

Table 1. Data Sources and Purpose for Landslide Susceptibility Mapping

Data	Data Purpose	Data Source	Scale / Resolution
District Administration Mandi, Himachal Pradesh	Administrative Boundary of Mandi	https://hpmandi.nic.in/map-of-district/	1:50000
H.P. Disaster Revenue Reports (2015-2019), Google Earth, GSI- BHUKOSH, Handheld GPS	Landslide Inventory	https://hpsdma.nic.in/ https://bhukosh.gsi.gov.in/	1:50000
ALOS-PALSAR DEM	Slope, Curvature, Aspect, Elevation, Drainage Density and TWI	https://search.asf.alaska.edu	12.5 m
Landsat-8 OLI	NDVI and Lineaments	http://earthexplored.usgs.gov	30 m
Geological Survey of India (GSI), BHUKOSH	Geology	https://bhukosh.gsi.gov.in/	1:50000
Ministry of Road Transport and Highways (MoRTH)	Major roads of Mandi District	https://morth.nic.in/	1:50000
National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS and LUP)	Soil - Type, Depth & Drainage of Mandi District	https://www.nbsslup.in/	1:50000

Table 2. Multicollinearity Coefficients for Landslide Causative Factors

Model	Collinearity Statistics	
	Tolerance	VIF
Slope	0.698	2.451
Aspect	0.775	1.165
Curvature	0.514	8.793
Elevation	0.231	3.037
Drainage Density	0.282	8.525
Lineament Density	0.149	6.785
Geology	0.336	2.976
NDVI	0.131	7.631
Soil	0.472	5.270
Roads	0.287	7.638
TWI	0.312	4.686

Table 3. Spatial correlation between landslide occurrence and landslide causative factors

	Class Pixels	Percent of Pixels	Landslid e Pixels	Percent of Pixels	Frequency Ratio FR Values	Certainty Factor CF Value	Shanon Entropy Pij	Wj
Landslide Causative Factors								
Slope Gradient (Degree)								
Flat (<15°)	435014	0.102	9	0.008	0.079	-0.921	0.016	0.093
Moderate (15° - 25°)	948259	0.222	85	0.076	0.341	-0.659	0.069	
Moderately Steep (25° - 35°)	1374272	0.322	304	0.271	0.842	-0.158	0.170	
Steep (35° - 45°)	1047813	0.245	490	0.437	1.780	0.738	0.359	
Very Steep (>45°)	466470	0.109	234	0.209	1.910	0.777	0.386	
Plan Curvature								
Convex (-45 - -25)	94610	0.022	55	0.049	2.213	-0.548	0.299	0.033
Slight Convex (-25 - -5)	711548	0.167	407	0.363	2.178	-0.541	0.294	
Flat (-5 - 5)	1953189	0.457	254	0.226	0.495	0.310	0.093	
Slight Concave (5 - 25)	1346104	0.315	233	0.208	0.659	0.341	0.089	
Concave (25-50)	166377	0.039	73	0.065	1.671	0.401	0.225	
Slope Aspect								
Flat	33660	0.008	4	0.004	0.452	0.114	0.054	0.013
North	484657	0.113	126	0.112	0.990	0.010	0.119	
Northeast	515422	0.121	115	0.102	0.849	0.151	0.102	
East	497821	0.117	81	0.072	0.619	0.381	0.074	
Southeast	503993	0.118	108	0.096	0.816	0.184	0.098	
South	545067	0.128	175	0.156	1.222	-0.182	0.147	
Southwest	647098	0.151	238	0.212	1.400	-0.286	0.16	

West	546964	0.128	195	0.174	1.357	-0.263	0.16	8	
Northwest	497146	0.116	80	0.071	0.613	0.387	0.07	3	
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Elevation (m)									
Low (400 - 1000)	995824	0.233	212	0.189	0.811	0.190	0.18	8	
Moderate (1000 - 1500)	162430	0.380	266	0.237	0.623	0.377	0.14	4	0.066
Moderately High (1500 - 2000)	102815	0.241	539	0.480	1.996	0.499	0.46	2	
High (2000 - 2500)	537465	0.126	101	0.090	0.715	0.285	0.16	6	
Very High(2500 - 3500)	86074	0.020	4	0.004	0.177	0.823	0.04	1	
Drainage Density									
Very Low (0 - 0.6)	129983	0.305	150	0.134	0.439	-0.561	0.01	7	
Low (0.6 - 1.2)	190848	0.448	229	0.204	0.456	-0.543	0.01	8	0.269
Moderate (1.2 - 1.8)	877782	0.206	337	0.300	1.459	0.316	0.05	8	
High (1.8 - 2.4)	179820	0.042	393	0.350	8.307	0.877	0.32	1	
Very High (2.4 - 3.0)	5908	0.001	23	0.020	14.797	0.933	0.58	6	
Lineament Density									
Very Low (-0.1 - 0.3)	585993	0.138	67	0.060	0.434	-0.565	0.08	1	
Low (0.3 - 0.6)	109392	0.257	113	0.101	0.392	-0.607	0.07	3	0.048
Moderate (0.6 - 0.9)	110920	0.260	329	0.293	1.126	0.115	0.21	1	
High (0.9 - 1.2)	108591	0.255	407	0.363	1.423	0.299	0.26	6	
Very High (1.2 - 1.6)	396788	0.093	206	0.184	1.971	0.494	0.36	9	
Geology									
Larji Group	17112	0.004	6	0.005	1.335	-0.251	0.11	5	
Shali Group	480871	0.113	99	0.088	0.784	0.216	0.06	8	0.060
Jaunsar Group	90819	0.021	6	0.005	0.252	0.749	0.02		

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Middle Siwalik Group	77936	0.018	37	0.033	1.808	0.447	0.156	
Salkhala Group	1020010	0.239	326	0.291	1.217	-0.178	0.105	
Hajaribagh Granite and Pegmatite	481719	0.113	77	0.069	0.609	0.391	0.052	
Dharmasala Group	761109	0.178	186	0.070	1.679	0.696	0.145	
Upper Siwalik Group	258408	0.060	4	0.004	0.059	0.094	0.005	
Rampur Group	2779	0.001	0	0.000	0.000	0.285	0.000	
Lower Siwalik Group	61338	0.014	3	0.003	0.186	0.085	0.016	
Sundernagar Formation	100192	0.023	33	0.119	0.650	0.203	0.056	
Malani Volcanic Suite	15813	0.004	1	0.007	0.112	0.144	0.010	
Simlipal Ultramafics	368975	0.086	144	0.128	1.486	0.327	0.128	
Kulu Formation	534747	0.125	200	0.178	1.424	0.298	0.123	
NDVI								
Waterbodies (- 0.15 - 0.015)	16242	0.004	33	0.029	7.736	0.871	0.574	
Urban (0.015 - 0.14)	492012	0.115	286	0.255	2.213	0.548	0.164	0.121
Barren Land (0.14 - 0.18)	470706	0.110	152	0.135	1.230	-0.187	0.091	
Shrubs and Grassland (0.18 - 0.27)	1933318	0.453	399	0.356	0.786	0.214	0.058	
Sparse Vegetation (0.27 - 0.36)	1204917	0.282	219.000	0.195	0.692	0.308	0.051	
Dense Vegetation (0.36 - 0.74)	154633	0.036	33	0.029	0.813	0.188	0.060	
Soil								
Lesser Himalayan Soils of Side / Reposed Slopes	2736453	0.641	899	0.801	1.251	0.201	0.289	
Lesser Himalayan Soils of Fluvial Valleys	280750	0.066	124	0.111	1.682	0.705	0.389	0.075
Siwaliks Soils of Side / Reposed Slopes	1083902	0.254	79	0.070	0.278	0.623	0.064	
Siwaliks Soils of Fluvial	62713	0.015	16	0.014	0.971	0.429	0.22	

Valleys							5	
Lesser Himalayas Soils of Summits and Ridge Tops	108010	0.025	4	0.004	0.141	-0.459	0.03 3	
TWI								
Very Low (0.00 - 4.00)	319258 6	0.747	349	0.311	0.416	-0.584	0.00 4	
Low (4.00 - 10.00)	103133 0	0.241	436	0.389	1.610	-0.379	0.01 4	0.140
Moderate (10.00 - 16.00)	37036	0.009	208	0.185	21.383	0.451	0.18 2	
High (16.00 - 22.00)	9038	0.002	105	0.094	44.232	0.978	0.37 7	
Very High (22.00 - 28.00)	1838	0.000	24	0.021	49.715	0.980	0.42 4	
Distance from Road (m)								
0 - 100	240721	0.056	406	0.362	6.421	0.844	0.35 9	
100 - 200	196740	0.046	297	0.265	5.747	0.826	0.32 1	0.082
200 - 300	172030	0.040	111	0.099	2.456	0.593	0.13 7	
300 - 400	156805	0.037	80	0.071	1.942	0.485	0.10 9	
400 - 500	145918	0.034	43	0.038	1.122	0.109	0.06 3	
>500	335961 4	0.787	185	0.165	0.210	-0.790	0.01 2	

Table 4. Percent change in landslide susceptibility classes due to road construction

	Frequency Ratio			Certainty Factor			Shanon Entropy		
	Percent Area LSM _N	Percent Area LSM _R	Percent Change	Percent Area LSM _N	Percent Area LSM _R	Percent Change	Percent Area LSM _R	Percent Area LSM _R	Percent Change
Class									
Very Low	19.20	18.99	-0.21	25.08	23.79	-1.28	24.36	23.03	-1.33
Low	20.21	20.30	0.09	23.95	21.46	-2.49	21.75	21.04	-0.71
Medium	24.34	20.28	-4.05	20.92	22.02	1.10	23.74	21.69	-2.05
High	22.96	24.57	1.60	23.04	24.03	0.99	19.35	21.69	2.34
Very High	13.29	15.86	2.57	7.02	8.70	1.68	10.80	12.55	1.75