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Pertinent Nutrient Status in Soil and Water of Kargah and Napuras Streams in Gilgit Valley

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Authors' contributions

This work was carried out in collaboration among all authors. Author BUZ designed the study, wrote the protocol and conducted study with author HK. Author HK collected soil and water samples from the study areas. BUZ and HK analyzed the samples. HK and MT managed the literature searches and performed the statistical analysis. MT improved the figure of the sampling area. Author BUZ wrote the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To observe the status of salinity build up besides inorganic nutrient status at different sites in Kargah and Napuras streams of Gilgit valley.
Study Design: one-way ANOVA means using LSD test.
Place and Duration of Study: Kargah and Napuras streams and nearby village in Gilgit valley and the duration of the study was 3 months.
Methodology: Soil and water sampling to analyze pertinent salinity parameters besides inorganic nutrient status.
Results: Soil and water properties for important salinity parameters were normal at mid point after entering the village areas of Kargah and Napuras streams. Human activities especially to raise crops by applying fertilizers needs to monitor with a specific time scale in order to avoid salinity build up.

Keywords: Gilgit river; nutrient status; soil; water; Kargah; Napura.

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1. INTRODUCTION

Human socio-economic development is linked to the availability, usability and sustainability of water. Safe drinking water is essential to lifetime of consumption [1]. On earth 69 % of freshwater is in the form of ice and permanent snow in mountains. The use of fresh water in irrigation, domestic and industry is 70, 8 and 22 % respectively [2]. Glaciers and snow are major components of solid water bodies in mountains to regulate the stability of local water sources. These are strongly affected by climate change [3]. Humanly activities alter the conditions of healthy water that results in the damage to the water quality flowing on the land [4]. Physical and chemical disorders are caused by livestock in catchment areas [5]. The physical condition of water might refer such water unfit for drinking [6].

The Gilgit River starts from Shandur Lake. Alam Bridge is a junction point between Indus and Gilgit River at coordinates between 35°45′ and 74°37′ [7]. Indus River originates from Lake *Manasarovar* in Tibet, China, which traverses a total length of 3200 Kilometers. From the point of origin, the river flows in the northwest direction and then turns southward after reaching the Hindu Kush Mountains. Many smaller tributaries join the Indus River on its way including Gilgit River. Near *Kalabagh*, Punjab, Pakistan it enters into the alluvial plain of Punjab. Indus is the main river of Pakistan. It flows from Karakorum ranges to south and finally joins the Arabian Sea. Water pollution occurs due to anthropogenic activities [8]. The surface water quality drops due to the addition of raw municipal and industrial effluents and agriculture runoff into water resources [9]. Soil and sediments regulate the ecosystem [10] including plant cover. Generally, the soil of this area is derived from different materials including river alluvium.

The Kargah and Napura streams, important ecological feature of this area, are related to Gilgit River. Water pollution may also occur here due to human activities. Adequate, clean and safe drinking water supply has to be available for various users [11]. Rapid population growth over the past half century has intensified the pressure on agriculture and the need for irrigation water [12]. A case study was carried out to observe the status of salinity build up besides inorganic nutrient status at different sites in Kargah and Napuras streams (Kargah and Napuras naalah or stream; *only onward will be called as* Kargah and Napuras) and the soils of localized areas.

2. MATERIALS AND METHODS

The Kargah and Napura streams are an important ecological feature of Baseen villages areas around Gilgit city. Water and soil samples were collected from these areas (Fig. 1). Color, taste and odor were observed with the help of senses. New polyethylene bottles having capacity of 200cc were pretreated with diluted 0.05 % (v/v) HNO_3 and double de-ionized distilled water. These bottles were used to collect water. The samples were taken from eight locations of Napura and Kargah including the junction point of Kargah and Gilgit River. The taste of water analyzed was unobjectionable. The soil samples were air dried, ground using pestle and mortar and were passed through 2 mm sieve. Chemical parameters i.e. pH, electrical conductivity (ECe.), and Cl^{1-}, HCO_3^-, Ca^{2+}, Mg^{2+}, Na^+, K^+ phosphorus, sulphur in soil and water were determined as [13]. Analyzed the data statistically according to one-way ANOVA means using LSD test by using as [14].

3. RESULTS

3.1 Soil Status for ECe, pH, TDS, Bicarbonate and Chloride

At Kargah, ECe of the soil was 11 % higher than Napura. But at midpoint of Napura in the village it was 72 % than midpoint of village. At near fields of Kargah, it was 53 % lower than near field of Napura. At Napura, near junction point of Kargah and Gilgit River and bank of Gilgit River pH was 7.8. At midpoint of Napura, near field of Napura, midpoint of village (Kargah) and near fields of Kargah, remained 7.6. At Napura bicarbonates increased 1.4 than Kargah. At midpoint of Napura it decreased 6.2 times than entry point of Napura. At Kargah chlorides increased 0.71 times than Napura. At midpoint of Napura in village it increased 1.73 times than entry point of Napura. At Kargah it decreased 0.54 times than Napura (Table 1).

3.2 Soil Status for Calcium, Magnesium, Sodium, Potassium, Sulphur and Phosphorus

Calcium concentration at Napura midpoint was 3 times higher than Napura entry point. Magnesium concentration at Napura was 2.5 times higher than Kargah stream. Its concentration was at midpoint of Napura was 2 times higher than midpoint of Kargah. Its concentration was 0.74 lower at Kargah than near fields. Sodium concentration was higher (55.7 mg L^{-1}) at Napura and midpoint of Napura than the other locations. Potassium concentration was highest (275.7 mg L^{-1}) at Napura. At near junction point of Kargah and bank of Gilgit River it was 53.7 and 49.7 mg L^{-1}). At Napura sulphur was 1.62 times higher than Kargah. At midpoint of Napura in village sulphur was 1.56 times higher than Kargah. At Napura it was twice that of Kargah. At Kargah phosphorus was 0.63 times higher than at Napura. At midpoint of Napura phosphorus was 1.42 times higher than Kargah. At Napura phosphorus was 1.74 times higher than at Kargah (Table 2).

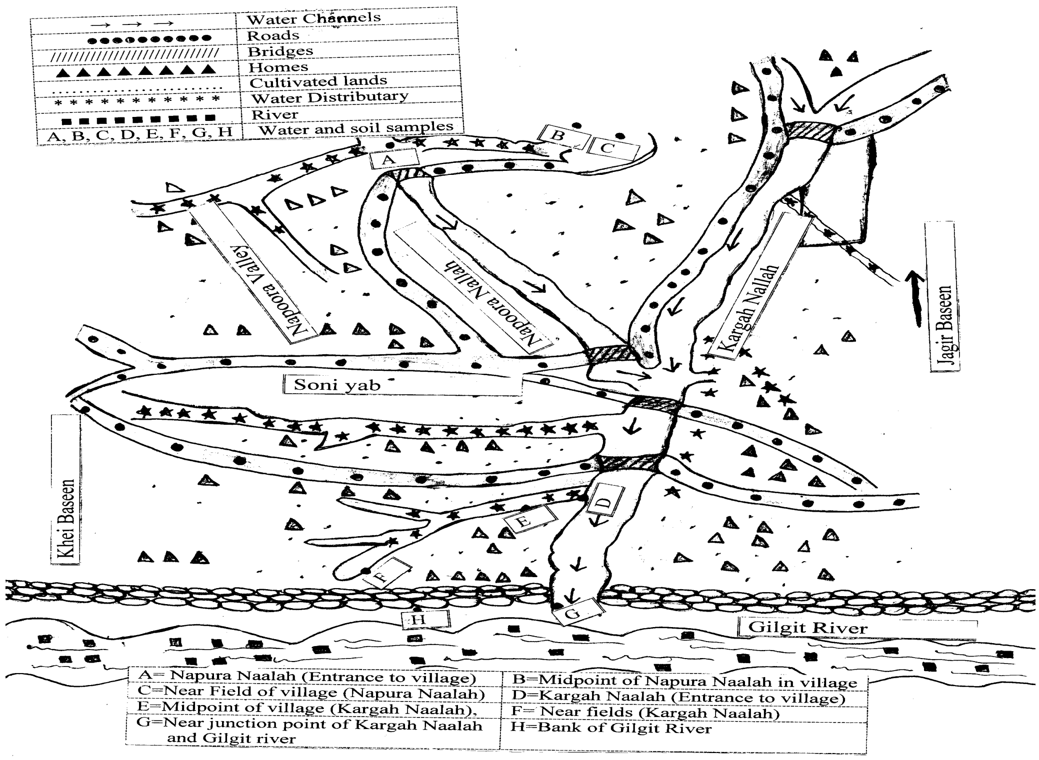

Fig. 1. Sites of soil and water sampling at Kargah and Napura of Baseen villages of Baseen villages areas around Gilgit city

Table 1. Electric conductivity, pH, total dissolved salts (TDS), bicarbonates and chloride ions in soils collected from different locations of Gilgit district

Locations	ECe (dS m^{-1})	pH	TDS (mgL^{-1})	HCO_3^{-1} (mg L^{-1})	Cl^{-1}(mg L^{-1})
A	0.1290 c	7.8 a	60.67 g	1157.8 f	154.67 b
B	0.1980 c	7.6 ab	94.67 e	1489.4 d	144.67 c
C	0.3367 b	7.6 ab	160.67 c	1192.8 e	134.67 d
D	0.1427 c	7.4 b	67.67 f	826.8 g	216.67 a
E	0.1150 c	7.6 ab	53.67 h	238.8 h	83.67 e
F	0.7110 a	7.6 ab	454.00 a	2811.8 a	216.67 a
G	0.0827 c	7.8 a	115.67 d	1653.0 c	144.67 c
H	0.3997 b	7.8 a	192.67 b	2310.9 b	154.67 b

Means sharing similar letter(s) in a column do not differ significantly at $p < 0.01$;A= Napura Stream(entrance to village); B= Midpoint of Napura Streamin village; C= Near Field of village (Napura Stream); D= Kargah Stream(entrance to village); E=Midpoint of village (Kargah Stream); F= Near fields (Kargah Stream); G=Near junction point of Kargah Streamand Gilgit River; H=Bank of Gilgit River

Table 2. Calcium, magnesium, sodium, potassium, sulphur and phosphorus (mgL^{-1}) of soil samples collected from different locations of Gilgit district

Locations	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	S	P
A	119.7 a	115.2 a	55.7 a	275.7 a	789.7 a	172.3 e
B	99.7 b	47.7 b	49.7 b	57.7 c	373.5 c	273.7 b
C	99.7 b	35.7 c	37.7 c	111.7 b	495.7 b	338.7 a
D	39.7 d	47.7 b	35.7 d	57.7 c	488.6 b	271.8 b
E	59.7 c	23.7 d	35.7 d	57.7 c	239.6 e	192.4 d
F	59.7 c	47.7 b	35.7 d	57.3 c	250.7 d	194.9 d
G	39.7 d	35.7 c	30.7 e	53.7 d	99.7 f	198.3 c
H	59.7 c	23.7 d	31.7 f	49.7 e	71.5 g	122.8 f

Means sharing similar letter(s) in a column do not differ significantly at $p < 0.01$; NB: Locations are defined in Table 1

3.3 Water Status for ECe, pH, TDS, Bicarbonate and Chloride

At Kargah ECe of water was higher 0.75 times than at Napura. At Napura, midpoint of Napura in village, Near field of Napura and at Kargah pH was neutral but at midpoint of Kargah, near fields of Kargah, near junction point of Kargah and Gilgit River and bank of Gilgit River it was slightly alkaline. At entry point of Kargah to the village and at midpoint, total dissolved salts in water were 25 to 27 % higher than that of Napura. At Napura (entrance to village) and midpoint of Napura in village bicarbonates were 12 % higher than at Kargah Stream(entrance to village) and midpoint of village (Kargah Stream) . Near field of village (Napura stream) it was 7 % lower than at near fields (Kargah). At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura) and also at Kargah and near junction point of Kargah and Gilgit River chlorides were 0.55 and 0.62 mg L^{-1} respectively. At bank of Gilgit River it was lowest (0.31 mg L^{-1}), (Table 3).

3.4 Water Status for Calcium, Magnesium, Sodium, Potassium, Sulphur and Phosphorus

At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura) calcium was 1.51times lower than at Kargah (entrance to village), midpoint of village (Kargah), near fields (Kargah) and near junction point of Kargah and Gilgit River. However, at bank of Gilgit River its concentration was the lowest (4.7 mg L^{-1}). At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura) 22 % higher than at locations from Kargah (entrance to village), midpoint of village (Kargah), Near fields (Kargah), Near junction point of Kargah and Gilgit River, and bank of Gilgit River. Sodium was in the range of 2.3 to 2.7 mg L^{-1} at all locations but it was the lowest (1.7 mg L^{-1}) at bank of Gilgit River. At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura) potassium was 1.54 times higher than at Kargah (entrance to village), midpoint of village (Kargah), near fields (Kargah), Near junction point of Kargah, Gilgit River and bank of Gilgit River. At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura stream) sulphur was 20 % lower than at Kargah (entrance to village), midpoint of village (Kargah), Near fields (Kargah, Near junction point of Kargah and Gilgit River, and bank of Gilgit River. At Napura (entrance to village), midpoint of Napura in village and near field of village (Napura) phosphorus was 19 % lower than at Kargah (entrance to village), midpoint of village (Kargah), Near fields (Kargah), Near junction point of Kargah and Gilgit River, and bank of Gilgit River (Table 4).

4. DISCUSSIONS

Electrical conductivity (ECe) and total dissolved salts (TDS) are the parameters that indicate health of soil or water. Health of soil depends on parent material [15]; and man induced changes in environmental factors including quality of water. When parent material is normal and nontoxic, then originating soil is normal. Merely, at the same time it is at risk. Decline in its positive characteristics highly depends on environmental factors [16] including quality of water. The area under study has been less intervened by human activities in the past. Therefore, the soil and water samples are non saline especially in non agricultural practices areas. Some deviation in normal properties of

Table 3. Electric conductivity, pH, total dissolved salts, bicarbonates and chloride ions in water samples collected from different locations of Gilgit district

Locations	ECe (dS m^{-1})	pH	TDS (mgL^{-1})	HCO_3^{-1} (mg L^{-1})	Cl^{-1} (mg L^{-1})
A	92.2 g	7.3 c	43.7 d	119.1 d	0.55 b
B	94.8 f	7.2 d	44.7 d	132.4 c	0.55 b
C	95.3 f	7.1 e	44.7 d	185.3 a	0.56 b
D	124.7 e	7.2 d	59.7 c	105.9 e	0.61 a
E	125.9 d	7.5 b	59.7 c	119.1 d	0.62 a
F	128.4 c	7.5 b	60.7 c	199.1 d	0.62 a
G	166.6 a	7.6 a	79.7 a	199.1 d	0.62 a
H	137.7 b	7.6 a	64.7 b	145.6 b	0.31 c

Means sharing similar letter(s) in a column do not differ significantly at p < 0.01; NB: Locations are defined in Table 1

Table 4. Calcium, magnesium, sodium, potassium, sulphur and phosphorus (mg L^{-1}) of water samples collected from different locations of Gilgit district

Locations	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	S	P
A	9.7 b	2.7 a	2.3 b	4.2 a	10.2 b	0.22 b
B	9.7 b	2.7 a	2.3 b	4.3 a	10.2 b	0.23 b
C	9.7 b	2.8 a	2.3 b	4.3 a	10.1 b	0.22 b
D	14.7 a	2.3 b	2.5 a	2.9 b	12.8 a	0.28 a
E	14.7 a	2.2 b	2.5 a	2.9 b	12.5 a	0.27 a
F	14.6 a	2.3 b	2.5 a	2.8 b	12.6 a	0.26 a
G	14.4 a	2.2 b	2.6 a	2.9 b	12.5 a	0.27 a
H	4.7 c	2.2 b	1.7 c	2.8 b	12.2 a	0.27 a

Means sharing similar letter(s) in a column do not differ significantly at p < 0.01; NB: Locations are defined in Table 1

soil and water due to intervention of human population and agricultural practices are seen. Slow incremental of salts caused start of salinity issues. ECe of the soil was highest at near fields (Kargah Stream) (0.71 dS m^{-1}) with TDS (454 mgL^{-1}). Bicarbonates and chlorides were also highest at this place; but not in toxic range. ECe of water at near junction point of Kargah Stream and Gilgit River was highest (166.6 0.71 dS m^{-1}) with TDS (79.7 mgL^{-1}). In the water samples, pH was from 7.1 to 7.6. In this range almost all nutrients are in available to root systems. Potassium ion was higher than sodium ion. The concentration of other ions i.e calcium, magnesium, sulphur and phosphorus were in adequate amounts.

Cl was highest in the soil of the field area. Chlorine is an essential micronutrient for higher plants, and a minimal requirement for crop is 1 µg g^{-1} of dry mass of a plant. This quantity can generally be met in a rainfall. Natural inputs of chlorine to soils come mainly from rainwater or fertilizer applications [17]. Chloride is not adsorbed or held back by soils, therefore it moves readily with the soil-water, is taken up by the crop, moves in the transpiration stream, and accumulates in the leaves.

The availability of plant nutrients to root system of growing plants is a function of pH. It was slightly alkaline 7.4-7.8. Slightly alkaline or higher pH soil can cause a problem with the availability of iron to some plants, for example oak. Increasing bicarbonate in soil tends to increase pH over time. The concentration of potassium ion was higher than sodium ion. Higher K^+/Na^+ ratio is beneficial for plant growth and it also prevents salt stress development [18]. The concentration of other ions i.e., calcium, magnesium, sulphur and phosphorus were in adequate amount.

5. CONCLUSIONS

Soil and water properties for important salinity parameters were normal at mid point after entering the village areas of Kargah and Napuras streams. Human activities especially to raise crops by applying fertilizers needs to monitor with a specific time scale in order to avoid salinity build up either in soil or water and also to avoid pollution in Gilgit River.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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