Physicochemical Properties of Soil and Water Along Haro River and Khanpur Dam, Haripur, Pakistan

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Abstract: This study was conducted along the Haro River and Khanpur dam in southern Haripur Tehsil to evaluate the physio-chemical properties of soil and water to determine its agricultural suitability and to demonstrate the effectiveness of GIS techniques for this analysis. There were 42 samples (20 of soil and 22 of water) collected along the Haro River and Khanpur dam in autumn season after rain. ArcGIS 9.3 software and 3D Analyst extension were used to interpolate the collected samples. It was found that water pH was in the range of 6.94 to 8.11 while EC dsm-1 was from 0.19 to 0.41 which was within the normal range having no salinity and sodicity hazard. Water is fit for irrigation. Soil data showed that pH was in the range of 7.2 to 8.32 and EC dsm-1 in the range of 0.04 to 1.166, while soil texture was sandy clay loam to sand type. Whereas all the soil in study area was mostly calcareous. Organic matter was deficit in most of the soil samples. It was found that the remote sensing, GIS and GPS survey techniques were also very useful to identify and analyze the trends of soil and water parameters.

Keywords: Agriculture, pH, electrical conductivity, physico-chemical, GPS, remote sensing, GIS.

Introduction

The whole world depends on water. Clean water is a vital natural resource for industry, agriculture, and for production of energy (www.wri.org/ourthe work/topics/water). Water is important for agricultural activities. Rivers, springs and lakes are sources of water for irrigation which are facing the problems of pollution. (Wimbaningrum, et al., 2013).Water quality depends upon the reflection of physical, chemical and biological constituents that are dissolved in water. Human activities and natural processes contribute to these constituents. Natural factors i.e. geology, topography, wildlife, soils, vegetation, climate and population influence the water quality (Committee on Watershed Management, National Research Council, 1999).

The selected area for this research study is southern Haripur Tehsil which covers 867 sq.km area. The west to east extent of study area was 72.547595° E (DMS:72° 32′ 51.34″E) to 73.22° E (DMS:73° 13′ 13.75″E) and south to north extent was 33.716569°N(33° 42′ 59.65″N) to 34.440°N(34° 26′ 25.66″N). The study area, southern Haripur is bounded by Northern Haripur Tehsil towards the north, by Abbottabad toward the east, by Islamabad capital city to the south(Figure 1).

A study was conducted on the catchment of Soan River located in Rawalpindi/Islamabad to evaluate the physico-chemical and bacteriological status. Arc GIS 9.3 software was used to show the spatial variability and locations of soil and water samples. 3D Analyst extension was used to show the altitude interval for highlighting the altitudinal effects on sample's parameters. It was found after testing the physicochemical and bacteriological parameters that present situation of the Soan River (especially in Zone 1) water was not suitable for humans as well as aquatic lives of this river. The sources of bacteriological parameters were total coliform and fecal coliform (Jalil and Khan, 2014).

Materials and Methods

In this paper it was focused to assess the physicochemical properties and fertility status of different soil and water samples of the study area. Primary and secondary data sources were used during this study. Arc GIS 9.3 software product of ESRI (Environmental System Research Institute) with its 3D Analyst extension was used for interpolation of soil and water quality analysis and methodology given in Figure 2 was followed.

A field visit was conducted for this study during September 2014. Soil and water samples were collected along the Haro River, Khanpur dam, small dams (Rehana dam, Kahal dam andMang dam) as a primary data source. GPS (Global Positioning System) locations (latitude, longitude, elevations above mean sea level) of all the samples were also taken with Garmin GPS receiver Etrex.

In secondary data source a topo map, soil map and a union council of Haripur district were used to extract the boundary of study area comprising 22 union councils of Haripur Tehsil located in southern Haripur Tehsil.

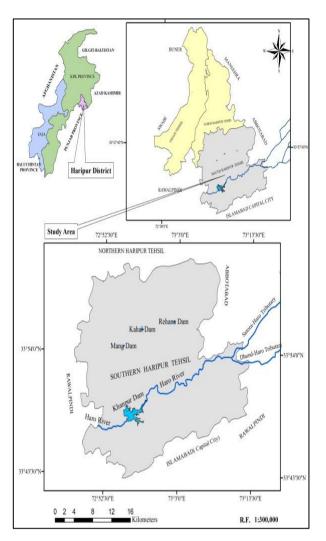


Fig. 1 Location map of study area.

The upper layer of soil was thoroughly mixed by hand air dried, and kept in well stoppered polyethylene bags having capacity 500grams and numbered according to the planned field codes. On the other side, water samples were collected from streams and nullahs (drains) contributing to the main river of study area named, Haro River, Khanpur dam, and small dams (Rehana dam, Kahal dam and Mang dam).Water samples were taken exactly near the same location from where soil samples were taken. Clean plastic bottles were used for water sampling and coded accordingly. All collected samples of water and soil were tested in the laboratory of Centre for Integrated Mountain Research, University of the Punjab, Lahore. The pH of soil and water was tested by using turbidity meter and their EC was checked by using electrical conductivity meter and RSC (Residual Sodium Carbonate) of 22 water samples was calculated by using following formula:

$RSC = (CO_3 + HCO_3) - (Ca + Mg)$

According to a study (Rashidi and Seilsepour, 2011) Sodium Adsorption Ratio of all soil samples was calculated by using following formula:

$$SAR = \frac{Na}{\sqrt{\frac{Ca^2 + Mg^2}{2}}}$$

Calcium carbonate of all soil samples was analyzed by pouring HCL (Hydrochloric acid on all soil samples) and soil texture of soils was analyzed by sieve analysis technique.

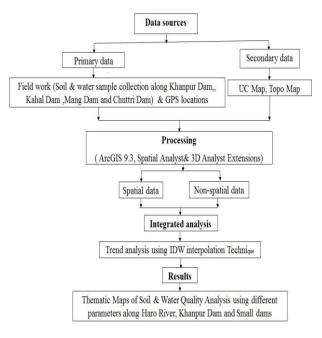


Fig. 2 Flow diagram.

GPS data collection of water and soil samples

The spatial locations of collected samples of soil and water along Haro River, Khanpur dam and small dams (Rehana dam, Kahal dam and Mang dam) were added into ArcMap, a component of ArcGIS software 9.3 by connecting GPS receiver Etrex.

Assessment of physico-chemical properties of water

The parameters i.e. pH, EC, Turbidity, CO₃, HCO₃, Cl, SO₄, Ca+Mg, Na, K and RSC of water samples were assessed in the lab and an Excel sheet of all the parameters was prepared. Assessed physio-chemical properties of water samples were impolated to Arc Map and spatial locations (spatial data) and physio-chemical parameters (non-spatial data) were integrated into Arc GIS by using their unique field of Id as shown in Figure 3. Water pH, EC, Turbidity, CO₃, HCO₃, Cl, SO₄, Ca+Mg, Na and K were interpolated in Arc GIS by using GIS technique of interpolation named IDW (Inverse Distance Weighted).

Physicochemical properties of soil

GPS locations of soil samples collected along Haro River, Khanpur, Rehana, Kahal and Mang dams were shown in Table 1 and Figure 4. The parameters i.e. pH, EC, CO₂, HCO₃, Cl, SO₄, Ca+Mg, Na, CaCO₃ and texture of soil samples are assessed in the lab and an Excel sheet of all the parameters was prepared.

Assessed physico-chemical properties of soil and their spatial locations (spatial data) were integrated into Arc GIS by using the same integration technique of GIS (Fig. 4).

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GPS_L ample Kot Najeebulah anrawa Bridge Sample angur Dam Boal Kato Sample hangur Dam Boal Stop Sample habi Bridge dige 1 Jabbri Rd Sample angur Dam East corner Sample angur Dam East corner Sample andi Sample hund-Sator Confluence Sample und farro Stream Sample	ples Long_DMS 72*5025573*E 72*549.06*E 72*5549.06*E 72*5519.27*E 72*5581.79*E 72*5843.30*E 72*581.37*E 73*033.11*E 73*033.11*E 73*038.12*E	33'48'11.30''N 33'47'40.24''N 33'47'0.24''N 33'47'56.43''N 33'47'56.43''N 33'47'12.88''N 33'47'12.88''N 33'47'12.88''N 33'47'49.99''N 33'47'49.99''N 33'48'49.99''N 33'48'49.99''N 33'48'49.99''N 33'48'44.99''N 33'48''.48''N 33'51'44.46''N 33'51'44.46''N	1 2 3 4 5 6 7 8 9 10 11 11 12 13	1 2 3 4 5 6 6 7 7 8 9 9 10 11 11 12 13 14	3A 4A 5A 6A 7A 8A 9A 10A 11A 11A 12 13 13 14 16	Haro River Kot Najeeb Ullah Tarnawa Bridge Khanpur Road Bismilah Pövver Pint Solitway Khanpur Dam Khanpur Dam Boad Stop Chhai Brd on Nalan Nullah Bridge 1 on Jabbin Road Khanpur Dam east corner Dartian Babutari Jandi Dhund-Satora Confluence	7.5 7.4 7.4 7.4 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6	0.3 0.34 0.27 0.34 0.31 0.36 0.36 0.35 0.31 0.33 0.33 0.33 0.29 0.38	12 / 09 / 3.1 / 16 / 0.4 / 0.4 / 0.4 / 0.4 / 0.4 / 0.3 / 3.8 / 7.5 / 0.2 /		1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.2 2.4 2.7 3.2	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.4 1 1.3 0.2 0.4	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.2	2.4 3.2 2.3 3 2.8 3.4 3.2 3 2.8 2.7 3.2 2.7 3.2 2.4 3.6	0.6 0.2 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.3 0.5 0.1 0.4 0.2	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.2 0.4	Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve V	
GPS_L ample Kot Najeebulah anrawa Bridge Sample anrawa Bridge Sample manpur Dam Soltway Sample nanpur Dam Boat Stop Sample nhai Bridge 1 Jabbri Rd Sample manpur Dam East corner Sample anapur Dam East corner Sample abduff Sample abduff Sample abduff Sample hund-Satora Confluence Sample hund-Satora Sample Sample Sample	Long_OMS Z'5025.73"E 72'549.06"E 72'5528.41"E 72'5528.41"E 72'5528.41"E 72'5528.41"E 72'5584.30"E 72'5813.37"E 73'033.17"E 73'333.17"E 73'1031.81"E 73'116.90"E	33'48'11.30''N 33'4740.24''N 33'470.08''N 33'4756.43''N 33'4756.43''N 33'4756.43''N 33'47'288''N 33'47'288''N 33'47'288''N 33'47'54.30''N 33'47'54.30''N 33'59'282''N 33'51'18.53''N 33'51'18.53''N 33'53'22.83''N	1 2 3 4 5 6 7 8 9 9 10 11 11 12 13 14	1 2 3 4 4 5 6 6 7 7 8 9 9 10 11 11 12 13 14 15	3A 4A 5A 6A 7A 8A 9A 10A 11A 12 13 14 18 17	Haro River Kot Najeeb Ullah Tarnawa Bridge Khanpur Road Bismilan Power Plant Spillway Khanpur Dam Khanpur Dam Boat Stop Chal Bird on Nabhri Road Bridge 2 on Jabbri Road Khanpur Dam east corner Dartian Babutari Jandi Dhund-Sator Confluence Dhund Taro Stream	7.5 7.4 7.4 7.4 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1	0.3 0.34 0.27 0.34 0.36 0.36 0.36 0.35 0.31 0.33 0.33 0.33 0.29 0.38 0.34	12 / 09 / 31 / 16 / 0.7 / 18 / 0.4 / 0.4 / 0.4 / 0.3 / 3.8 / 7.5 / 0.2 / 0.2 / 1 /		1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.2 2.4 2.7 3.2 2.8	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.4	2.4 3.2 2.3 3 2.8 3.4 3.2 3 2.8 2.7 3.2 2.4 3.6 3.2	0.6 0.2 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.3 0.5 0.1 0.4 0.2 0.3	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve V	
GPS_L ample Kot Najeebulah arrawa Bridge Sample angwo Bandge Sample hangur Dam Spilvay Sample hangur Dam Boat Stop Sample hangur Dam Boat Stop Sample nidge 1 Jabbri Rd Sample hangur Dam East corner Sample artian Vilage Sample autri Sample hund Haro Stream Sample abbri Mang Bridge Sample babri Man Bridge Sample	ples Long_DMS 72'54'9.06'E 72'54'9.06'E 72'5528.41'E 72'5528.41'E 72'5519.27'E 72'56'81.79'E 72'56'81.79'E 72'56'81.79'E 72'56'81.77'E 73' 0'33.11'E 73' 0'33.11'E 73' 0'33.11'E 73' 0'33.81'Z'E 73' 0'33.81'E 73' 0'33.81'E 73' 0'33.81'E 73' 0'33.81'E 73' 0'33.81'E	33'46'11.30''N 33'47'40.24''N 33'47'56.43''N 33'47'56.43''N 33'47'56.43''N 33'47'56.43''N 33'47'56.43''N 33'47'56.43''N 33'47'56.30''N 33'47'56.30''N 33'47'56.30''N 33'56'76.30''N 33'56'76.46''N 33'55'76.46''N 33'55'76.26''N	1 2 3 4 5 6 7 8 9 10 11 11 12 13 14 15	1 2 3 4 4 5 5 8 8 7 7 8 9 9 10 11 11 12 13 14 15 16	3A 4A 5A 5A 6A 7A 8A 10A 11A 11A 12 13 14 16 17 20	Haro River Kot Najeeb Ullah Tarnawa Bridge Khangur Road Biemilan Power Pint Spillway Khangur Dam Khangur Dam Boad Stop Chhai Bridge 1 on Jabbri Road Bridge 2 on Jabbri Road Bringe 2 on Jabbri Road Bringe 2 on Jabbri Road Bringe 2 on Jabbri Road Bringe 2 on Jabbri Road Dartian Babutari Jandi Dhund-Satora Confluence Dhund Haro Stream Man Jabbri Roige	7.5 7.4 7.4 7.4 7.2 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1 7.3	0.3 0.34 0.27 0.34 0.31 0.36 0.36 0.35 0.31 0.33 0.33 0.33 0.29 0.38 0.34 0.34	12 / 0.9 / 1.6 / 0.7 / 1.8 / 0.4 / 0.4 / 0.7 / 0.3 / 3.8 / 7.5 / 0.2 / 1 / 2.4 /		1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.4 2.2 2.4 2.7 3.2 2.8 2.8 2.8	1.1 1.4 0.5 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4 0.7	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.4 0.3	2.4 3.2 2.3 3 2.8 3.4 3.2 2.8 2.8 2.7 3.2 2.4 3.6 3.2 2.9	0.6 0.2 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.1 0.4 0.2 0.3 0.3 0.3	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.5 0.4 0.5 0.4 0.5	Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve V	
GPS_L ample Kot Najeebulah anrawa Bridge Sample Shridge Sample ananyur Dam Boat Stop Sample hanipur Dam Boat Stop Sample habi Bridge J Jabbri Rd Sample andis Sample andis Sample andi Sample andi Sample babri Mange Sample abbri Sample Sample abbri Bridge Sample abbri Bridge Sample babri Bridge Sample	Cong_OMS 21'5025.73'E 72'549.06'E 72'5528.41'E 72'5528.41'E 72'5591.27'E 72'5591.27'E 72'5593.71'E 72'5593.71'E 72'5593.30'E 73'58.03'E 73' 138.03'E 73'11'B.90'E 73'945.06'E 73'945.06'E 73'945.06'E	33'46'11.30''N 33'470.24''N 33'470.24''N 33'4756.43''N 33'47'12.86''N 33'47'12.86''N 33'47'12.86''N 33'47'12.86''N 33'47'2.86''N 33'47'2.86''N 33'47'2.86''N 33'50'2.26''N 33'55'42.86''N 33'55'22.83''N 33'55'22.83''N	1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 10 111 12 13 13 14 15 16 16 16 16 16 16 16 16 16 16 16 16 16	1 2 3 4 4 5 6 8 9 9 10 11 11 12 13 14 15 16 17	3A 4A 5A 6A 7A 8A 9A 10A 11A 112 13 14 16 17 20 221	Haro River Kot Najeeb Ullah Tarnawa Bridge Khanpur Road Bismilan Power Pint Sofitway Khanpur Dam Khanpur Dam Boat Stop Chal Brid on Nath Nullah Bridge 1 on Jabbin Road Khanpur Dam east corner Dartian Babutari Jandi Dhund-Satro Confluence Dhund-Stream Main Jabbir Bridge Jabbir Bridge 3	7.5 7.4 7.4 7.4 7.2 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1 7.3 7.0	0.3 0.34 0.27 0.34 0.36 0.36 0.36 0.35 0.31 0.33 0.33 0.33 0.29 0.38 0.34 0.34 0.31 0.31	12 / 0.9 / 16 / 0.7 / 0.7 / 0.4 / 0.4 / 0.4 / 0.4 / 0.4 / 0.4 / 0.7 / 0.3 / 3.8 / 0.7 / 0.3 / 2.4 / 0.2 / 0.2 / 0.2 / 0.2 / 0.2 / 0.9 / 0.8 / 0.7 / 0.	A A A A A A A A A A A A A A A A A A A	1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.2 2.4 2.7 3.2 2.6 2.8 2.6	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4 0.7 1.4	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.4 0.3 0.9	2.4 3.2 2.3 3 2.8 3.4 3.2 3 2.8 2.7 3.2 2.4 3.6 3.2 2.9 3.8	0.6 0.2 0.4 0.4 0.3 0.2 0.4 0.4 0.5 0.3 0.5 0.1 0.5 0.1 0.4 0.2 0.3 0.3 0.3 0.2	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.2 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve V	
GPS_L ample Kot Najeebulah arrawa Brdge Sample Brdge Sample Mangur Dam Spitway Sample hangur Dam Spitway Sample hangur Dam Sat Sop Sample hangur Dam East corner Sample abudri Sample abudri Sample abudri Sample bath Sample bath Sample bath Man Stream Sample abbri Bridge 3 Sample abbri Bridge 4 Sample abbri Bridge 4 Sample	Long_DMS Z'5025.73"E 72'549.06"E 72'5528.41"E 72'5528.41"E 72'5588.71"E 72'5688.71"E 72'5688.71"E 73' 033.11"E 73' 138.03"E 73' 458.03"E 73' 458.03"E 73' 945.03"E 73' 945.03"E 73' 958.41"E 73' 958.41"E	33*46*11.30*N 33*4740.24*N 33*4740.24*N 33*4756.43*N 33*4756.43*N 33*4712.86*N 33*4712.86*N 33*4712.86*N 33*4712.86*N 33*4744.99*N 33*51746.45*N 33*51*16.45*N 33*51*16.45*N	1 2 3 3 4 4 5 6 6 7 7 8 8 9 9 9 10 11 11 12 13 14 14 15 16 17	1 2 3 4 5 6 8 9 9 10 11 11 2 13 14 15 16 17 7 18	3A 4A 5A 6A 7A 8A 9A 10A 11A 12 13 14 16 17 20 21 22	Haro River Kot Najeeb Ullah Tarrawa Bridge Khanpur Road Bismilan Power Pant Spilway Khanpur Dam Khanpur Dam Boat Stop Chal Bird on Nahan Nulah Bridge 1 on Jabbri Road Bridge 2 on Jabbri Road Khanpur Dam east comer Dartian Babutari Jandi Dhund-Satora Confluence Dhund Haro Sitream Man Jabbri Bridge Jabbri Bridge 3 Jabbri Bridge 4	7.5 7.4 7.4 7.4 7.4 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1 7.3 7.0 7.2	0.3 0.34 0.27 0.34 0.31 0.36 0.35 0.35 0.35 0.35 0.35 0.35 0.33 0.29 0.38 0.34 0.31 0.34 0.31 0.35	12 / 0.9 / 3.1 / 1.6 / 0.7 / 1.8 / 0.4 / 0.7 / 0.3 / 0.4 / 0	A I A I	1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.2 2.4 2.7 3.2 2.8 2.8 2.8 2.8 2.6 2.2	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4 0.4 0.7 1.4 1.2	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.4 0.3 0.9 0.2	2.4 3.2 2.3 3 2.8 3.4 3.4 3.2 3 2.8 2.7 3.2 2.4 3.8 3.8 3.2 9 3.8 2.9 3.8 2.8	0.6 0.2 0.4 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.1 0.4 0.5 0.3 0.5 0.1 0.4 0.2 0.3 0.3 0.3 0.2 0.3 0.2 0.3 0.2 0.3 0.2 0.4	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.2 0.4 0.5 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	_Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve	
GPS_L Sample Kot Najecebulah Sample Kot Najecebulah Sardye Sample Shanghar Youer Phart, Khanpur Jhang Prutang Sample Shang Prutang Sample Sange 2 Jabhir Rd Sample Chanpur Dam East corner Sample Santuri Sample Jandar Sample Jandar Sample Jandar Sample Sample Sample	Long_DMS 72'5025.73'E 72'549.00'E 72'549.00'E 72'5526.41'E 72'5526.41'E 72'5526.41'E 72'558.71'E 72'569.71'E 72'569.71'E 73' 033.11'E 73' 033.11'E 73' 033.11'E 73' 103.61'E 73' 950.41'E 73' 950.41'E 73' 950.41'E 73' 950.41'E	334671307N 337470247N 337470247N 3374756437N 3374756437N 3374712867N 3374712867N 3374712867N 3374712867N 3374712867N 3374712867N 3374712867N 3374724307N 3375314467N 3375314467N 337531747N 3375312857N 337534287N 337534287N	1 2 3 3 4 4 5 6 6 7 7 8 8 9 9 10 11 11 12 13 14 15 16 6 17 7 18	1 22 3 4 5 5 8 9 9 9 10 11 11 12 13 14 15 16 17 7 18 19	3A 4A 5A 6A 7A 8A 9A 10A 11A 112 13 14 16 17 20 21 22 23	Haro River Kot Najeeb Ullah Tarnawa Bridge Khanpur Road Bismilan Power Pint Solitway Khanpur Dam Khanpur Dam Boad Stop Chhai Brd on Nalan Nullah Bridge 1 on Jabbin Road Khanpur Dam east corner Dartian Babutari Jandi Dhund-Satora Confluence Dhund Satora Confluence Dhund-Satora Confluence Dhund-Satora Confluence Dhund-Bator Stream Man Jabbin Bridge 3 Jabbin Bridge 3 Jabbin Bridge 3	7.5 7.4 7.4 7.4 7.4 7.2 7.3 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1 7.3 7.0 7.2 7.2 7.3 7.7 7.2 7.3 7.7 7.2 7.3 7.7 7.4 7.4 7.4 7.4 7.4 7.4 7.4 7.4 7.4	0.3 0.34 0.27 0.34 0.31 0.36 0.36 0.36 0.36 0.35 0.33 0.33 0.29 0.38 0.34 0.34 0.34 0.34 0.35 0.29 0.38 0.34	12 / 0.9 / 3.1 / 1.6 / 0.7 / 0.3 / 0.4 / 0.7 / 0.3 / 7.5 / 0.2 / 1 / 0.2 / 2 / 0.2 / 0.2 / 0.4 / 0.4 /		1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.4 2.7 3.2 2.8 2.8 2.8 2.8 2.6 2.2 2.3	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4 0.4 0.7 1.4 1.2 0.3	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.4 0.3 0.9 0.2 0.2	2.4 3.2 2.3 3 2.8 3.4 3.2 3 3 2.8 2.7 3.2 2.4 3.6 3.2 2.4 3.6 3.2 2.8 3.2 2.8 2.2	0.6 0.2 0.4 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.3 0.5 0.1 0.4 0.2 0.3 0.3 0.2 0.3 0.2 0.3 0.2 0.3 0.2 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	_Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve	
Attributes of GPS Autumn Water Sam GPS_L Sample Kot Hagebulah Tarnawa Bridge Sample Blamilah Power Plant,Khanpur Khanpur Dam Boal Stop Sample Chall Bridge Bridge 1 Jabbri Rd Sample Bridge 1 Jabbri Rd Sample Bridge 2 Jabbri Rd Sample Babudri Sample Babudri Sample Daund-Satora Confluence Sample Dhund Haro Stream Sample Jabbri Ringe Sample Jabbri Ringe Sample Jabbri Bridge Sample Khanpur Dam Center Sample Khanpur Dam Center Sample Khanpur Dam Canter Sample Khanpur Dam Canter Sample Khanpur Dam Canter Sample Khanpur Dam Canter Sample Khanpur Khan Sample	Cong_OMS 2'5025.73"E 72'549.06"E 72'5528.41"E 72'5528.41"E 72'5578.27"E 72'5592.77"E 72'5592.77"E 72'5592.77"E 72'5592.77"E 72'5592.77"E 73'1033.01"E 73'1031.81"E 73'1031.81"E 73'1031.81"E 73'959.41"E 73'9592.81"E 72'5528.81"E	334671307N 334740247N 334740247N 334756437N 334756437N 334742867N 334742867N 334742867N 334742867N 334742867N 33475487N 33475487N 33475487N 33457367N 335571747N 335572837N 335542857N 33554287N 3354828787N 3348528787N	1 2 3 3 4 4 5 5 6 8 9 9 9 9 10 111 112 133 144 155 166 177 188 19	1 2 3 3 4 4 5 6 7 7 8 9 9 10 11 11 12 13 14 15 16 17 7 18 19 9 20	3A 4A 5A 6A 7A 8A 9A 10A 11A 113 114 113 114 115 12 20 21 22 23 22 24	Haro River Kot Najeeb Ullah Tarnawa Bridge Khanpur Road Bismilan Power Plant Spillway Khanpur Dam Khanpur Dam Boat Stop Chhai Brd on Nabhri Road Bridge 2 on Jabbri Road Khanpur Dam east corner Dartian Babutari Jandi Dhund-Staro Confluence Dhund Haro Stream Man Jabbri Bridge Jabbri Bridge 3 Jabbri Bridge 3 Jabbri Bridge 3 Jabbri Bridge 3	7.5 7.4 7.4 7.4 7.4 7.2 7.2 7.2 7.3 7.2 7.3 7.2 7.3 7.7 8.1 7.6 7.1 7.3 7.0 7.2 7.4 7.4 7.4	0.3 0.34 0.27 0.34 0.31 0.36 0.35 0.31 0.33 0.33 0.33 0.33 0.33 0.33 0.34 0.34	12 0.9 3.1 1.6 0.7 1.8 0.4 0.4 0.7 0.3 0.3 0.3 0.3 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.4 0.4 0.7 0.3 0.4 0.7 0.3 0.7 0.3 0.2 0.2 0.2 0.4 0.4 0.7 0.3 0.2 0.2 0.2 0.4 0.4 0.4 0.7 0.3 0.2 0.2 0.2 0.4 0.4 0.4 0.7 0.3 0.2 0.2 0.2 0.2 0.4 0.4 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5		1.6 2 1.3 2.1 1.7 2.4 2.3 2.1 2.2 2.4 2.7 3.2 2.8 2.8 2.8 2.8 2.6 2.2 2.3	1.1 1.4 0.5 1.1 0.6 1.1 1.2 1.4 1 1.3 0.2 0.4 0.4 0.4 0.7 1.4 1.2 0.3 0.2	0.1 0.4 0.6 0.2 0.4 0.5 0.6 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.2 0.2 0.2 0.3	2.4 3.2 2.3 3 2.8 3.4 3.2 3 2.8 2.7 3.2 2.4 3.6 3.2 2.9 3.8 3.2 2.9 3.8 2.2 2.4	0.6 0.2 0.4 0.4 0.3 0.2 0.4 0.5 0.3 0.5 0.1 0.4 0.2 0.3 0.2 0.7 0.6 0.2	1 1.8 0.5 1 0.2 0.6 0.7 0.15 0.4 0.3 0.4 0.2 0.4 0.2 0.4 0.5 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	_Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve _Ve	

Fig. 3 Water samples' integration (spatial and non-spatial data in excel sheet) techniques.

ititog ♥ ▶ ♥ Task: Create New Feature ayer: ⓒ GPS Autumn Water Samples ♥ ① ★ ♥ Layers ♥ GPS Autumn Soil Samples ♥ GPS Autumn Soil Samples ♥ Murree Location ♥ Haro Src&Mouth ♥ Haro Src&Mouth ♥ Haro River Tributaries ♥ Khanpur Dam ♥ Study Area	1:707,424		PS Aut	Image: Control of the second secon		s ing Dam am 12.1as th 4 Bham	rc 4 Nat	this Gati	2424 1	M) _{Src 2}	st Viuree (214 ee Ca+Mg	• = 0 M) 3ali (27) ali (2500	00 X0 0 X0 0 X0 0 X0 0 X0 0 X0 0 X0 0 X	a Texture	
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ayer:	→ → ,,,,,,,,			SS Field Code	St Location Haro River Kot Najed Ullah	s am am b + Bham Bhage ridge ECdam -1	nc. 4. Nat	thia Gatio	24341	MJSrc 2 ▲Src Src 3.4 Src 5.1 Murr	ANP(254(1-Dunga G Changla G a shurrec(214 ee	0 M) Jali (270 18 M)	00 M() 1 M) 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M	Texture	
✓ Layers ✓ GPS Autumn Soil Samples ○ ✓ ✓ Murree Location ✓ Haro Src&Mouth ✓ Haro River Tributaries ✓ Haro River Tributaries ✓ Khanpur Dam ✓ Study Area ✓ Attributes of GPS Autumn Soil Samples ✓ GPS_L Long_DMS Sample Kot Najeebulah 72'50'25'.73'E Hanon Bodge Sample 72'54'40.82'E Bismilah Power Plant, Khanpur 72'55'19.27'E Chall Bridge 72'55'19.27'E Chall Bridge 72'55'19.27'E Chall Bridge 72'58'13.77'E Bridge 1 Jabbir Rd Sample 72'58'13.37'E Khanpur Dam East corner Sample 73' 033.11'E	Q Q Q X	Id 1 2		3A	an Vilan Vid Kaji ajastoliti SS Location Haro River Kat Najeeb Ullah	hal Dam am • 12-Jas th 4-Bham a Bridge ridge	npe antie ila(60) 1	M		Asrc 3-0 Src 5-1 Murr	1-Dunga G Changla G a Murree(214 ee	3ali (2500 48 M)	CaCo3	Texture	
I Supers □ GPS Autumn Soil Samples □ Murree Location □ Haro Src&Mouth □ Haro Src&Mouth □ Haro River Tributaries □ Khanpur Dam □ Study Area □ Study Area □ Attributes of GPS Autumn Soil Samples GPS_L Long_DMS Sample Kot Negebulan 72'552.77°E Tarnawa Bridge Sample 72'5549.08°E Bismilah Power Plant, Khanpur 72'549.08°E Bismilah Power Plant, Khanpur 72'5519.27°E Chala Bridge 72'552.8.1°E Bridge 1 Jabbir Rd Sample 72'5873.7°E Bridge 2 Jabbir Rd Sample 72'5813.7°E Bridge 2 Jabbir Rd Sample 72'5813.37°E Khanpur Dam East corner Sample 72'5813.37°E Bridge 1 Jabbir Rd Sample 73'033.11°E	C	1 2	1	3A	an Vilan Vid Kaji ajastoliti SS Location Haro River Kat Najeeb Ullah	hal Dam am • 12-Jas th 4-Bham a Bridge ridge	npe antie ila(60) 1	M		Asrc 3-0 Src 5-1 Murr	1-Dunga G Changla G a Murree(214 ee	3ali (2500 48 M)	CaCo3	Texture	
I Supers □ GPS Autumn Soil Samples □ Murree Location □ Haro Src&Mouth □ Haro Src&Mouth □ Haro River Tributaries □ Khanpur Dam □ Study Area □ Study Area □ Attributes of GPS Autumn Soil Samples GPS_L Long_DMS Sample Kot Negebulan 72'552.77°E Tarnawa Bridge Sample 72'5549.08°E Bismilah Power Plant, Khanpur 72'549.08°E Bismilah Power Plant, Khanpur 72'5519.27°E Chala Bridge 72'552.8.1°E Bridge 1 Jabbir Rd Sample 72'5873.7°E Bridge 2 Jabbir Rd Sample 72'5813.7°E Bridge 2 Jabbir Rd Sample 72'5813.37°E Khanpur Dam East corner Sample 72'5813.37°E Bridge 1 Jabbir Rd Sample 73'033.11°E	C	1 2	1	3A	an Vilan Vid Kaji ajastoliti SS Location Haro River Kat Najeeb Ullah	hal Dam am • 12-Jas th 4-Bham a Bridge ridge	npe antie ila(60) 1	M		Asrc 3-0 Src 5-1 Murr	1-Dunga G Changla G a Murree(214 ee	3ali (2500 48 M)	Caco3	Texture	
GPS_L Long_DMS Sample Kot Najeebullah 72'50'25,75"E Tarna wa Bridge Sample 72'54'9,06"E Bismilah Power Plant, Khanpur 72'54'9,06"E Khanpur Dam Spilvay Sample 72'55'19,27"E Chail Bridge 72'55'19,27"E Chail Bridge 72'55'19,27"E Bridge 1 Jabbir Rd Sample 72'58'13,71"E Bridge 2 Jabbir Rd Sample 72'58'13,71"E Dartian Village Sample 73' 0'33,11"E	33°48'11.30"N	1 2	1	3A	Haro River Kot Najeeb Ullah		Co3	HCo3	CI	So4	Ca+Mg	Na+			Fi+/
Sample Kot Najeebullah 72'50'25,73'E Tarnawa Bridge Sample 72'54'9,08'E Bismilah Power Plant, Khanpur 72'54'9,08'E Ishangur Dam Spilway Sample 72'55'10,27'E Khanpur Dam Boat Stop Sample 72'55'10,27'E Chhail Bridge 72'56'10,27'E Bridge 2 Jabbri Rd Sample 72'58'43,38'E Fridge 1 Jabbri Rd Sample 72'58'13,77'E Dartian Village Sample 73' 0'33,11'E	33°48'11.30"N	1 2	1	3A	Haro River Kot Najeeb Ullah		000		01	304	Curing	nu.			
Tarnawa Bridge Sample 72'54'9.08" Biemilah Power Plant, Khanpur 72'54'9.08" Khanpur Dam Sphway Sample 72'55'19.27"E Khanpur Dam Boat Stop Sample 72'55'19.27"E Chall Bridge 72'58'19.27"E Bridge 1 Jabbir Rd Sample 72'58'13.71"E Bridge 2 Jabbir Rd Sample 72'58'13.71"E Bridge 2 Jabbir Rd Sample 72'58'13.71"E Dartian Village Sample 73' 0'33.11"E			2				A	0.4	1	0.000	1.2	0.3		Sandy loam	Fit
Bismilah Power Plant,Khanpur 72'54'49.26'E khanpur Dam Spilvay Sample 72'55'26.4'I'E Khanpur Dam Boat Stop Sample 72'55'19.27'E Chhai Bridge 72'56'1.79'E Bridge 1 Jabbri Rd Sample 72'58'8.71'E Bridge 2 Jabbri Rd Sample 72'58'43.38'E Khanpur Dam East corner Sample 72'58'13.77'E Dartian Village Sample 73' 0'33.11'E						0.04	100	0.2	0.3		0.2			Sand	Fit
khanpur Dam Spilway Sample 72*55'26.41"E Khanpur Dam Boat Stop Sample 72*55'19.27"E Chhai Bridge 72*56'1.79"E Bridge 2 Jabbri Rd Sample 72*58'8.71"E Bridge 2 Jabbri Rd Sample 72*58'43.33"E Khanpur Dam East corner Sample 73*0'33.11"E	33°48'0.09"N	3		5A	Bismillah Power Plant	0.122		0.6	0.55		0.8		VSC	Sandy loam	Fit
Khanpur Dam Boat Stop Sample 72*55'19.27*E Chhai Bridge 72*65'1.78*E Bridge 1 Jabbit Rd Sample 72'587.37*E Bridge 2 Jabbit Rd Sample 72'587.37*E Khanpur Dam East corner Sample 72'58'13.77*E Dartian Vilage Sample 73' 033.11*E	33°47'56.43"N	4		6A	Spillway Khanpur Dam	0.84		2.4	4		4.8		VSC	Loamy sand	Fit
Chhai Bridge 72*56'51.79'E Bridge 1 Jabbri Rd Sample 72*58'8.71'E Bridge 2 Jabbri Rd Sample 72*58'3.38'E Khanpur Dam East corner Sample 72*58'1.37'E Dartian Village Sample 73* 0'33.11'E	33°48'48.30"N	5		7A	Khanpur Dam Boat Stop	1,167	A	3.2	6.4	1.600	6.8		SC	Sandy clay loam	Fit
Bridge 2 Jabbri Rd Sample 72*58'43.38"E Khanpur Dam East corner Sample 72*58'13.77"E Dartian Village Sample 73* 0'33.11"E	33°47'12.88"N	6	6	8A	Chhai Brd on Nilan Nullah	0.267	A	0.8	1.4	0.400	2	0.6	VSC	Sandy loam	Fit
Khanpur Dam East corner Sample 72°58'13.77"E Dartian Village Sample 73° 0'33.11"E	33°47'37.61"N	7	7	9A	Bridge 1 on Jabbri Road	0.067	A	0.3	0.4	0.000	0.6	0.1	SC	Sand	Fit
Dartian Village Sample 73° 0'33.11"E	33°47'54.30"N	8	8	3 10A	Bridge 2 on Jabbri Road	0.051	A	0.2	0.3	0.000	0.4	0.1	VSC	Sand	Fit
	33°48'49.99"N	9	9	11A	Khanpur Dam east corner	0.179	A	0.8	1	0.000	1.2	0.6	VSC	Loamy sand	Fit
Babutri Sample 73° 3'8.72"E	33°50'32.92"N	10	10	12	Dartian	0.13	A	0.6	0.4	0.300	0.8	0.5	SC	Loamy sand	Fit
	33°51'18.53"N	11	11	13	Babutari	0.143	A	0.8	0.5	0.100	1.2	0.2	SC	Sandy loam	Fit
Jandi Sample 73° 4'58.03"E	33°51'44.46"N	12	12	2 14	Jandi	0.054	A	0.2	0.4	0.000	0.4	0.2	SC	Sandy loam	Fit
Dhund-Satora Confluence Sample 73°10'31.81"E	33°53'41.74"N	13	13	16	Dhund-Satora Confluence	0.174	A	0.8	0.6	0.300	1.2	0.5	SC	Sandy loam	Fit
Dhund Haro Stream Sample 73°11'6.90"E	33°53'22.83"N	14	14	17	Dhund Haro Stream	0.111	A	0.6	0.4	0.200	0.8	0.4		Sand	Fit
Jabbri Main Bridge Sample 73° 9'45.08"E	33°53'42.95"N	15		20	Main Jabbri Bridge	0.056	A	0.3	0.2	0.000	0.4	0.2		Sand	Fit
Jabbri Bridge 3 Sample 73° 9'59.41"E	33°54'42.78"N	16		21	Jabbri Bridge 3	0.9	A	3.2	5	0.800	6.4	2.6		Sand	Fit
Jabbri Bridge 4 Sample 73° 9'26.81"E	33°56'11.58"N	17	17	22	Jabbri Bridge 4	0.193	A	0.8	0.9	0.200	1.2	0.7	SC	Sand	Fit
Mang Dam 72°55'1.01"E		18		25	Mang Dam	0.265	A	1	1.4	0.200	1.8	0.8		Sandy loam	Fit
Kahal Dam,Pind kamal Khan 72°57'44.57"E	33°54'25.96"N	19	19		Kahal Dam	0.182	A	0.6	0.9	0.300	1.2	0.6	MC	Sand	Fit

Fig. 4 Soil samples Integration (Spatial and non-spatial data in excel sheet) techniques.

Id	Field Code	GPS Locations of Soil samples	Latitude	Longitude
1	3A	KotNajeebullah	33°48'11.30"N	72°50'25.73"E
2	4A	Tarnawa Bridge	33°47'40.24"N	72°54'9.08"E
3	5A	Bismillah Power Plant, Khanpur	33°48'0.09"N	72°54'49.26"E
4	6A	Khanpur Dam Spillway	33°47'56.43"N	72°55'26.41"E
5	7A	Khanpur Dam Boat Stop	33°48'48.30"N	72°55'19.27"E
6	8A	Chhai Bridge	33°47'12.88"N	72°56'51.79"E
7	9A	Bridge 1 on Jabbri Road	33°47'37.61"N	72°58'8.71"E
8	10A	Bridge 2 on Jabbri Road	33°47'54.30"N	72°58'43.38"E
9	11A	Khanpur Dam east corner	33°48'49.99"N	72°58'13.77"E
10	12	Dartian village	33°50'32.92"N	73° 0'33.11"E
11	13	Babutari village	33°51'18.53"N	73° 3'8.72"E
12	14	Jandi village	33°51'44.46"N	73° 4'58.03"E
13	16	Dhund-Satora Confluence	33°53'41.74"N	73°10'31.81"E
14	17	DhundHaro Stream	33°53'22.83"N	73°11'6.90"E
15	20	Main Jabbri Bridge	33°53'42.95"N	73° 9'45.08"E
16	21	Jabbri Bridge 3	33°54'42.78"N	73° 9'59.41"E
17	22	Jabbri Bridge 4	33°56'11.58"N	73° 9'26.81"E
18	25	Mang Dam	33°54'25.96"N	72°55'1.01"E
19	26	Kahal Dam	33°55'59.88"N	72°57'44.57"E
20	27	Rehana Dam	33°56'36.88"N	73° 2'20.60"E

Table 1 The GPS locations of soil samples.

Table 2 The parameters of soil samples in southern Haripur Tehsil.

Id	SS F-Code	SS Location	РН	ECdsm ⁻¹	CO ₃	HCO ₃	Cl	SO ₄	Ca+Mg	Na+	CaCO ₃	Texture	Fit/Unfit
1	3A	Haro R KotNajeebUllah	8.2	0.15	А	0.4	1	A+	1.2	0.3	MC	Sandy loam	Fit
2	4A	TarnawaBrdKhanpur	8.35	0.04	А	0.2	0.3	А	0.2	0.2	VSC	Sand	Fit
3	5A	Bismillah Power Plant	7.7	0.122	А	0.6	0.55	А	0.8	0.4	VSC	Sandy loam	Fit
4	6A	Spillway Khanpur Dam	7.4	0.84	А	2.4	4	2	4.8	3.6	VSC	Loamy sand	Fit
5	7A	Khanpur Dam Boat Stop	7.66	1.167	А	3.2	6.4	1.6	6.8	3.2	SC	Sandy clay loam	Fit
6	8A	ChhaiBrd on NilanNullah	7.5	0.267	А	0.8	1.4	0.4	2	0.6	VSC	Sandy loam	Fit
7	9A	Brd 1 on Jabbri Rd	7.91	0.067	А	0.3	0.4	А	0.6	0.1	SC	Sand	Fit
8	10A	Brd 2 on Jabbri Rd	7.9	0.051	А	0.2	0.3	А	0.4	0.1	VSC	Sand	Fit
9	11A	Khanpur Dam east corner	7.2	0.179	А	0.8	1	А	1.2	0.6	VSC	Loamy sand	Fit
10	12	Dartian	8.1	0.13	А	0.6	0.4	0.3	0.8	0.5	SC	Loamy sand	Fit
11	13	Babutari	7.83	0.143	А	0.8	0.5	0.1	1.2	0.2	SC	Sandy loam	Fit
12	14	Jandi	7.9	0.054	А	0.2	0.4	А	0.4	0.2	SC	Sandy loam	Fit
13	16	Dhund-Satora Confluence	8.04	0.174	А	0.8	0.6	0.3	1.2	0.5	SC	Sandy loam	Fit
14	17	DhundHaro Stream	8.32	0.111	А	0.6	0.4	0.2	0.8	0.4	SC	Sand	Fit
15	20	Main JabbriBrd	7.8	0.056	А	0.3	0.2	А	0.4	0.2	SC	Sand	Fit
16	21	JabbriBrd 2	7.7	0.9	А	3.2	5	0.8	6.4	2.6	SC	Sand	Fit
17	22	JabbriBrd 3	7.51	0.193	А	0.8	0.9	0.2	1.2	0.7	SC	Sand	Fit
18	25	Mang Dam	7.43	0.265	А	1	1.4	0.2	1.8	0.8	SC	Sandy loam	Fit
19	26	Kahal Dam	8.1	0.182	А	0.6	0.9	0.3	1.2	0.6	MC	Sand	Fit
20	27	Rehana Dam	7.85	0.125	А	0.4	0.6	0.2	0.8	0.4	MC	Sand	Fit

Results and Discussion

Following parameters of soil samples were interpolated in the Arc GIS software 9.3 using GIS technique of interpolation named IDW (Inverse Distance weighted).Trends of following parameters of soil was identified as given below:

After using IDW technique of interpolation the minimum value (7.2 to 7.32) of soil pH was found 9.The maximum value (8.22 to 8.35) of pH soil was

determined in soil sample 2 beyond the spillway of Khanpur dam (Fig. 5).

The minimum range of Electrical Conductivity (ECdsm-1) of soil in the area was found from 0.0405 to 0.1656 dsm⁻¹ along the samples 2, 7, 8, 10,11,12,13, 14and 15. The maximum range of EC from 1.04 to 1.16 dsm-1 was found near the sample 5 and CO₃ was analyzed and found nil in all soil samples. Soil parameter of HCO₃ was found in the range of 0.2 to 0.53 in samples2, 7, 8, 12, 15and 20 (Table 2).

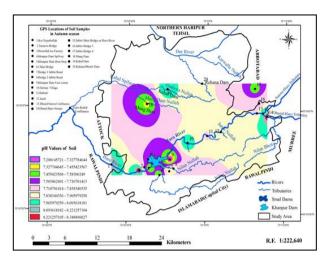


Fig. 5. The pH trends of soil in the study area.

Chloride in soil was found in minimum range from 0.2 to 0.88 in samples 2,7,8,10,11,12, 13,14,15 and maximum value of chlorine was found near sample 5. Minimum value from 0.00 to 0.22 of SO₄ was found in the soil samples (2, 7, 8, 9, 11, 12, 14, 15, 18 and 20). The maximum content of SO₄ (1.77 to 1.99) was obtained in sample 4. The (Ca+Mg) content of soil samples was minimum (0.2 to 0.93) in samples 2, 7, 8, 9, 10, 12, 14, 15 and 20 and its maximum value (6.06 to 6.79) was found in 5 and 16.

Value of Na in study area was found minimum (0.1 to 0.488) in samples 2,7,8,10,12,14,15. Maximum range (3.21-3.59) was found in samples 4, 5 and 16 (Sureshi et al., 2010). CaCO₃ content was categorized as moderately calcareous in samples 1, 19 and 20; strongly calcareous in samples 5,7,10,11,12,13,14,15,16,17,18 and very strongly calcareous in samples 2, 3, 4, 6, 8, and 9 (Fig. 6).

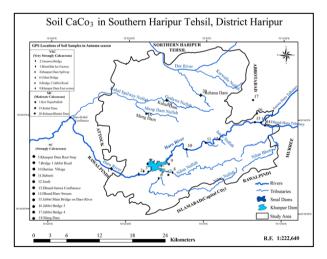


Fig. 6 Classes of CaCO₃ in study area.

Soil textural classification was determined by the percentage of sand, silt and clay tested in collected samples from the study area. From these percentages, four soil textures are then classified according to the soil textural triangle. It was found that the sandy clay loam textural class was shown in soil sample 5. While, sandy loam type soil was at 1, 3, 6, 11, 12, 13, 18 locations, Loamy sand texture was determined in samples 4, 9, 10. Further, sand type was found in soil samples 2, 7, 8, 14, 15, 16, 17, 19 and 20 (Fig. 7).

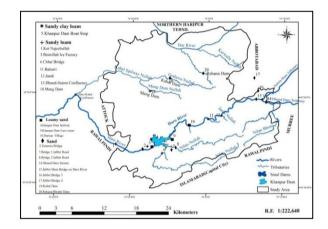


Fig. 7 Textural classes of soil in the study area.

The soil of the study area was suitable for agricultural purpose especially for maize and wheat, peanut and citrus orchards cultivation in southern Haripur Tehsil. It was found that sandy soil was moderately suitable. While, loamy sand, sandy loam and sandy clay loam were most suitable for agricultural purpose (Fig. 7). Tests of water samples indicated that water was highly suitable for the maize, wheat, peanuts and citrus orchids which are also the main crops, grown in study area.

In Figure 8 the higher value of soil pH was found in soil sample 14. Values of Ca+Mg were higher in sample 5. Electrical conductivity of soil was higher in location 5 and lower in sample 2. Linear trend indicated the higher contents of HCO_3 in sample 5 and 16 and lower values were found in samples 2, 8 and 12 (Table 2).

In Figure 9 the bar graph showed higher content of sodium (Na) was in sample 4 and lower concentrations were obtained in samples 7 and 8. The Cl content was found higher in sample 5 and lower in sample 15.The bar graph was found very low for all soil parameters except pH.

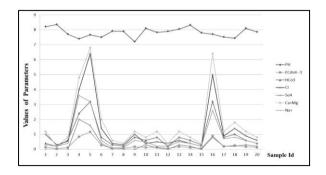
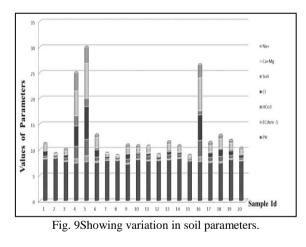


Fig. 8 Showing the linear trend in different soil parameters.

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Id	WS F- Code	WS Location	РН	ECdsm ⁻¹	Turbidity	CO ₃	HCO ₃	Cl	SO ₄	Ca+ Mg	Na	К	RSC	Fit/ Unfit
1	3A	Haro R KotNajeebUllah	7.5	0.3	1.2	А	1.6	1.1	0.1	2.4	0.6	1	_Ve	Fit
2	4A	TarnawaBrdKhanpur Rd	7.43	0.34	0.9	Α	2	1.4	0.4	3.2	0.2	1.8	_Ve	Fit
3	5A	Bismillah Power Plant	7.48	0.27	3.1	Α	1.3	0.5	0.6	2.3	0.4	0.5	_Ve	Fit
4	6A	Spillway Khanpur Dam	7.4	0.34	1.6	Α	2.1	1.1	0.2	3	0.4	1	_Ve	Fit
5	7A	Khanpur Dam Boat Stop	7.4	0.31	0.7	Α	1.7	0.6	0.4	2.8	0.3	0.2	_Ve	Fit
6	8A	ChhaiBrd on NilanNullah	7.2	0.36	1.8	Α	2.4	1.1	0.5	3.4	0.25	0.6	_Ve	Fit
7	9A	Brd 1 on Jabbri Rd	7.26	0.36	0.4	Α	2.3	1.2	0.6	3.2	0.41	0.7	_Ve	Fit
8	10A	Brd 2 on Jabbri Rd	7.3	0.35	0.4	Α	2.1	1.4	0.1	3	0.5	0.15	_Ve	Fit
9	11A	Khanpur Dam east corner	7.29	0.31	0.7	Α	2	1	0.1	2.8	0.3	0.4	_Ve	Fit
10	12	Dartian	7.33	0.33	0.3	Α	2.2	1	0.1	2.7	0.5	0.3	_Ve	Fit
11	13	Babutari	7.75	0.33	3.8	А	2.4	1.3	0.1	3.2	0.1	0.4	_Ve	Fit
12	14	Jandi	8.11	0.29	7.5	Α	2.7	0.2	Α	2.4	0.4	0.2	_Ve	Fit
13	16	Dhund-Satora Confluence	7.64	0.38	0.2	Α	3.2	0.4	0.2	3.6	0.2	0.4	_Ve	Fit
14	17	DhundHaro Stream	7.19	0.34	1	Α	2.8	0.4	0.4	3.2	0.3	0.5	_Ve	Fit
15	20	Main JabbriBrd	7.33	0.31	2.4	А	2	0.7	0.3	2.9	0.3	0.4	_Ve	Fit
16	21	JabbriBrd 2	7.05	0.41	0.2	Α	2.8	1.4	0.9	3.8	0.2	0.6	_Ve	Fit
17	22	JabbriBrd 3	7.25	0.35	0.5	Α	2.6	1.2	0.2	2.8	0.7	0.8	_Ve	Fit
18	23	Khanpur Dam Centre	7.45	0.27	0.4	Α	2.2	0.3	0.2	2.2	0.6	0.4	_Ve	Fit
19	24	Khanpor Dam Island	7.47	0.27	1	Α	2.3	0.2	0.3	2.4	0.2	0.3	_Ve	Fit
20	25	Mang Dam	7.26	0.19	1.5	Α	1.2	0.7	Α	2	0.1	0.2	_Ve	Fit
21	26	Kahal Dam	6.94	0.31	1.2	Α	2	0.6	0.5	2.8	0.3	0.1	_Ve	Fit
22	27	Rehana Dam	6.99	0.23	0.8	Α	1.4	0.6	0.3	2	0.3	0.2	_Ve	Fit

Table 3 Shows the parameters of water samples in southern Haripur Tehsil.



Physicochemical properties of water

The physico-chemical properties of water were determined in the lab and the parameters of water i.e. pH, EC, turbidity, CO₃, HCO₃, Cl, SO₄, Ca+Mg, Na and K were interpolated using GIS technique of IDW.

The pH of water was found in minimum range of 6.94 to 7.07 in samples 16, 21and22 and maximum from 7.97 to 8.11 in sample 12(Fig.10).

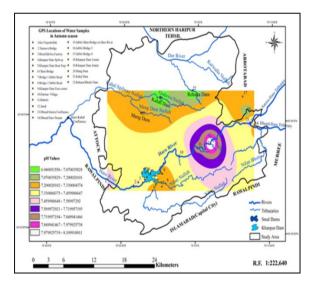


Fig. 10 Trend of water pH in the study area.

Electrical conductivity (EC dsm⁻¹EC) of water was found in minimum range (0.19 to 0.2)1 in sample 20 and maximum (0.28 to 0.41) in water sample 16. In Figure 11 the graph showed the linear trend of higher values of pH and turbidity of water in sample 12, while lower content of potassium (K) was obtained in sample21.

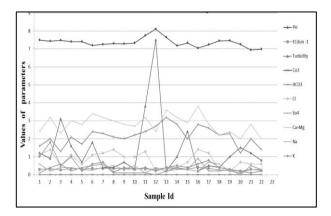


Fig. 1 Linear trend in different water parameters.

The Figure 12 showed clearly higher values of water pH and turbidity and lower concentrations of K in sample 21.The minimum range of water turbidity was found from 0.2 to 1.01 in samples 2, 5, 6, 7, 8, 9, 10, 13, 14, 16, 18, 19 and 22 and maximum turbidity range was obtained from 6.68 to 7.49 in sample 12.

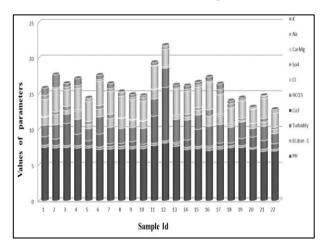


Fig. 12 Show variation in water parameters.

 CO_3 was found nil in all the water samples. Minimum value of HCO_3 of water ranged from 1.2 to 1.42 in samples 20 and 22 and maximum (2.97 to 3.19) was determined in sample 13. Minimum chloride (Cl) ranged from 0.2 to 0.33 in sample 12 and its maximum concentration was found (1.26 to 1.39) in samples 2,7,11 and 16.

Minimum range of SO_4 in water was found from 0.00 to 0.09 in samples 12 and 20. While maximum value was obtained from 0.79 to 0.89 in sample 16. Minimum (Ca+Mg) content was found from 2.00 to 2.2 in samples 20 and 22 and maximum content was found from 3.59 to 3.79 in sample 16. Minimum contents of Na (0.1 to 0.16) in sample 11 and 20 and maximum range (0.43 to 0.49) concentration were found in samples 8 and 10 (Jalil and Khan. 2012).

The minimum range (0.1 to 0.28) of potassium (K) was obtained from samples 8, 12, 20, 21 and 22 and

maximum; value was in range of 1.61 to 1.79 in sample 2.

RSC (Residual Sodium Carbonate) of 22 water samples was also analyzed and found negative which means it was not fit for irrigation. Calculated Sodium Adsorption Ratio (RSC) was interpolated using GIS interpolation technique of IDW available in 3D analyst extension tool of Arc GIS 9.3 software. It was found in minimum range (0.08-0.13) in sample 11 and 20. Maximum value of RSC ranged from 0.53-0.58 in water sample 18 taken from the Khanpur dam centre.

Conclusion

This study was conducted to evaluate the physiochemical properties of soil and water for agricultural purpose. Forty two samples (20 of soil and 22 of water) were collected from the area. It was found that water pH was in the range of 6.94 to 8.11 while EC dsm-1 ranged from 0.19 to 0.41 which was within the normal range with no salinity and sodicity hazard. Water is fit for irrigation. Soil data showed that pH was in the range of 7.2 to 8.32 and EC dsm-1 ranged 0.04 to 1.16. It was concluded that sandy soil was moderately suitable and loamy sand, sandy loam and sandy clay loam soils were most suitable for agricultural purpose especially for maize, wheat, peanuts and citrus orchids.

The water sample analysis indicated that water is highly suitable for maize and wheat, which are main crops of the area. It was also concluded by the analysis of soil and water in Arc GIS software that GIS techniques were very useful to identify the trends of soil and water parameters in the study area. GIS tools provided best fit results for further analysis for different applications. Further, remote sensing and GPS survey techniques were also useful for finding the location of all samples on the satellite image and in the ground respectively.

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