Supplementary Materials

Spatiotemporal assessment of habitat quality and sediment delivery ratio in a coastal district of Thailand

Table S1. MOLUSCE ANN configurations tested (training statistics)

Model	Samples	Learning rate	Iterations	Hidden layers	Momentum	Min. validation error	Validation kappa
1	3,000	0.010	400	7	0.015	0.01902	0.709
2	5,000	0.001	50	5	0.010	0.01887	0.676
3	10,000	0.001	50	5	0.001	0.01890	0.712
4	10,000	0.001	150	5	0.001	0.01747	0.729
5 (selected)	10,000	0.001	300	5	0.001	0.01681	0.736

Training statistics reported by the MOLUSCE ANN module. All models used a 1×1-pixel neighbourhood; Model 5 was used for the projection (Section 2.2.1).

Table S2. Hindcast validation: simulated 2020 (from the 2010 map) vs. observed 2020 map

Simulated \ Observed (ha)	Others	Dense short veg.	Tree	Sparse veg.	Wetland dense short veg.	Open water	Cropland	Built-up	Mangrove	Wetland tree cover	Total
Others	3	0	0	1	8	123	0	22	0	0	158
Dense short veg.	0	2	0	0	2	2	2	28	0	0	37
Tree	0	0	0	0	0	0	0	3	0	0	3
Sparse veg.	1	0	0	2	22	62	0	25	1	0	114
Wetland dense short veg.	13	13	0	10	1,927	1,212	105	1,546	141	149	5,117
Open water	82	5	0	76	1,319	12,674	34	2,004	195	96	16,486
Cropland	0	0	0	0	13	4	10	13	0	0	41
Built-up	12	27	1	8	1,077	932	45	16,716	275	172	19,265
Mangrove	1	2	1	3	309	440	11	417	2,246	102	3,532
Wetland tree cover	0	0	0	0	74	9	2	106	13	93	298
Total	**113**	**50**	**3**	**100**	**4,752**	**15,459**	**210**	**20,880**	**2,870**	**614**	**45,051**

Class	Observed 2020 (ha)	Simulated 2020 (ha)	User's accuracy (%)	Producer's accuracy (%)	F1
Others	113	158	1.9	2.6	0.02
Dense short veg.	50	37	6.3	4.7	0.05
Tree	3	3	2.8	3.6	0.03
Sparse veg.	100	114	1.6	1.8	0.02
Wetland dense short veg.	4,752	5,117	37.7	40.5	0.39
Open water	15,459	16,486	76.9	82.0	0.79
Cropland	210	41	25.6	5.0	0.08
Built-up	20,881	19,265	86.8	80.0	0.83
Mangrove	2,870	3,532	63.6	78.2	0.70
Wetland tree cover	614	298	31.2	15.2	0.20

The model fitted to 2000-2010 transitions was used to simulate 2020, and the result was compared with the observed 2020 map. Quantity and allocation disagreement follow [53]; figure of merit follows [54]. Overall agreement 74.74%; kappa 0.617; quantity disagreement 4.69%; allocation disagreement 20.57%. Change relative to 2010: observed 12,310 ha, simulated 2,805 ha; hits 1,564 ha, wrong hits 609 ha, misses 10,137 ha, false alarms 632 ha; figure of merit 12.1%. Agreement of a no-change (persistence) map: 72.7%.

Table S3. Spatial relationship between habitat quality (HQ) and sediment delivery on habitat pixels

Year	Spearman ρ HQ vs. sediment export	Spearman ρ HQ vs. avoided export	High HQ & high export (ha)	High HQ & low export (ha)	Low HQ & high export (ha)	Low HQ & low export (ha)
2000	-0.66	-0.22	0.6	1,185	365	9,118
2020	-0.64	-0.04	0.1	1,195	166	5,995
2040	-0.60	-0.08	0.2	1,308	66	5,050

Calculated for habitat pixels where both outputs are defined (Section 2.2.4). High HQ: ≥ 0.6. High export: ≥ the 75th percentile of sediment export in the district for that year (0.076, 0.151, and 0.163 t ha^{-1} yr^{-1} in 2000, 2020, and 2040). Pixels on the drainage network (rivers and canals), where the SDR model does not calculate sediment values, are excluded. Both indicators depend on the same land-cover map, so the relationship is partly structural.

Table S4. Sensitivity of SDR results to model parameters (one-at-a-time variation)

Model run	ΔUSLE 2020-2040 (%)	ΔSediment export (%)	ΔDeposition (%)	ΔAvoided export (%)	Sediment export 2020 (t yr^{-1})
Baseline (as in manuscript)	+0.86	+4.28	+0.87	+3.64	5,853
Flow-accumulation threshold 500	+0.85	+3.45	+0.91	+3.37	6,492
Flow-accumulation threshold 2000	+0.84	+4.31	+0.80	+3.50	5,231
k_b = 1	+0.86	+5.82	+1.05	+2.43	1,091
k_b = 3	+0.86	+3.17	+0.80	+3.05	10,921
IC0 = 0.25	+0.86	+4.25	+0.84	+3.73	6,518
IC0 = 0.75	+0.86	+4.30	+0.90	+3.54	5,248
SDRmax = 0.7	+0.86	+4.28	+0.90	+3.50	5,122
Without drainage layer	+1.06	+3.91	+1.09	+3.39	4,934
MFD flow routing	+0.87	+4.29	+0.97	+3.31	4,484
Built-up C = 0.25	-2.49	+0.50	-2.14	+2.82	2,494
Built-up C = 0.75	+2.09	+5.54	+1.95	+3.97	9,787
Water/wetland C = 0.001	+0.83	+4.27	+0.84	+3.62	5,858

Baseline parameters: flow-accumulation threshold 1000 pixels, k_b = 2, IC0 = 0.5, SDRmax = 0.8, D8 routing, drainage layer (derived from the DEM) included, and C factors as in Table 5. Each run changed one parameter; all other inputs were as in Section 2.2.3. Totals were calculated as in Table 10.

Table S5. Sensitivity of Habitat Quality results to model parameters

Model run	Total HQ-ha 2000	2020	2040	Δ 2000-2020 (%)	Δ 2020-2040 (%)	Mean HQ habitat 2000 / 2020 / 2040	High degradation (ha) 2000 / 2020 / 2040	Spearman ρ vs. baseline (2020)
Baseline	4,643	3,613	3,420	-22.2	-5.3	0.376 / 0.415 / 0.448	5,618 / 2,724 / 1,952	1.000
k = 0.5 (InVEST default)	6,558	4,968	4,624	-24.2	-6.9	0.531 / 0.570 / 0.606	5,618 / 2,724 / 1,952	0.999
k = 0.25	2,604	2,060	1,990	-20.9	-3.4	0.211 / 0.236 / 0.261	5,618 / 2,724 / 1,952	0.997
Weights: cropland 0.6, built-up 1.0	3,614	2,674	2,441	-26.0	-8.7	0.292 / 0.307 / 0.320	8,012 / 4,890 / 4,150	0.949
Equal weights (1.0, 1.0)	4,091	3,107	2,892	-24.0	-6.9	0.331 / 0.357 / 0.379	5,920 / 2,866 / 2,098	0.990
Max distances ×0.5	6,149	4,599	4,279	-25.2	-7.0	0.498 / 0.528 / 0.561	2,769 / 1,284 / 864	0.908
Max distances	4,084	3,191	3,006	-21.9	-5.8	0.330 / 0.366 /	6,380 / 3,151 /	0.971

×1.5						0.394	2,322	
Built-up decay linear	4,262	3,364	3,191	-21.1	-5.1	0.345 / 0.386 / 0.418	5,997 / 2,913 / 2,085	0.991
Built-up threat only	2,648	1,816	1,546	-31.4	-14.9	0.214 / 0.209 / 0.203	10,207 / 7,258 / 6,835	0.494

Baseline: k = 0.369; cropland threat weight 1.0, maximum distance 4 km, linear decay; built-up threat weight 0.6, maximum distance 2 km, exponential decay. 'Built-up threat only' sets the cropland weight to near zero. Degradation does not depend on k, so the high-degradation area is identical for the k variants. Each run changed one parameter; values for habitat pixels as in Table 7.

Table S6. LULC transition matrices (ha) for 2000-2020 (observed) and 2020-2040 (scenario)

2000 → 2020 (observed); rows = from, columns = to

From \ To	Mangrove	Wetland tree cover	Wetland dense short veg.	Cropland	Open water	Built-up	Other*	Total 'from'
Mangrove	2,538	157	539	19	838	1,707	16	5,814
Wetland tree cover	16	439	52	5	26	390	0	928
Wetland dense short veg.	92	5	2,584	117	1,091	983	25	4,898
Cropland	3	0	49	18	62	110	4	247
Open water	176	12	1,515	44	13,362	1,922	155	17,187
Built-up	43	0	0	0	0	15,461	0	15,504
Other*	1	0	13	7	79	307	65	472
Total 'to'	**2,870**	**614**	**4,752**	**210**	**15,459**	**20,881**	**266**	**45,051**

2020 → 2040 (scenario); rows = from, columns = to

From \ To	Mangrove	Wetland tree cover	Wetland dense short veg.	Cropland	Open water	Built-up	Other*	Total 'from'
Mangrove	2,603	0	0	0	20	247	0	2,870
Wetland tree cover	0	200	63	0	200	150	0	614
Wetland dense short veg.	0	0	4,391	0	120	241	0	4,752
Cropland	0	0	79	75	38	18	0	210
Open water	0	0	4	0	15,126	329	0	15,459
Built-up	0	0	0	0	0	20,881	0	20,881
Other*	0	0	54	0	33	22	157	266
Total 'to'	**2,603**	**200**	**4,592**	**75**	**15,537**	**21,888**	**157**	**45,051**

*Other small classes: others, dense short vegetation, tree, and sparse vegetation (each < 1% of the district). Values are rounded to whole hectares. Rows show the class in the earlier year and columns the class in the later year; diagonal cells are unchanged area.