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Quality Of Jajjar Nalla and Painthal Nalla Waters of Udhampur District, Jammu Himalaya, in Relation to Human Consumption and Agricultural Use

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ABSTRACT

Ten water samples, each from Jajjar and Painthal nallas, Udhampur district, J&K were analysed for Ca, Mg, Na, K, Fe, Mn, Ni, Cu, Zn and Pb using Atomic Absorption Spectrophotometer. In both streams, all the elements were present within the permissible limits except Fe and Mn which were found higher according to Bureau of Indian Standard (1991) and WHO (1984). Sulphates, bicarbonates and nitrates were all found in safer levels and as such the waters of both these streams are considered fit for human consumption and also for agriculture. For irrigation purposes all the cations were present in safer levels and cannot be considered harmful. Total Dissolved Salts (TDS), Total Hardness (TH), conductivity and pH are all present in safer levels. Low values of SAR and SSP are both favourable indicators for using the waters of the streams for irrigation. The higher turbidity values in both the streams are objectionable.

Key words : Conductivity, Polluting elements in water of Jajjar and Painthal Nallas of J&K, TDS, Water Quality.

Jajjar Kotli (33^0 54' 02" : 74^0 58' 55") is one of the famous beauty spots of Jammu province, where tourists from neighbouring areas throng during the summer months. It is 32 km from Jammu, situated on the National Highway (NHIA) and is 590 m above mean sea level.

Jajjar and Painthal nallas are two streams both originating in Vaishnodevi Limestone Formation of North India. Both these streams meet one km south of Dami village and flow as one broader stream in southeast direction and debouche its waters into Tawi stream half a kilometer southeast of Tara village (Fig. 1).

Jajjar nalla and Painthal nalla waters are being used by around 10,000 inhabitants along these two streams for human consumption and agricultural purposes. These two nallas occur on the eastern slopes of Vaishnodevi Hill and both nallas during monsoons become very torrential and cause severe erosion of the cliffs of Katra terrace.

The present study was carried out to assess the quality of water of two nallas for direct consumption and irrigation.

MATERIAL AND METHODS

Close sampling of water was done during June, 2005 at intervals of 0.5 km and 20 samples were collected from Jajjar nalla and Painthal nalla river courses and stored in polythene bottles after rinsing it with triple distilled water. pH of all the samples was found in the field by using field kit. Twenty samples collected were subjected to trace elemental anaysis carried out on GBC-902 Atomic Absorption Spectrophotometer (AAS), using pure elements as standards. A blank run was taken after aspirating every five samples and readings were recorded in ppm. Full procedure of sampling and aspirating them in the AAS was followed after Vogel (1962). pH, EC and TDC were measured at the site using field kit (Naina NPC 360D). Total hardness and Ca were estimated by EDTA titrimetric method and Mg estimated by their difference. Na and K were estimated by Flame Photometer and bicarbonate by titrimetric method and sulphate by $Ba(ClO_4)_2$ titration. Sample sites are shown in Fig. 1

RESULTS AND DISCUSSION

Analysis and other quality parameter measurements for Jajjar nalla are given in Table 1. Safer levels of various cations, anions and other parameters were compared with the standards given by different workers and summarised in Table 3.

The Ca concentration in Jajjar nalla lies between 1.90 ppm to 2.7 ppm with an average of 2.23 ppm. Ca concentration is governed by mainly Vaishnodevi Limestone Formation from where the soluble ions of Ca mix with the waters of the Jajjar stream. The Murrees and the Siwaliks rocks also contribute reasonable ions of Ca to the waters as the limestone rocks lie in close contact with the Murrees and the Siwaliks along the stream course.

The values are less than 75 ppm as suggested by WHO (1984) and BIS (1991) and as such the waters can safely be used for human consumption. A low concentration of 2.22 ppm on average basis cannot be considered toxic for agricultural purposes and for Jajjar nalla the concentration lies between 0.018 to 0.042. The K values for potable waters recommended is 50 ppm (BIS, 1991), and, therefore, with respect to K, the waters are safe to be used for human consumption. The low values of K cannot be considered harmful for irrigation as well (Table 3).

The Fe concentration in all the ten samples of Jajjar nalla was higher than the permissible limits of 0.3 ppm (WHO, 1984) and hence with respect to Fe, the waters are toxic for human consumption. For agricultural purposes, all the values are below the permissible limits (Table 3). The values of Cu, Ni, Zn and Pb are all present in safer levels as far as both human consumption and agriculture are concerned, as is evident from the perusal of the Table 3. The Pb values no doubt indicated a rising trend in the values (Fotedar and Singh, 1994a; 1994b).

The conductivity values for Jajjar nalla waters in micromhos/cm at 25^0C ranged between 0.028 to 0.09. According to Richards (1954) and US Laboratory Salinity Staff (1984), the values fall in low salinity zone and hence the waters can be used safely for irrigation on all types of soils. The classification of water with reference to SAR, Herman Bouwer (1978) was followed : 0 – 6 (with no problem as far as quality of water is concerned), 6 – 9 (increasing problem), > 9 (severe problem). All the samples of Jajjar nalla have values far less than 6 and hence these fall in 'no problem category'. The values lie between 0.46 – 0.63 which indicates that no hazard of alkalinity (Richards, 1954) is anticipated as far as irrigation with Jajjar nalla waters is concerned. The water is of excellent quality according to SAR classification of Raghunath (1987) also.

Similarly, SSP values for all the ten samples of Jajjar nalla waters were less than 60% (Kudesia, 1989) and hence Jajjar nalla waters are safe to be used for agricultural purposes, as far as this parameter is concerned. Turbidity values were high, whereas the concentratino of sulphates, bicarbonates, nitrates and hardness values were less than the permissible limits as fixed by Kudesia (1989). pH values for all the ten samples were well within the permissible limits (WHO, 1984).

PAINTHAL NALLA

Analysis and other quality parameter measurements for Painthal nalla are given in Table 2. Safer levels of various cations, anions and other parameters are compared with the standards given by different workers and these are summarized in Table 3.

Average value of Ca (6.93) ppm and Mg (4.67 ppm) for Painthal nalla are lower than permissible limit of 75 ppm and 30 ppm as recommended respectively by WHO (1984) and BIS (1991). The higher value of Ca and Mg in Painthal nalla are due to both calcic and dolomitic nature of limestones present in the catchment area (Chadha, 1992). The waters with respect to Ca and Mg are safe for human consumption. The hardness values are mostly due to Ca and Mg salts present in waters and in the present case, the low average value of hardness is 30.4 ppm which cannot be expected to cause any harm to crops if the waters are used for agriculture.

K and Na values are present in a very low concentration and cannot be expected to cause any sodium hazard in the soils. The SAR values should be less than 6, when it can be considered not harmful for agriculture (Harman Bouwer, 1978; Raghunath, 1987). In the present case, SAR values for all the samples were found less than 6 and hence the waters are safer to be used for agriculture. Similarly the SSP values for all the ten samples of Painthal nalla are less than 60 (recommended value, Kudesia, 1989), as such with respect to SSP values also the waters of Painthal nalla can safely be used for agriculture. Conductivity values for Painthal nalla waters are less than one falling in low salinity zone according to US Salinity Laboratory Staff (1984) and as such the waters are not hazardous for agriculture.

The values of Fe in all the ten samples is higher than the recommended value for potable waters (0.3 ppm), therefore, with respect to Fe, the Painthal nalla waters are toxic for human consumption. The high values of iron could be attributed to high iron concentration of Murree shales and shales of Siwalik Formation, which fall in the catchment area of the Painthal nalla. In acid waters, the concentration of iron is usually present in several ppm (Wedepohl, 1978), but in the present case the pH of the waters is on the alkaline side and hence it did not become unstable during the weathering phase. Secondly, the suspension may have got subsequently stabilized by and intimately associated with organic matter (Shapiro, 1964). Also more of erosion in the Painthal area has resulted in accumulation of more clay particles in their detrital matter, which is responsible for transporting sufficient quantities of iron in them as coatings (Caroll, 1958). Excessive erosion of the cliffs producing large amount of clay, which because of large surface area provided good mechanism of transport for Fe in the form of coatings (Krauskopf, 1956; Jenne, 1968; Gibbs, 1977; Genne *et al.*, 1980).

The average concentration of Mn in Painthal nalla waters was 0.19 ppm, highr than the

recommended value of 0.1 ppm for potable waters (WHO, 1984). Mn ions in many rivers of the world get greatly diminished because of decreasing grain size. This sort of decrease of grain size has been observed by number of workers in the Chenab waters, Akhnoor (Fotedar *et al.*, 1993); Springs and nallas of Patnitop and Batote (Fotedar and Kumar, 1993); In Jajjar nalla, Jammu (Fotedar *et al.*, 1993a, 1993b; Fotedar and Singh, 1994a, 1994b; Fotedar and Loan, 2004); The Banganga river of Vaishnodevi Hill, Jammu (Bukhari *et al.*, 1999); Sewa river, Kathua district, Jammu (Fotedar, 2006); Bichlari nalla, Jammu (Tikoo, 2004). Grain size gets diminished downstream and due to discharges it gets washed off. Mn is the first element to get transported among Mn, Fe, Cr, Ni, Cu and Ca in many streams of the world (Horowitz, 1974). In Jajjar and Painthal nallas, grain size gets diminished downstream and same mechanism appeared to have worked in these two streams as is the case with streams worldwide.

The range of Cu varied from 0.009 ppm to 0.02 ppm with an average value of 0.013 ppm which is far less than the recommended value of 1 ppm (BIS, 1991). The waters are equally safe for irrigation with Cu content being far less than the recommended value of 200 ppm (Kudesia, 1989).

The other heavies, Ni and Zn with average values of 0.002 ppm and 1.382 ppm, respectively in case of Painthal nalla waters were present in safer levels (Table 3) and as such the waters are fit for human consumption as well as for agriculture. Both Ni and Zn are expected to have been contributed by chalcophile phase of rocks of Vaishnodevi limestone (Chadha, 1992).

Pb concentration lies between 0.01 ppm to 0.042 ppm with an average value of 0.028 ppm. In many samples of the Painthal nalla, Pb approaches very nearer to the permissible limits, which is alarming. It may be due to the Pb mineralization occurring at various places in Vaishnodevi limestone (Chadha, 1992). Bad sanitation also occurring in whole area is one of the reasons that has been observed in Painthal nalla waters in comparison to other waterbodies occurring in Jammu Himalaya. A number of workers have reported bad sanitation being one of the important factors to have caused increase of Pb in various waterbodies in India, such as Kudesia (1989), Fotedar and Singh (1994b), Fotedar and Singh (1995) and Bukhari *et al.* (1999). As a remedial measure, planting vetiver grass in the higher reaches of the stream courses will be helpful in checking Fe, Mn and Pb to enter the solution of waters. Lavania (2000; 2004) have reported Vetiver Grass Technology as one of the cost effective methods of purifying water on one hand and checking mass wastage and landslides on the other hand. Also vetiver grass has proved a good soil binder in various parts of Himalaya to check mass wastage.

Sulphates and bicarbonates were both present in safer levels in Painthal nalla waters and, therefore, are not considered toxic for human consumption as well as for use in agriculture.

Turbidity values in all the samples were high due to fast rate of weathering. Dissolved salts were less than 300 ppm and the waters with respect to these values are safe to be used for human consumption. Recommended value of TDS for agricultural purposes is 2000 ppm (BIS, 1991) and average TDS value for Painthal nalla waters is 99.65 and hence the waters are safe to be used for irrigation.

pH of all the samples of Painthal nalla waters is well within the permissible limits (Table 4).

Nitrate values for Painthal nalla waters varied between 1.70 ppm to 3.10 ppm with an average value of 1.65 ppm. These values indicate higher concentration as compared to other waterbodies of Jammu Himalaya (Fotedar and Singh, 1994a). Though the concentration of nitrates has not reached to the alarming stage, yet the rise in the nitrate values is apt to prove hazardous for young children during the years to come.

Fotedar (1994) has observed rising trend in the value of nitrates while doing the pollution studies of river Jhelum for the period from 1986 to 1993 which according to author is closely linked with bad sanitation prevailing all over the banks of river Jhelum. Fotedar and Kumar (1993) observed many of the sewers running into the springs between Batote and Patnitop, both places being famous health resorts on the National Highway between Jammu and Srinagar and all these springs recorded high nitrate levels in them.

Nitrate polluton during the last fifteen years has been rising in many parts of India in both underground and surface waters, as recorded by a number of workers (Ramchanderan *et al.*, 1991; Ozha *et al.*, 1993; Vijay Kumar *et al.*, 1993; Fotedar and Singh, 1994a; Tikoo, 2004; Fotedar, 2006). Good control over rising of nitrates during the years to come needs to be taken before it is too late. Build-up of nitrates in both Jajjar and Painthal nallas is not significant and the heavy monsoon rains usually wash away a good quantity of nitrates, but in drier months when the run-off is at its minimum, the nitrate values are apt to go higher, when these can prove hazardous for children. A strong drive for improving the sanitation in both Jajjar and Painthal areas needs to be taken at an earliest.

Table 1. Chemical analysis of Jajjar Nalla waters with other quality measurement parameters

Element / Parameter	Sample Nos.										Average Range
	1	2	3	4	5	6	7	8	9	10	
Ca (ppm)	2.70	2.40	2.60	2.500	1.90	2.00	2.10	2.08	2.00	2.00	2.22
Mg (ppm)	0.014	0.015	0.012	0.023	0.031	0.024	0.016	0.017	0.018	0.018	0.018
K (ppm)	0.02	0.042	0.032	0.016	0.017	0.014	0.018	0.019	0.021	0.030	0.023
Na (ppm)	1.04	1.00	0.80	0.940	0.80	0.70	0.77	0.78	0.80	0.82	0.85
Fe (ppm)	0.312	0.314	0.32	0.34	0.36	0.40	0.42	0.43	0.46	0.46	0.35
Mn (ppm)	0.322	0.412	0.323	0.421	0.516	0.413	0.422	0.413	0.414	0.33	0.40
Cu (ppm)	0.014	0.012	0.011	0.021	0.015	0.016	0.017	0.009	0.010	0.09	0.02
Ni (ppm)	0.012	0.010	0.009	0.010	0.008	0.007	0.007	0.010	0.010	0.009	0.009
Zn (ppm)	0.004	0.005	0.009	0.010	0.006	0.005	0.003	0.006	0.004	0.006	0.005
Pb (ppm)	0.038	0.024	0.041	0.035	0.035	0.050	0.002	0.004	0.004	0.007	0.024
Total Hardness (ppm)	32	28	27	36	29	23	21	23	26	24	23.7
HCO_3^{-1} (ppm)	12.00	17.12	16.22	15.00	19.40	18.10	17.90	17.40	19.0	16.20	16.83
SO_4^{-2} (ppm)	0.90	1.20	1.40	1.42	1.70	1.60	0.90	0.96	1.20	1.20	1.24
NO_3^{-1}	2.84	2.80	2.60	3.10	2.80	1.70	1.60	1.72	1.91	1.87	2.23
Conductivity (micro mhos/cm at 25^0c)	0.037	0.060	0.064	0.090	0.030	0.028	0.040	0.053	0.052	0.050	0.028-0.009
TDS (ppm)	50.42	82	85	119	40	38	54	72	70	69	67.94
Turbidity	5.6	6.7	6.0	5.5	5.10	5.20	6.0	5.5	6.0	5.6	5.5-6.7
pH	7.7	7.6	7.7	7.4	7.8	7.7	7.5	7.4	7.1	7.2	7.1-7.8
SAR	0.63	0.64	0.49	0.59	0.57	0.46	0.53	0.54	0.56	0.57	0.46-0.63
SSP	0.28	0.29	0.23	0.27	0.29	0.23	0.26	0.26	0.28	0.29	0.23-0.29

Table 2. Chemical analysis of Painthal Nalla waters, Jammu Himalaya alongwith other quality measurement parameters

Element / Parameter	Sample Nos.										Average Range
	1	2	3	4	5	6	7	8	9	10	
Ca (ppm)	8.10	7.60	10.30	7.35	6.12	5.10	5.08	6.12	7.13	6.40	6.93
Mg (ppm)	6.30	4.30	5.72	5.60	4.30	3.10	4.40	4.30	4.32	4.43	4.67
K (ppm)	1.50	1.80	1.70	1.75	1.40	1.20	1.22	1.16	1.10	1.12	1.40
Na (ppm)	0.80	0.77	0.94	0.72	0.71	0.74	0.80	0.76	0.74	0.60	0.75
Fe (ppm)	1.12	1.10	1.10	0.94	0.70	0.72	1.20	1.12	1.33	1.16	1.04
Mn (ppm)	0.30	0.26	0.24	0.24	0.17	0.16	0.17	0.14	0.14	0.10	0.19
Cu (ppm)	0.02	0.01	0.01	0.02	0.01	0.01	0.009	0.02	0.03	0.02	0.013
Ni (ppm)	0.002	0.001	0.001	0.002	0.001	0.003	0.04	0.001	0.001	0.001	0.002
Zn (ppm)	2.01	1.716	1.423	1.222	1.161	1.091	1.082	1.071	1.615	1.432	1.382
Pb (ppm)	0.020	0.021	0.031	0.042	0.011	0.01	0.022	0.041	0.042	0.039	0.028
Total Hardness (ppm)	30	28	24	30	32	35	34	36	27	28	30.4
HCO_3^{-1} (ppm)	56	47	58	60	42	54	50	47	48.5	54.5	51.7
SO_4^{-2} (ppm)	0.01	0.24	0.20	1.20	1.22	0.30	0.50	0.40	0.30	0.32	0.47
NO_3^{-1}	1.40	1.30	1.20	1.50	2.10	2.14	2.13	2.26	1.28	1.23	1.65
Conductivity (micro mhos/cm at 25^0c)	0.050	0.050	0.046	0.047	0.052	0.047	0.060	0.048	0.040	0.042	0.042-0.06
TDS (ppm)	100	112.5	95	96	107	94	124	98	84	86	99.65
Turbidity	6	6.	5.5	5.5	6.5	6.2	6.8	6.4	6.8	6.5	6-6.5
pH	7.2	7.3	7.5	7.8	7.6	7.6	7.5	7.5	7.3	7.7	7.2-7.8
SAR	0.21	0.22	0.23	1.22	0.22	0.22	0.26	0.23	0.21	0.18	0.18-0.26
SSP	0.13	0.17	0.16	0.16	0.17	0.19	0.18	0.16	0.13	0.13	0.13-0.18

Table 3. Average concentration values of different cations, anions and values pertaining to other parameters for Jajjar Nalla and Painthal Nalla waters, Jammu

Element / Parameter	Average conc. sample		Conc.recommended for human consumption	Reference	Toxic/Non-toxic	Conc.recommended for agriculture (References and Remarks)
1	2		3	4	5	6
	Jajjar Nalla	Painthal Nalla				
Ca	2.22 ppm	6.93 ppm	75 ppm	BIS, 1991	Non-toxic	Such a low conc. cannot be taken as toxic for agriuclture use
Mg	0.018 ppm	4.67 ppm	30 ppm	-do-	-do-	-do-
K	0.023 ppm	1.40 ppm	50 ppm	-do-	-do-	-do-
Na	0.85 ppm	0.75 ppm	Not defined	-	-do-	-do-
Fe	0.35 ppm	1.04 ppm	0.3 ppm	BIS,1991	Toxic	5000 ppm (Kudesia, 1983)
Mn	0.40 ppm	0.19 ppm	0.1 ppm	WHO, 1984	Toxic	200 ppm (Kudesia, 1983)
Cu	0.02 ppm	0.013 ppm	1 ppm	BIS, 1991	Non-toxic	200 ppm (Kudesia, 1983)
Ni	0.009 ppm	0.002 ppm	.05 ppm	Rodier, 1975	-do-	200 ppm (Kudesia, 1983)
Zn	0.005 ppm	1.382 ppm	5 ppm	WHO, 1984	-do-	2000 ppm (Kudesia, 1983)
Pb	0.024 ppm	0.028 ppm	0.05 ppm	Rodier, 1975	in 4 samples it has reached to the lower margin of safer level	5000 ppm (Kudesia, 1983)
HCO_3^{-1}	16.83 ppm	5.7 ppm	Not defined	-	Non-toxic	Such a low con.cannot be said to be toxic for crops
SO_4^{-2}	1.24 ppm	0.47 ppm	50 ppm	BIS, 1991	-do-	-do-
NO_3^{-1}	2.23 ppm	1.65 ppm	45 ppm	-do-	-do-	-do-
TDS	67.9 ppm	99.65 ppm	500 ppm	BIS, 1991	-do-	2000 ppm (Kudesia, 1983)
TH (Total Hardness)	23.7 ppm	30.4 ppm	300 ppm	Kudesia, 1983	-do-	Such a low values of hardness are not expected to be toxic for agricultural use
Conductivity (micro mhos/cm at 25^0c)	0.028-0.09	0.042-0.06	-	-	-	The values less than 1 do not fall in high salinity zone and hence with respect to conductivity the waters are safe to be used for irrigation for all types of crops (Richards, 1954)
Turbidity	5.5-6.7	6-6.5	5 units	Kudesia, 1983	Toxic	-
pH	7.1-7.8	7.2-7.8	6.5-8.5	Kudesia, 1983	Non-toxic	pH values in the present case are not expected to be harmful for crops
SAR	0.46-0.63	0.18-0.26	-	-	-	<6 (Herman Bouwer, 1978)
SSP	0.23-0.29	0.13-0.18	-	-	-	<60 (Kudesia, 1983)

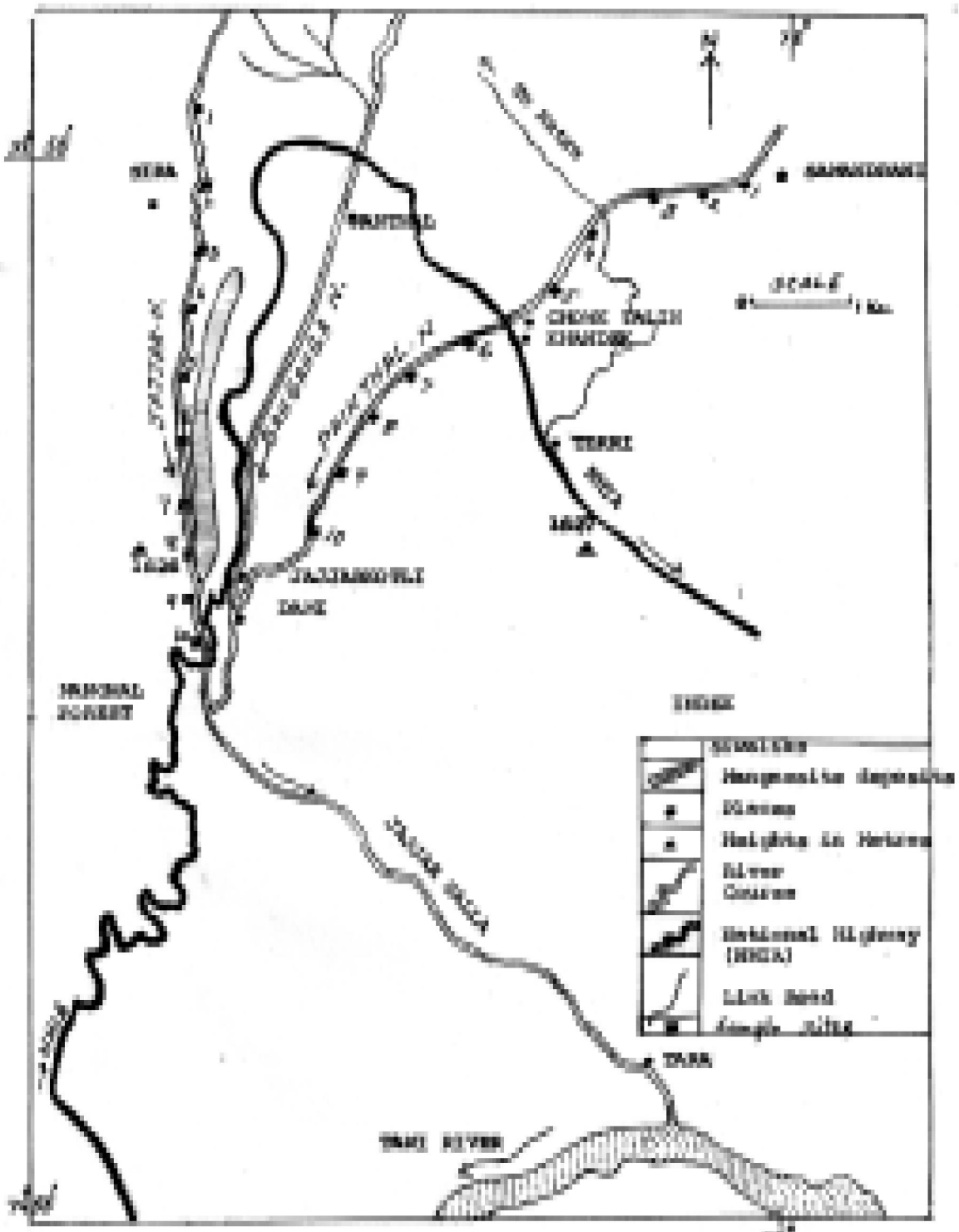

FIG 1 GEOLOGICAL MAP OF JAJJAR NALLA AND PAINTHAL NALLA CATCHMENT, JAMMU HIMALAYA, J & K.

MANAGEMENT AND CONTROL

In the area, in and around Jajjar and Painthal areas, Udhampur district, J&K, a number of adequate measures need to be taken, to save the aquatic ecology of the area. These measures are :-

1. Proper filtration methods and disinfection with chlorine/bromine are necessary to render the waters of both Jajjar nalla and Painthal nalla safe for human consumption.
2. The areas from northwest of Manthal to Tara village and from Painthal to Jajjar Kotli and its park is full of filth and human excreta. More so, the local people unabatingly defeacate near the banks of Jajjar and Painthal nallas, making the waters highly contaminated. There is a clear indication of rise in concentrations of nitrates and Pb in waters and this is ascribed to bad sanitation throughout in the two basins. Separate privacy corners in the whole belt should be constructed, so that with proper sewerage system all the drainage can be diverted off and not allowed to mix with the waters of the two streams.
3. The watershed area constituting backdrop of Vaishnodevi Hill and areas of Siwaliks and a few Murree outcrops should properly be forested. It will arrest many of the unwanted inorganic and organic materials and render the waters safe for drinking purposes. Vetiver grass technology also needs to be applied on the hillocks through which Jajjar and Painthal nallas flow. It will bind the soil together and reduce erosion and screen many of the cations especially Fe, Mn and Pb from entering the solution of the waters.
4. As Painthal nalla and Jajjar nalla both become dry in summer months, check dams should be constructed in the whole basin as a measure of conservation of water.

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