high than that of second sample. From Table 2 we can say that percentage of nitrogen of all soil samples are in medium range.

Phosphorous (P)

Phosphorous is essential for plant growth and is especially vital to early growth that promotes early root formation and growth and also improves the quality of many fruits, vegetables and grain crops. Phosphorous in samples ranges from 48 to above 100 kg/ha. Samples $S_1$ and $S_2$ has above 100 kg/ha of phosphorous and the sample $S_3$ contain 48 kg/ha of phosphorous. From Table 2 we can say that samples $S_1$ and $S_2$ high amount of phosphorus and the amount in sample $S_3$was in medium range.

Potassium (K)

Potassium is essential for protein synthesis and cell division of plants and crops. It decreases the water requirement of plants. It is important in fruit formation. It helps plants to survive in winter and also it helps to improve stalk strength and resistance to lodging. Potassium of samples ranges from 132 – 362 kg/ha. From Table 2 we can say that samples $S_1$ and $S_2$ has high amount of potassium and the range was medium in sample $S_3$.

**Conclusion**

The different soil samples collected from various agricultural sites in Bansbari were found to have variation in physico-chemical parameters. Thus the present research work concludes the deterioration of soil quality due to direct discharge of industrial effluents. Although the major nutrient of sample $S_2$ was in the range of fertile soil but the other parameters like conductivity and alkalinity were very high in this sample, which shows the variation in different parameters. Through this study, it is concluded that effluent from the industries causes negative impact in the soil which alters different soil parameters from its normal range of fertility.

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