The Dual-Edged Role of Vegetation in Evaluating Landslide Susceptibility: Evidence from Watershed-Scale and Site-Specific Analyses

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Table S1: Zonal statistical results of landslide influencing factors

Factor	Classification	Evaluation level	Area of classification (km^2)	Number of Landslides (count)	Landslide point density (points/km^2)
Elevation (m)	≦1000	9	55.61	43	0.77
	(1000–1500]	7	122.56	66	0.54
	(1500–2500]	5	357.09	112	0.31
	(2500–3000]	3	63.73	6	0.09
	> 3000	1	5.59	0	0.00
Slope (°)	≦10	1	40.11	19	0.47
	(10–20]	3	102.18	53	0.52
	(20–35]	5	266.52	95	0.36
	(35–45]	7	140.18	47	0.34
	> 45	9	51.71	13	0.25
Aspect	Flat	1	0.85	0	0.00
	North	5	57.74	32	0.55
	Northeast	5	70.98	18	0.25
	East	5	79.92	19	0.24
	Southeast	5	90.09	24	0.27
	South	3	75.86	28	0.37
	Southwest	3	83.83	50	0.60
	West	3	77.15	26	0.34
	Northwest	3	64.28	30	0.47
Rainfall (mm)	≦1000	3	110.5	0	0.00
	(1000–1100]	5	248.13	16	0.06
	(1100–1200]	6	117.63	83	0.71
	(1200–1300]	7	68.7	45	0.66
	(1300–1400]	8	39.3	39	0.99
	> 1400	9	20.29	44	2.17
Lithology	Acidic plutonic	3	6.97	6	0.86
	Carbonate sedimentary	5	84.97	18	0.21
	Pyroclastics	1	50.06	13	0.26
	Mixed sedimentary	7	315.17	103	0.33
	Intermediate volcanic	9	147.99	87	0.59
Distance from fault (km)	≦3	9	63.17	44	0.70
	(3–6]	7	83.41	56	0.67
	(6–9]	6	98.47	33	0.34

	(9–12]	5	99.74	24	0.24
	(12–15]	3	102.09	27	0.26
	> 15	1	157.7	43	0.27
Distance from road (m)	≦200	9	81.32	30	0.37
	(200–400]	7	51.65	24	0.46
	(400–,600]	5	42.71	21	0.49
	(600–800]	3	37.72	19	0.50
	> 800	1	391.16	133	0.34
Distance from river (m)	≦500	9	103.34	34	0.33
	(500–1000]	7	90.89	36	0.40
	(1000–1500]	5	84.43	34	0.40
	(1500–2500]	3	138.74	57	0.41
	> 2500	1	187.15	66	0.35
NDVI	≦ 0.2	1	10.28	1	0.10
	(0.2–0.4]	2	81.4	25	0.31
	(0.4–0.6]	4	184.13	70	0.38
	(0.6–0.8]	6	319.13	126	0.39
	> 0.8	8	9.15	5	0.55
Wind speed (ms^{-1})	≦1.5	3	23.68	17	0.72
	(1.5–2]	5	74.25	49	0.66
	(2–3]	7	389.46	134	0.34
	> 3	9	117.17	27	0.23

Table S2: Results of consistency test of AHP judgment matrix

	λ_{max}	CI	RI	CR	Test result
I	7.59	0.10	1.34	0.07	Satisfy the standard
II	8.83	0.12	1.40	0.09	
III	8.65	0.09	1.40	0.07	
IV	9.91	0.11	1.45	0.08	
V	10.96	0.11	1.49	0.07	

Table S3: Weight results obtained by AHP

Factor	Feature vector					Weight value (%)				
	I	II	III	IV	V	I	II	III	IV	V
Elevation	0.61	0.56	0.55	0.51	0.59	8.65	6.93	5.72	6.93	5.92
Slope	1.59	1.28	1.38	1.43	1.46	22.72	16.01	15.90	17.26	14.58
Aspect	0.55	0.52	0.53	0.50	0.50	7.83	6.54	5.50	6.65	4.95
Lithology	1.52	1.68	1.58	1.33	1.36	21.66	21.00	14.78	19.72	13.62
Distance from fault	0.94	1.05	0.85	1.23	1.27	13.42	13.18	13.67	10.64	12.71

Distance from road	0.99	0.88	0.89	0.80	0.86	14.07	11.04	8.84	11.15	8.58
Distance from river	0.82	0.77	0.75	0.75	0.81	11.66	9.58	8.36	9.40	8.11
NDVI		1.26		1.14	1.24		15.72	12.65		12.36
Rainfall			1.46	1.31	1.40			14.59	18.26	13.97
Wind speed					0.52					5.20

Table S4: Fitness results for structural equation model

Indicator Name	Indicator Value	Indicator Standard	Result
CMID/DF	2.79	<3	
CFI	0.99	>0.9	
GFI	1	>0.8	
IFI	0.99	>0.9	Good fit
TLI	0.99	>0.9	
RMESA	0.06	<0.08	
SRMR	0.01	<0.08	

Note: CMIN (χ^2) = chi-square statistic for model fit. DF = Degrees of Freedom. CFI = Comparative Fit Index. GFI = Goodness of Fit Index. IFI = Incremental Fit Index. TLI = Tucker-Lewis Index. RMSEA = Root Mean Square Error of Approximation. SRMR = Standardized Root Mean Square Residual

Table S5: Basic parameters of landslide region

Region	Longitudinal length (m)	Width (m)	Average width (m)	Average thickness (m)	Landslide area (m^2)	Landslide volume (m^3)
Unstable	76	20–30	23	6	2147	1.3×10^4
Scraping and shoveling	96.4	15–20	17	3	2293	0.7×10^4
Accumulation	110.9	30–50	38	6	5234	3.1×10^4

Supplementary Texts

Text S1：Height, movement distance and area

In landslide risk assessment, the ratio of height difference (H) to movement distance (L) is an important reference indicator (Goren et al., 2010; Manzella et al., 2008; Roback et al., 2018). A higher ratio signifies greater energy release during the landslide (Su et al., 2019). This also implies a larger scale and greater intensity of the landslide.

The International Union of Geological Sciences (IUGS) (Oberhänsli et al., 2017), defines a "rapid landslide" as one with an H/L ratio below 0.6, an average speed greater than 5 m/s, and a wide impact area. These landslides exhibit high intensity and destructive potential. When the H/L ratio exceeds 0.6, the landslide is classified as general or small-scale, with relatively lower speed, shorter travel distance, and reduced destructive potential. However, the potential hazards of such landslides cannot be entirely ruled out.

Text S2：Correlation analysis between influencing factors and the number of landslides

Table S1 illustrates areas and the number of landslides within different threshold ranges of the influencing factors. The details are shown as below:

(1) Topographic factors

Elevation: When elevation is below 1000 m, the area is 55.61 km², with 43 landslides occurring, resulting in the highest landslide density of 0.77 landslides/km². As elevation increases, the number of landslides first rises and then falls, while landslide density shows a continuous decline.

Slope: When the slope is between 10 ° and 20°, the landslide density reaches its peak at 0.52 landslides/km², with 53 landslides occurring. Both the number of landslides and the density increase initially and then decrease.

Aspect: The southwest-facing zone has an area of 83.83 km², and the highest landslide density of 0.6 landslides/km², with 50 landslides.

(2) Meteorological factors

Rainfall: the area is only 20.29 km², but when rainfall exceeded 1400 mm, 44 landslides occurred, resulting in the highest landslide density of 2.17 landslides/km².

Wind Speed: The area is 389.46 km², with 17 landslides occurring and a maximum landslide density of 0.72 landslides/km² when wind speed was below 3 m/s, In the 2–3 m/s wind speed range, the highest number of landslides occurred, totaling 134. As wind speed increases, the number of landslides first rises and then falls, while landslide density shows a continuous decreasing trend.

(3) Lithology

The lithology of the study area is: acidic plutonic, carbonate sedimentary, pyroclastic, mixed sedimentary, and intermediate volcanic rocks. Among these, mixed sedimentary covers the largest area at 315.17 km², with 103 landslides occurring. Acidic sedimentary has the highest landslide density at 0.86 landslides/km² but covers the smallest area of 6.97 km². When the distance to fault is less than 3 km, the area is 63.17 km², with 44 landslides occurring and the highest landslide density of 0.7 landslides/km². As the distance increases, the influence of fault activity diminishes, and the overall trend of landslide density decreases.

(4) Other factors

Distance to Road: When the distance to roads is less than 200 m, the highest number of landslides occurs, totaling 30, with a landslide density of 0.37 landslides/km^2.

Distance to Rivers: In the range of (1500, 2500] m, both the area (138.74 km^2) and landslide density (0.41 landslides/km^2) are at their maximum, with 57 landslides recorded.

Normalized Difference Vegetation Index: When NDVI is in the range of (0.6, 0.8], the area and the number of landslides reach their maximum at 319.13 km^2 and 124, respectively, with a landslide density of 0.39 landslides/km^2. This indicates that the study area has relatively high vegetation coverage. When NDVI exceeds 0.8, landslide density peaks at 0.55 landslides/km^2, with five landslides occurring. When NDVI is below 0.8, the number of landslides consistently increases with rising NDVI, matching the trend in area, and landslide density also continues to rise. This aligns with the observation mentioned earlier that areas with higher vegetation coverage tend to experience more frequent landslides.

Supplementary Figures

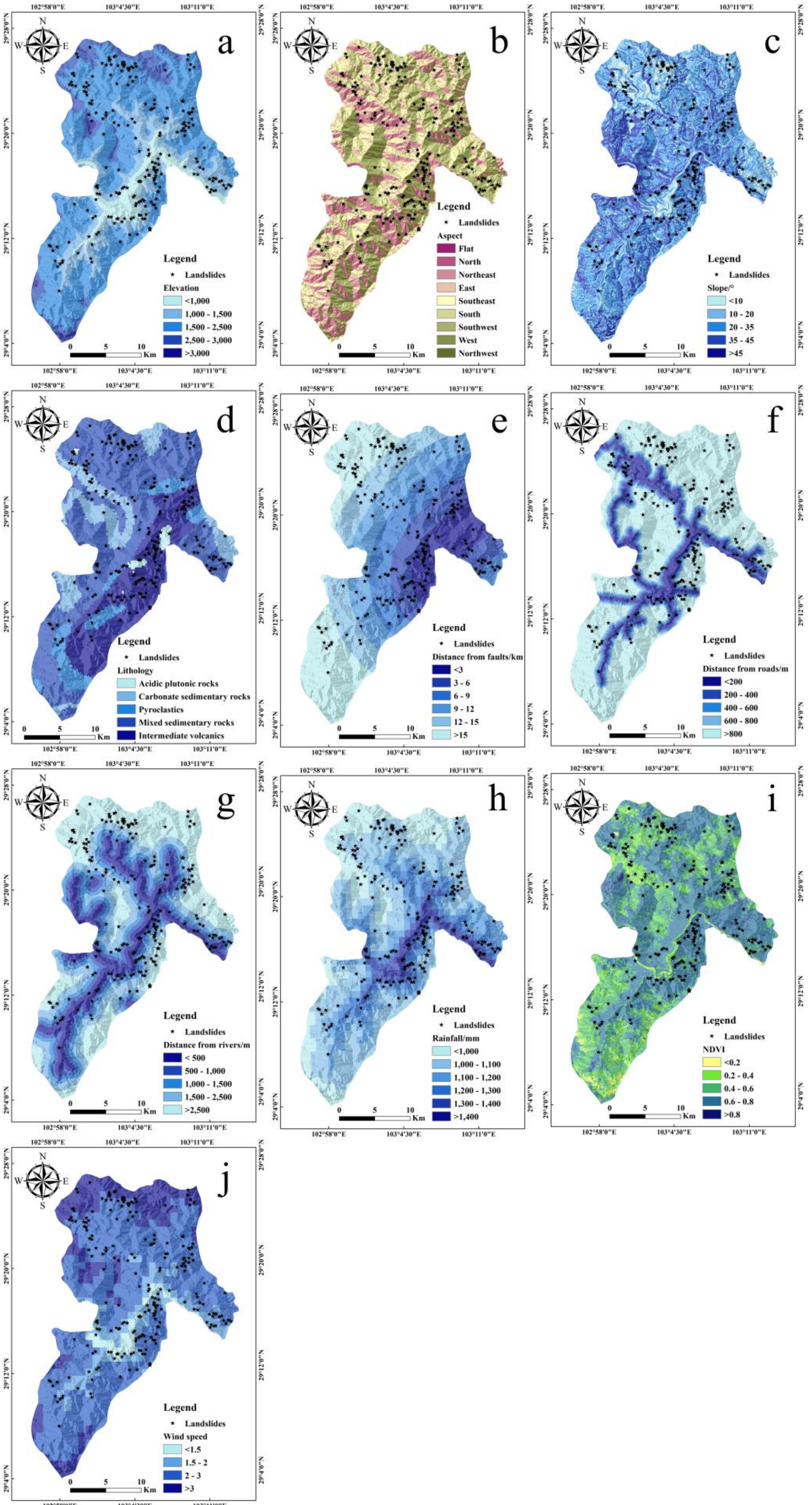
a
Legend
Landslides
Elevation
<1,000
1,000 - 1,500
1,500 - 2,500
2,500 - 3,000
>3,000
b
Legend
Landslides
Aspect
Flat
North
Northeast
East
Southeast
South
Southwest
West
Northwest
c
Legend
Landslides
Slope/°
<10
10 - 20
20 - 35
35 - 45
>45
d
Legend
Landslides
Lithology
Acidic plutonic rocks
Carbonate sedimentary rocks
Pyroclastics
Mixed sedimentary rocks
Intermediate volcanics
e
Legend
Landslides
Distance from faults/km
<3
3 - 6
6 - 9
9 - 12
12 - 15
>15
f
Legend
Landslides
Distance from roads/m
<200
200 - 400
400 - 600
600 - 800
>800
g
Legend
Landslides
Distance from rivers/m
< 500
500 - 1,000
1,000 - 1,500
1,500 - 2,500
>2,500
h
Legend
Landslides
Rainfall/mm
<1,000
1,000 - 1,100
1,100 - 1,200
1,200 - 1,300
1,300 - 1,400
>1,400
i
Legend
Landslides
NDVI
<0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
>0.8
j
Legend
Landslides
Wind speed
<1.5
1.5 - 2
2 - 3
>3
N
S
W
E
0 5 10 Km
102°58'0"E
103°4'30"E
103°11'0"E
29°28'0"N
29°20'0"N
29°12'0"N
29°4'0"N

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Figure S1: Thematic maps of landslide susceptibility influencing factors according to the classification criteria of the landslide susceptibility evaluation system (Table S1). The factors in figures a to j are successively Elevation, Aspect, Slope, PrC, Lithology, Distance from fault, Distance from road, Distance from river, Rainfall, NDVI, Wind speed.

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