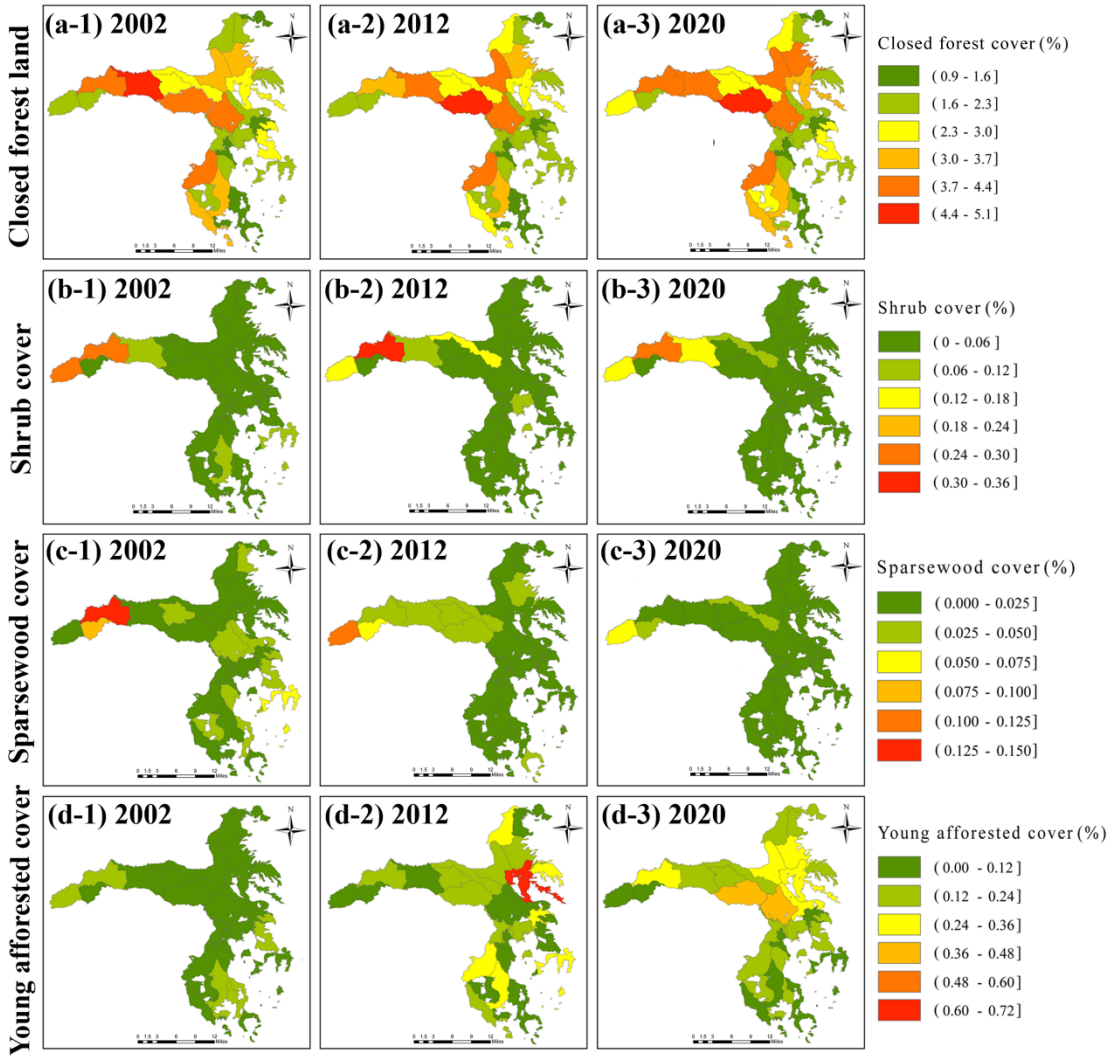
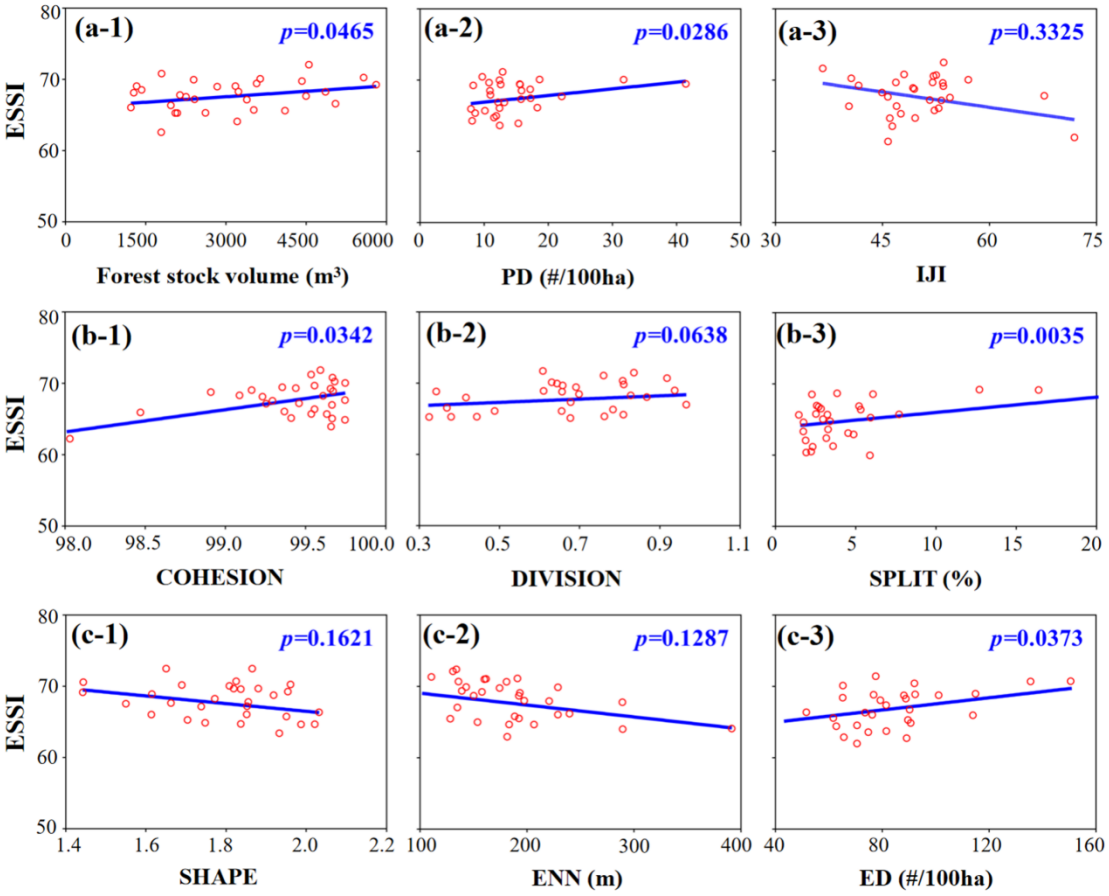
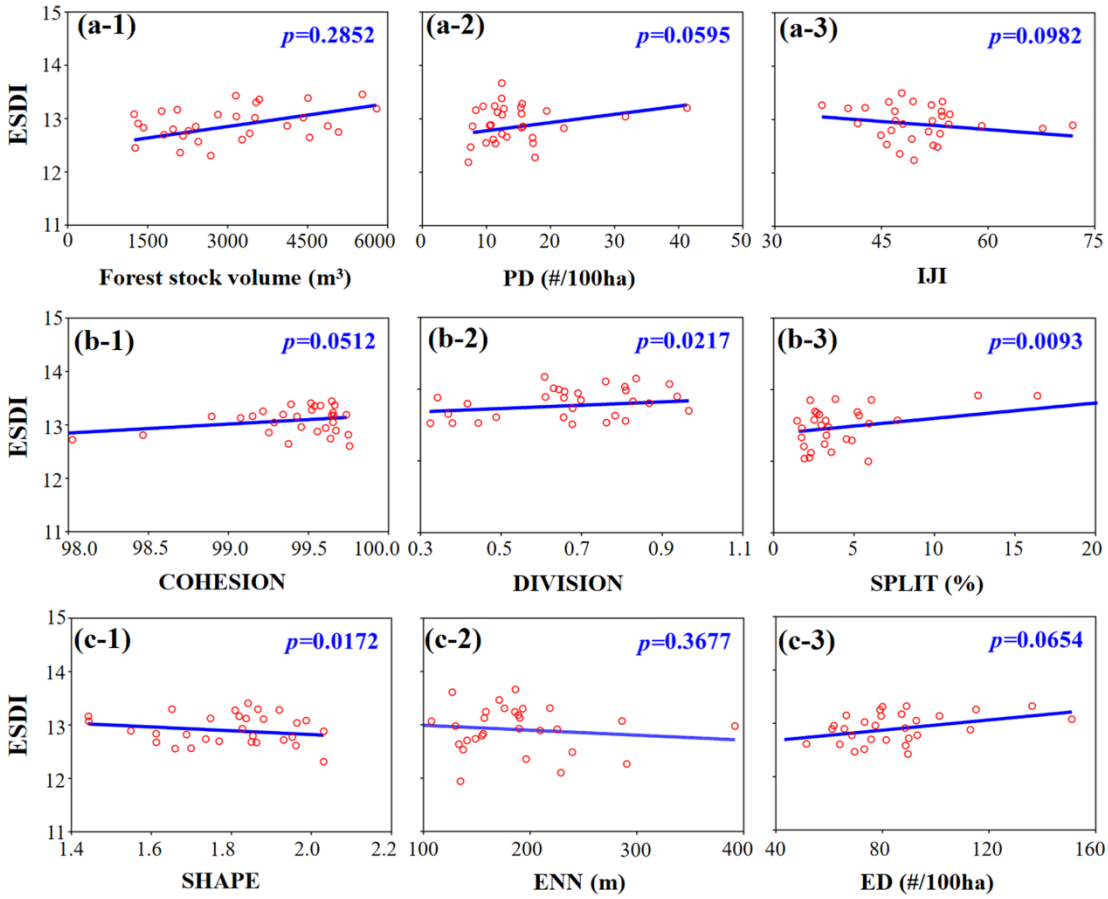
Supplementary materials



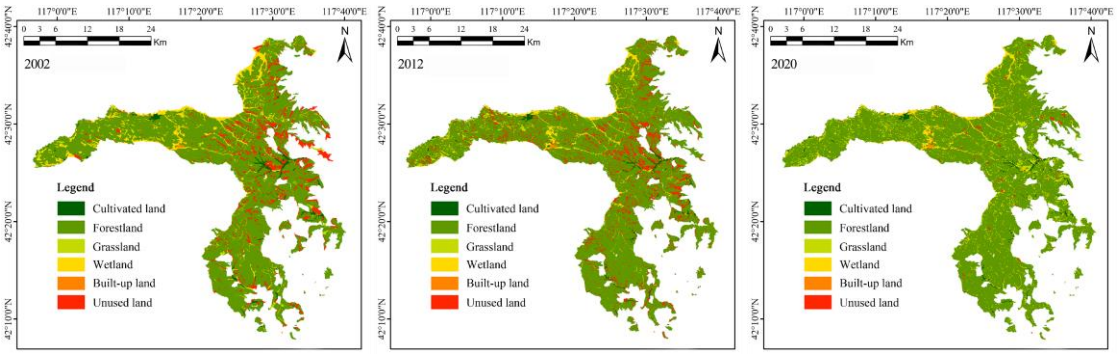
Supplementary Figure S1 Spatial patterns of different forest types in the Saihanba for 2002, 2012, and 2020.



Supplementary Figure S2. Correlations between the ESSI, forest stock volume and landscape, metrics.



Supplementary Figure S3. Correlations between the ESDI, forest stock volume and landscape metrics.



Supplementary Figure S4. LUCC maps in Saihanba for 2002, 2012, and 2020.

Supplementary Table S1 Characteristics of primary and secondary classification system of the LUCC classifications.

Primary types	Secondary types	Explanations
Cultivated land	Arid land	The cultivated land that lacks an irrigation water source and facilities, relying on natural water to grow crops.
Forestland	Closed forest land	Natural and artificial forests with crown density above 30%, including timber, economic, and protective forests, etc.
	Shrub land	Bushes with a crown density higher than 30% and less than 2 m in height.
	Sparsewood land	Natural and artificial forests with crown densities of forests between 10% and 30%
	Young afforested land	Land that has been afforested for less than 3-5 a or less than 7-10 a after fly-seeding.
	Cut-over land	Land that has not been replanted with trees after forest harvesting or fire.
Grassland	Highly covered grassland	Natural, improved or mowed grasslands with more than 50% cover, which generally have better moisture conditions
	Moderately covered grassland	Natural or improved grasslands with a cover of between 20% and 50%, which typically have insufficient moisture conditions.
	Low covered grassland	Natural grasslands with a cover between 5% and 20% have a poor utilization value for grazing.
Wetland	River	Natural or artificially excavated rivers.
	Lakes	Natural waterlogged areas.
	Swampland	Muddy areas that are subject to prolonged waterlogging.
Built-up land	Urban construction land	Land in the built-up areas of large, medium, and small cities, as well as at county and town levels.
	Rural settlements	Rural settlements that are independent of urban areas.
	Others	Land for factories, mines, and industrial zones etc.
Unused land	Bare soil	Land with less than 5% surface soil cover and less than 5% vegetation cover.
	Bare rock	Land covered by rock or gravel with an area of more than 5%.

Supplementary Table S2 The selected typical landscape indicators of Saihanba.

Landscape indexes	Level	Formulas	Descriptions
Patch density (PD)	Class/Landscape	$\mathrm{PD} = \frac{N}{A}$	N: total number of patches in the landscape A: total landscape area
Interspersion juxtaposition index (IJI)	Class/Landscape	$\mathrm{IJI} = \frac{-\sum_{k=1}^{m}\left[\frac{e_{ik}}{\sum_{k=1}^{m} e_{ik}} \ln\left(\frac{e_{ik}}{\sum_{k=1}^{m} e_{ik}}\right)\right]}{\ln(m-1)} \times 100\%$	e_{ik}: total length of the edges between patch types i and k. m: number of patch types
Patch cohesion index (COHESION)	Class/Landscape	$\mathrm{COHESION} = \left[1 - \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} p_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n} P_{ij}\sqrt{a_{ij}}}\right] \times \left[1 - \frac{1}{\sqrt{A}}\right]^{-1} \times 100$	a^{ij}: area of patch ij p^{ij}: perimeter of patch ij
Landscape division index (DIVISION)	Class/Landscape	$\mathrm{DIVISION} = 1 - \sum_{i=1}^{m}\sum_{j=1}^{n}\left(\frac{a_{ij}}{A}\right)$	a^{ij}: area of patch ij A: total landscape area
Splitting index (SPLIT)	Class/Landscape	$\mathrm{SPLIT} = \frac{A^2}{\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij}^2}$	a^{ij}: area of patch ij A: total landscape area
Shape index (SHAPE)	Patch	$\mathrm{SHAPE} = \frac{0.25 p_{ij}}{\sqrt{a_{ij}}}$	a^{ij}: area of patch ij p^{ij}: perimeter of patch ij
Euclidean nearest neighbor distance (ENN)	Patch	$\mathrm{ENN} = h_{ij}$	h_{ij}: distance between patch ij and the nearest neighboring patch of the same class.
Edge density (ED)	Class/Landscape	$\mathrm{ED} = \frac{E}{A} \times 10^{-6}$	E: total length of the edge in the landscape

Supplementary Table S3 Rationales and potential indicators of ecosystem services

ES type	Title	Rationales	Potential indicators
Regulating service	Local climate regulation	Changes in land cover can have an impact on local temperature, wind, radiation, and precipitation.	Temperature, precipitation, wind; temperature amplitudes; evapotranspiration
	Air quality regulation	The capacity of ecosystems to remove heavy metals, pathogens, and other hazardous substances from the atmosphere.	Leaf surface microstructural indexes; TSP; $PM_{2.5}$; PM_{10}
	Water source regulation	Ecosystem can effectively redistribute precipitation through the forest canopy, litter, and soil layer, thereby acting as a regulator for the water storage and runoff.	Precipitation; forest canopy interception rate; forest canopy density
	Water purification	The ecosystem can not only purify water but may also negatively impact its quality.	Quality of water
	Erosion regulation	Vegetation is critical for soil conservation and the prevention of landslides.	Soil erosion caused by wind or water; vegetation coverage
	Pollination	Changes in ecosystems affect not only the distribution, abundance, and effectiveness of pollinators, but also the direction and power of wind, which can affect wind-borne plant pollination.	Reproduction of plants; Efficiency of pollination
	Control of pests and diseases	Alterations in vegetation cover, temperature, and moisture can directly affect the population dynamics of pests and their natural enemies and could also have effects in the spread rate of pathogens/viruses.	Infection rate; spread rate; control effect; reduction in biomass; insect population density; lesion size
	Forest carbon sinks	Plants can absorb CO_2 from the atmosphere and sequester it within themselves or in the soil, thereby reducing the concentration of greenhouse gas of the environment.	Forest cover; forest stock; forest vegetation carbon stock
Providing service	Crops and fodder	Cultivation of edible plants for human and animals, respectively.	Plants biomass/ha; kJ/ha
	Wild foods	Harvest of wild plants such as berries and mushrooms.	Plants biomass/ha; kJ/ha
	Biochemicals and medicine	Production of biochemicals or medicines (Some plants can be used as natural medicines such as *Rhodiola Rosea*, *Trollius chinensis*-etc.).	Types or yield of products; PCs/ha or kg/ha
	Freshwater	Presence of freshwater.	Liters or m^3/ha
	Timber, wood fuel, and energy(biomass)	Trees or plants with a potential use for wood, fuel, and energy	Biomass of wood or plant /ha; kJ/ha
Cultural service	Forest health recreation	Specific to the landscape and visual quality of the study area	Number of tourists and facilities; questionnaires based on personal preferences
	Ecological civilization education	The forest landscape is used to educate ecological civilization and raise human awareness of protecting the ecological environment.	Number of visitors and educational bases.

Table S4 Assessment of GWR for 2002, 2012, and 2020 in SHB.

Year	Indicators	OLS	GWR
2002	AICc	232.834	188.436
	R^2	1.822	0.518
2012	AICc	235.352	192.815
	R^2	1.560	0.933
2020	AICc	158.382	176.700
	R^2	0.428	0.454

Notes: OLS and GWR represent ordinary least squares and geographically weighted regression, respectively.

Table S5 The spatial proportion of the driving factors influencing Saihanba's ES balance in 2002, 2012, and 2020.

	Operational area with positive GWR coefficient (%)		
Independent variables	2002	2012	2020
Stand Volume	0.00	50.00	100.00
PD	0.00	100.00	100.00
IJI	100.00	100.00	100.00
COHESION	0.00	6.67	0.00
DIVISION	0.00	20.00	100.00
SPLIT	0.00	0.00	100.00
SHAPE	0.00	0.00	100.00
ENN	0.00	70.00	100.00
ED	100.00	0.00	56.67