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Assessment of Groundwater Quality beneath Agriculturally Advanced Region of Northern Alluvial Plain, India

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Table S1. Quality standard (WHO, 2011), weight (w_n) and unit weight (W_n) for each parameter for calculating WQI and CGQII for groundwater samples in the Bist-Doab region of Punjab, India.

Parameters	Quality Standard	WQI		CGQII		
		Weight (w_n)	Unit Weight (W_n)	Indices	Quality Standard (Suitability Limit for Irrigation)	Unit Weight (W_n) {Proportionality Constant (K) = 0.39}
pH	6.5–8.5	4	0.082	SAR	26	0.0151
EC (S/cm)	500	4	0.082	RSC	2.5	0.1574
TDS (mg/l)	300	5	0.102	%Na	80	0.0049
TH (mg/l)	200	5	0.102	PI	75	0.0053
Ca^{2+} (mg/l)	75	2	0.041	KR	1	0.3936
Mg^{2+} (mg/l)	50	2	0.041	MH	50	0.0079
Na^{+} (mg/l)	200	3	0.061	PS	5	0.0787
K^{+} (mg/l)	12	1	0.02	K	44	0.0089
Cl^{-} (mg/l)	250	1	0.02	K_a	1.2	0.328
HCO_3^{-} (mg/l)	120	3	0.061			$\sum W_n = 1$
SO_4^{2-} (mg/l)	250	3	0.061			
NO_3^{-} (mg/l)	50	5	0.102			
NO_2^{-} (mg/l)	1	5	0.102			
F^{-} (mg/l)	1.5	5	0.102			
Br^{-} (mg/l)	0.5	1	0.02			
		$\sum w_i$ = 49	$\sum W_i$ = 1			

Table S2. Area under various physico-chemcial parameters of groundwater samples (n=148) of the Bist-Doab region of Punjab, India.

Parameters	Range	No. of Samples	Area (%)
EC (µS/cm)	< 500	93	52.99
	500–1000	48	45.71
	> 1000	7	1.3
TDS (mg/l)	< 300	48	32.03
	300–500	83	61.1
	500–1000	15	6.46
	> 1000	2	0.41
Total Hardness (TH) (mg/l)	< 200	18	4.55
	200–400	99	77.89
	400–600	21	13.34
	600–800	4	2.21
	800–1000	3	1.63
	> 1000	3	0.38
Ca^{2+}	< 75	66	35.98
	75–200	75	61.54
	> 200	7	2.4
Na^{+}	< 200	140	97.74
	> 200	8	2.26
Mg^{2+}	< 50	140	95.93
	> 50	8	4.07
K^{+}	< 12	139	92.65
	> 12	9	7.35
HCO_3^{-}	< 200	4	1
	200–400	105	77.34
	400–600	36	21.16
	> 600	3	0.5
Cl^{-}	< 250	144	96.97
	> 250	4	3.03
SO_4^{-2}	< 250	146	98.19
	250–500	1	1.5
	> 500	1	0.31
NO_3^{-}	< 45	130	91.54
	45–90	12	7.43
	90–135	4	0.75
	135–180	1	0.23
	> 180	1	0.05
F^{-}	< 1.5	147	99.96
	> 1.5	1	0.04
NO_2^{-}	< 1	146	98.45
	> 1	2	1.55

Table S3. Classification of groundwater of the Bist-Doab region of Punjab as per WQI and WAWQI (percentage in parenthesis).

Indices	Categories	Groundwater Quality	Number of Samples	Area (km²)
WQI	< 50	Excellent	66 (44.59%)	2734 (30.30%)
	50–100	Good	59 (39.86)	6057 (67.14%)
	100–200	Poor	23 (15.54%)	231 (3.56%)
	200–300	Very Poor	-	-
	> 300	Unsuitable	-	-
WAWQI	< 25	Excellent	140 (94.59%)	8561 (94.89%)
	25–50	Good	4 (2.71%)	346 (3.84%)
	50–75	Poor	2 (1.35%)	96 (1.06%)
	75–100	Very Poor	0	10 (0.11%)
	> 100	Unsuitable	2 (1.35%)	9 (0.1%)

Table S4. Weights assigned to various parameters of groundwater in the Bist-Doab region of Punjab (modified after Bhuiyan and Ray, 2017).

Parameters	Criteria	Weight Assigned
pH	< 7.5	1
	7.5–8.8	2
	> 8.8	3
TDS (mg/l)	< 500	1
	500–1500	2
	> 1500	3
TH (mg/l)	< 300	1
	300–600	2
	> 600	3
Ca (mg/l)	< 75	1
	75–200	2
	> 200	3
Mg (mg/l)	< 30	1
	30–100	2
	> 100	3
Cl (mg/l)	< 250	1
	250–1000	2
	> 1000	3
SO_4 (mg/l)	< 150	1
	150–400	2
	> 400	3
F	< 1	1
	1–1.5	2
	> 1.5	3
NO_3	< 10	1
	10–45	2
	> 45	3

Table S5. Classification of groundwater of the Bist-Doab region of Punjab as per MCDA (percentage in parenthesis).

Index Value	Domestic Water Quality	Number of Samples	Area (km²)
< 11	Very Good	7 (4.73%)	385 (4.27%)
11–13	Good	79 (53.37%)	183 (68.53%)
13–17	Moderate	54 (36.49%)	2262 (25.07%)
17–27	Bad	8 (5.41%)	192 (2.13%)
> 27	Very Bad	-	-

Table S6. Classification of groundwater for irrigation concerning various indices in the Bist-Doab region of Punjab (percentage in parenthesis).

Irrigation Indices	Index Value	Suitability for irrigation	No. of Samples	Area (km²)
RSC	< 1.25	Good	122 (82.44%)	7909 (87.66%)
	1.25–2.5	Doubtful	13 (8.79%)	845 (9.36%)
	> 2.5	Unsuitable	13 (8.79%)	268 (2.98%)
SAR	< 10	Excellent	148 (100%)	9022 (100%)
	10–18	Good	-	-
	18–26	Doubtful	-	-
	> 26	Unsuitable	-	-
%Na	< 20	Excellent	59 (39.86%)	2453 (27.19%)
	20–40	Good	60 (40.54%)	5144 (57.02%)
	40–60	Permissible	21 (14.49%)	1279 (14.17%)
	60–80	Doubtful	7 (4.73%)	146 (1.62%)
	> 80	Unsuitable	1 (0.68%)	-
KR	< 1	Suitable	132 (89.19%)	8066 (89.39%
	> 1	Unsuitable	16 (10.81%)	956 (10.61%)
MH	< 50	Suitable	133 (89.87%)	8626 (95.6%)
	> 50	Unsuitable	15 (10.13%)	396 (4.4)
PS	< 3	Excellent	136 (91.89%)	8096 (89.23%)
	3–5	Good	5 (3.38%)	414 (4.59%)
	> 5	Unsuitable	7 (4.73%)	512 (5.68%)
K	< 25	Excellent	148 (100%)	9022 (100%)
	25–36	Good	-	-
	36–44	Injurious	-	-
	> 44	Unsuitable	-	-
K_a	> 18	Excellent	97 (65.54%)	7200 (79.81%)
	6–18	Permissible	42 (28.38%)	1740 (19.29%)
	1.2–6	Doubtful	8 (5.41%)	82 (0.9%)
	< 1.2	Unsuitable	1 (0.67%)	-

Table S7. Classification of groundwater of the Bist-Doab region of Punjab as per CGQII (percentage in parenthesis).

CGQII Value (Mod)	Suitability for irrigation	Number of Samples	Area (km²)
< 25	Excellent	98 (66.21%)	5983 (66.32%)
25–50	Good	31 (20.95%)	1933 (21.43%)
50–75	Poor	8 (5.41%)	627 (6.95%)
75–100	Very Poor	5 (3.38%)	305 (3.38%)
> 100	Unsuitable	6 (4.05%)	174 (1.92%)