NOTE ON THE QUALITY OF GROUNDWATER FOR IRRIGATION IN THE SUBMONTANE TRACTS AND INTERMONTANE VALLEY OF UTTAR PRADESH

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EXPLORATORY drilling operations were successfully carried out for the construction of heavy duty water wells for irrigational purposes in the year 1959-60 in the *Bhabar* formations of Nainital District and in the intermontane valley of Dehra Dun District (Doon Valley).

Geologically the *Bhabar* formations are constituted of unconsolidated sand-boulder and clay-boulder beds and the Doon alluvial fill is made up of clays, sands and gravels associated with boulders, cobbles and pebbles of limestone, and quartzite.

For the study under consideration, water samples have been obtained from the successfully completed wells, from water-bearing formations occasionally as deep as four hundred and fifty feet below land surface. The studies are based on the latest methods adopted by the U.S. Department of Agriculture, using the "Sodium Adsorption Ratio" or SAR for studying the suitability of water for irrigation.

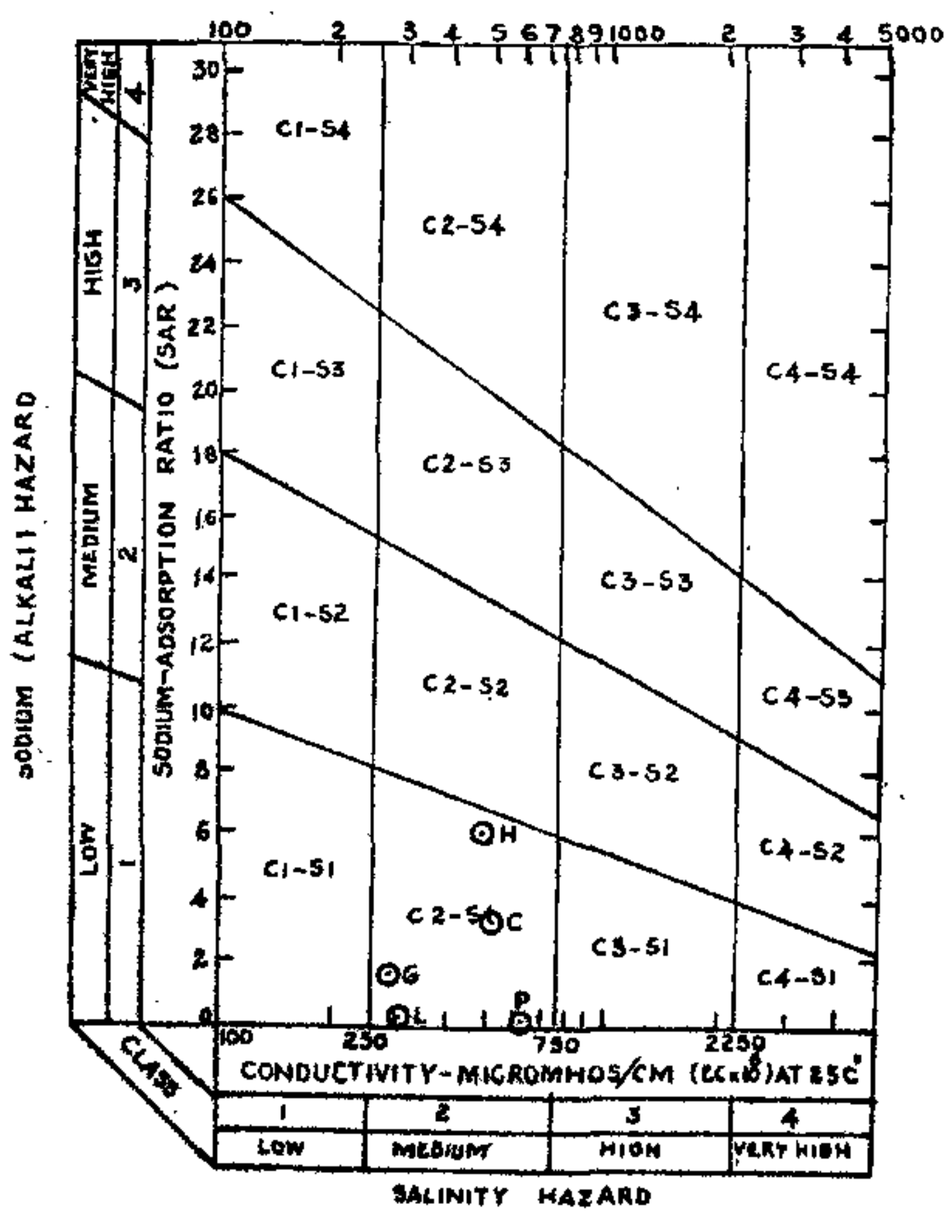

DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF IRRIGATION WATER.
G-GORAPARAV L-LALKUA C-CHANDINI
H-HIMMATPUR P-PREMNAGAR
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In plotting the points on the diagram the specific conductance is taken as TDS and for irrigation use, termed as "Salinity Hazard". The SAR values are computed from the analyses of well-waters and plotted on the vertical scale. Table I shows that water samples have been taken from set geological horizons.

From the locations of the points on the diagram (Class C2-S1), the following conclusions have been drawn :—

(1) Water wells located within the *Bhabar* and close to the foothills zone of the Himalayas, tap groundwater which is significantly low in salinity and sodium hazards and as such the water can be used on all soils and for most crops. The irrigation water from such wells shows that the calcium and magnesium ions exceed sodium ions slightly. The waters are useful for maintaining good tilth and permeability of the soils.

(2) Though all the values of SAR are generally well below ten as indicated in the diagram, there is a tendency for the groundwaters close to the seepage or spring line zone (*i.e.*, at the border of *Bhabar* and *Tarai*) to present a sodium hazard problem. Also the analyses indicate that sodium ions exceed the calcium and magnesium ions in quantity. In view of this, for any groundwater lift irrigation projects, the study of soils in this belt *vis-a-vis* chemical composition of groundwaters, may be desirable.

(3) The study of the usefulness of groundwaters, in the intermontane valley, for irrigation throws light on salinity hazard which needs study on the crop patterns. The high calcium content of the groundwater in the Doon Valley may be attributed to the geological setting of the valley, which borders the Krol limestone belt of Himalayas with its alluvial fill rich in gravels and pebbles of limestone. The soils are likely to be enriched in their permeability from the groundwaters, if applied for irrigational purposes. The sodium hazard is thereby minimised in this belt.

The studies are initiated for the first time in the submontane and intermontane tracts of Himalayas and bears significance in their future application to the entire *Bhabar* belt and intermontane valleys extending from Kashmir to Assam.

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TABLE I

Analyses of water samples from geological zones at various depths

Sl. No.		Well	Geological horizon	Depth of the zone (in feet below land surface)	Electrical conductivity in micromhos/cm. at 25° C.	Chemical analysis (in parts per million)						
						Total dissolved solids	pH	Hardness as $CaCO_3$	Bicarbonate HCO_3	Iron	Silica SiO_2	Calcium
1		2	3	4	5	6	7	8	9	10	11	12
1	District Nainital	Goraparav* (29°10′ : 79°32′)	*Bhabar* (well placed in *Bhabar*)	350′–496′	278‖	189	9·3	18·0	79·3	..	..	8·8
2		Lalkuat (29°05′:79°31′)	*Bhabar* (2½ miles N. of seepage or spring line)	138′–148′ 163′–203′ 223′–253′ & 268′–278′	302	205	7·5	163·0	186·0	Trace	25·6	20·4
3		Tanakpur* (29°04′ : 80°03′)	*Bhabar* (well in *Bhabar*)	70′– 90′ 110′–212′	300	..	8·2	6·0	219·06	..	..	..
4		Chandni* (29°01′ : 80°04′)	*Bhabar* (close to the southern extremity of *Bhabar*)	67′–168′	515‖	350	8·95	18·0	183·0	..	..	8·0
5		Himmatpur* (29 20′:79°03′)	*Bhabar* (close to the seepage or spring line)	142′–207′	480	325‖	8·50	18·0	251·10	..	..	17·60
6	District Dehra Dun	Premnagar† (30°20′:77°58′)	Doon alluvial fill	150′–170′ 185′–235′	612	418	7·5	344·0	329·0	..	19·60	96·34
7		Forest Research Institute‡ (30°20′:78°00′30′)	do.	280′–340′	..	500	..	350·0	..	..	..	..

Sl. No.		Well	Chemical analysis (in parts per million)								Remarks
			Magnesium	Potassium	Sodium	Sulphate	Chloride	Sodium** adsorption ratio (SAR)	Calcium + Magnesium Ions ($Ca^{++}+Mg^{++}$)	Sodium Ions (Na^{+})	
			13	14	15	16	17	18	19	20	21
1	District Nainital	Goraparav* .. (29°10′:79°32′)	17·76	2·6	35·6	18·4	8·0	1·589	1·8987	1·5486	$Ca^{++}+Mg^{++} > Na^{+}$
2		Lalkuat† (29°05′:79°31′)	27	1·8	6·2	17·0	8·1	0·212	3·239	0·2397	$Ca^{++}+Mg^{++} > Na^{+}$
3		Tanakpur* .. (29°04′:80°03′)	..	..	..	..	Trace	20·0	..	..	Analysis incomplete
4		Chandni* .. (29°01′:80°04′)	26·0	1·27	90·00	Nil	20·0	3·467	2·5374	3·9150	$Ca^{++}+Mg^{++} < Na^{+}$
5		Himmatpur* .. (29°20′:79°03′)	2·40	5·04	104·0	29·8	15·0	6·169	1·0755	4·524	$Ca^{++}+Mg^{++} < Na^{+}$
6	District Dehra Dun	Premnagar† .. (30°20′:77°58′)	25·2	1·0	6·69	79·0	11·3	0·157	6·880	0·2910	$Cr^{++}+Mg^{++} > Na^{+}$
7		Forest Research Institute‡ .. (30°20′:78°00′30′)	..	..	..	..	..	..	..	..	Analysis incomplete

* Analysis carried out in the laboratories of Indian Agricultural Research Institute, New Delhi.

† Analysis carried out in the laboratories of the Geological Survey of India, Calcutta.

‡ Analysis furnished by the Forest Research Institute and Colleges, Dehra Dun.

≈ Computed from the determined TDS value factor 0·678 derived from the chemical analysis of Lalkua water sample.

‖ Computed from the determined electrical conductivity value and the factor 0·678 derived from the chemical analysis of Lalkua water sample.

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