

**Table S1.** Standard scoring functions and indicators parameters in the study area (SSF Equations were adopted from Zeraatpisheh et al. [14]).

Indicator	FT	L	U	O	SSF Equation	
pH	OR	6.10	9.62	7	$S_L = \begin{cases} 1 & x \leq L \\ 1 - 0.9 \frac{x-L}{U-L} & L < x < U \\ 0.1 & x \geq U \end{cases}$	$\begin{matrix} \\ \\ Linear \end{matrix}$
EC (dS m <sup>-1</sup> )	OR	0.14	46.60	0.20-2.00		
SAR	LB	0.46	41.00	-		
Na <sub>aq</sub> (meq l <sup>-1</sup> )	LB	0.46	272.00	-	$S_{NL} = \frac{a}{(1 + (\frac{x}{x_0})^b)}$	$Non - linear$
CCE (%)	LB	2.00	42.00	-		
SP (%)	MB	18.00	54.23	-	$S_L = \begin{cases} 0.1 & x \leq L \\ 0.9 \frac{x-L}{U-L} + 0.1 & L < x < U \\ 1 & x \geq U \end{cases}$	$\begin{matrix} \\ \\ Linear \end{matrix}$
Ca <sub>aq</sub> (meq l <sup>-1</sup> )	MB	1.50	73.60	-		
Mg <sub>aq</sub> (meq l <sup>-1</sup> )	MB	0.60	56.00	-		
SOC (%)	MB	0.02	3.06	-	$S_{NL} = \frac{a}{(1 + (\frac{x}{x_0})^b)}$	$Non - linear$
TN (%)	MB	0.00	0.91	-		
P <sub>av</sub> (mg kg <sup>-1</sup> )	MB	0.20	80.00	-		
K <sub>av</sub> (mg kg <sup>-1</sup> )	MB	17.00	695.00	-		

EC: electrical conductivity, SP: saturation percentage, CCE: calcium carbonate equivalent, SOC: soil organic carbon, TN: total nitrogen, P<sub>av</sub>: available phosphorous, K<sub>av</sub>: available potassium, Ca<sub>aq</sub>: soluble calcium, Mg<sub>aq</sub>: soluble manganese, Na<sub>aq</sub>: soluble sodium, SAR: sodium absorption ratio. FT: function type; LB: the lower, the better; MB: the more, the better; OR: optimal range; SSF: standard scoring function; x: indicator value, S<sub>L</sub>: linear score of indicator; S<sub>NL</sub>: non-linear score of indicator; a: maximum score equal to 1 in this study; x<sub>0</sub>: mean value of the variable; b: slope assumed to be -2.5 for 'more is better' functions and +2.5 for 'low is better'; L: lower threshold values; U: upper threshold values.

**Table S2.** Environmental covariates were used as predictors in the study area.

Covariates	Covariate name (abbreviation)	Definition	Reference
Topographic attributes	Elevation (DEM)	Height over sea level	[1]
	Slope (Slope)	Gradient of line is changing of elevation in the direction and steepness	[1]
	Aspect (ASP)	Direction of the line of the steepest descent	[1]
	Curvature (Curvature )	The degree to which a curve deviates from a straight line	[1]
	Plan curvature (Plancurv)	Rate of change of aspect along a contour	[1]
	Profile curvature (Profcurv)	Rate of change of slope down a slope line	[1]
	Convergence (Convergence)	Highlights the convergent areas as channels and divergent areas as ridges.	[1]
	Hillshade	Angle between the surface and the incoming light beams	[1]
	Channel network	The interpolated channel network base level elevations	[2]
	Vertical distance to channel network (VDTCN)	Calculates the vertical distance to a channel network base level	[2]
	Topographic roughness index (TRI)	Measures terrain ruggedness	[3]
	Stream power index (LS)	A measure of the topographic control on the sediment transport (USLE's LS factor)	[3]
	Topographic wetness index (TWI)	A measure of the topographic control on soil wetness or the ratio	[3]
	Multi-resolution valley bottom flatness index (MRVBF)	Measure of flatness and lowness	[1]
	Multi-resolution of ridge top flatness index (MRRTF)	Measure of flatness and lowness	[1]
	Topographic position index (TPI)	Difference between a cell elevation value and the average elevation of the neighborhood around that cell	[2]
	Mass balance index (MBI)	Balance between soil mass deposited and eroded	[2]
	Wind effect	Dimensionless index indicating areas exposed to wind	[2]
	Valley depth	The vertical distance to a channel network base level	[2]
	Relative slope position (RSP)	The position of one point relative	[2]
	Terrain surface texture (Texture)	The geometrical irregularities present at a surface or the nested-means terrain classification	[2]
Remote sensing indices	Salinity Index (SI)	$\sqrt{B2 \times B4}$	[4]
	Salinity Index 1 (Salinity1)	$B2/B4$	[4]
	Salinity Index 2 (Salinity2)	$(B2-B4)/(B2+B4)$	[4]
	Salinity Index 3 (Salinity3)	$(B3 \times B4)/B2$	[4]
	Salinity Index 4 (Salinity4)	$(B2 \times B4)/B3$	[4]

Salinity Index 5 (Salinity5)	$(B2 \times B4) / B3$	[4]
Salinity Index 6 (Salinity6)	$(B4 \times B8A) / B3$	[4]
Normalized Difference salinity Index (NDSI)	$(B4 - B8A) / (B4 + B8A)$	[4]
Salinity Index-T (SI-T)	$(B4 / B8A) / 100$	[4]
(SI1)	$\sqrt{B3^2 + B4^2 + B8A^2}$	[5]
(SI2)	$\sqrt{B3^2 + B4^2}$	[5]
Soil Moisture Monitoring Index (SMMI)	$\sqrt{B8A^2 + B11^2} / \sqrt{2}$	[6]
Visible and Shortwave Drought Index (VSDI)	$1 - (B12 + B4 - 2 \times B2)$	[6]
Normalized Difference Water Index (NDWI)	$(B8A - B11) / (B8A + B11)$	[6]
Redness Index (RI)	$(B4^3) / (B3^3)$	[7]
Brightness Index (BI)	$\sqrt{(B4^2 + B3^2 + B2^2)} / 3$	[7]
Second Brightness Index (BI2)	$\sqrt{(B4^2 + B3^2 + B8A^2)} / 3$	[6]
Carbonate index (CaI)	$B4 / B3$	[8]
Ferrous iron (FeI)	$B4 / SWIR1$	[8]
Clay index (ClayI)	$SWIR1 / SWIR2$	[8]
Saturation Index (SI)	$(B4 - B2) / (B4 + B2)$	[7]
Coloration Index (CI)	$(B4 - B3) / (B4 + B3)$	[7]
Hue Index (HI)	$(2 \times B4 - B2) / (B4 + B2)$	[7]
Normalized difference (Geol)	$(SWIR1 - SWIR2) / (SWIR1 + SWIR2)$	[7]
Normalized difference (CalcI)	$(SWIR1 - B3) / (SWIR1 + B3)$	[7]
Grain size index (GSI)	$(B4 - B2) / (B4 + B3 + B2)$	[6]
Intensity index 1 (Intensity1)	$(B3 + B4) / 2$	[6]
Intensity index 2 (Intensity2)	$(B3 + B4 + B8A) / 2$	[6]
Infrared Percentage Vegetation Index (IPVI)	$B8 / (B8 + B4)$	[6]
Moisture Stress Index (MSI)	$SWIR1 / B8$	[6]
Normalized Multiband Drought Index (NMDI)	$\frac{B8A - (B11 - B12)}{B8A + (B11 + B12)}$	[6]
Normalized Shortwave- infrared Difference SM Index 3 (NSDSI3)	$(B11 - B12) / (B11 + B12)$	[6]
Perpendicular Drought Index 322 (PD322)	$(B4 - B3) / (B4 + B3)$	[6]
Enhanced Vegetation Index (EVI)	$\frac{2.5 \times (B8A - B4)}{(B8A + 6 \times B4 - 7.5 \times B2 + 1)}$	[6]
Normalized Difference Vegetation Index red- edge 1 (NDVIrel)	$(B8A - B5) / (B8A + B5)$	[6]
Normalized Difference Vegetation Index red- edge 2 (NDVIrel2)	$(B8A - B6) / (B5 + B6)$	[6]
Normalized Difference red-edge 1 (NDre1)	$(B6 - B5) / (B6 + B5)$	[6]

	Normalized Difference red-edge 2 (NDre2)	$(B7-B5)/(B7+B5)$	[6]
	Triangular Chlorophyll Index red-edge 1 (TCIrel)	$1.2 \times (B5 - B3) - 1.5 \times (B4 - B3) \times \sqrt{\frac{B5}{B4}}$	[6]
	Transformed Vegetation Index (TVI)	$\sqrt{\left(\frac{B8-B4}{B8+B4} + 0.5\right)} \times 100$	[6]
	Weighted Difference Vegetation Index (WDVI)	$B8 - (B8/B4) \times B4$	[6]
	Soil Adjusted Total Vegetation Index (SATVI)	$\left(\frac{B11 - B4}{B11 + B4 + L}\right) \times (1 + L) - \frac{B12}{2}$ L=1	[6]
	Green Normalized Difference Vegetation Index (GNDVI)	$(B8-B3)/(B8+B3)$	[6]
	Soil adjusted vegetation index (SAVI)	$\frac{(B8 - B4) \times (1 + L)}{(B8 - B4 + L)}$ L=0.5	[9]
	Optimized Soil-Adjusted Vegetation Index (OSAVI)	$(B8 - B4)/(B8 + B4 + 0.16)$	[10]
	Normalized difference vegetation index (NDVI)	$(B8A-B4)/(B8A+B4)$	[11]
	Ratio Vegetation Index (RVI)	$(B8/B4)$	[12]
	Difference Vegetation Index (DVI)	$(B8-B4)$	[13]
	Green-Red Vegetation Index (GRVI)	$(B3-B4)/(B3+B4)$	[13]
	Modified Soil Adjusted Vegetation Index (MSAVI)	$\frac{2 \times B4 + 1 - \sqrt{(2 \times B8A + 1)^2 - 8 \times (B8A - B4)}}{2}$	[14]
	Land use map		
Parent material	Geology map		
Soil, parent material, topography	Landform map		[15]
Groundwater quality parameters	HCO <sub>3</sub> <sup>-</sup> , Cl <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> , Na <sup>+</sup> , Ca <sup>2+</sup> , Mg <sup>2+</sup> , EC, pH, SAR, and TDS		[16]

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