Supplemental Material

S1. Summary of in-situ data

Transects and sample quadrats design

We constructed the species-area relationship by using the nest pattern method to continuously expand the sample area. Among them, the determination standard of the minimum sample area is when the sample area increases by 10% while the number of species increases by no more than 10%. After field investigation and calculation, it is determined that the size of forest quadrat in the study area is 10m×10m and the size of abandoned quadrat is 5m×5m.

Soil data sampling methods

Sampling points were selected according to the principles of "randomness", "uniformity" and "multi-point mixing", using "S" shaped sampling points, which not only avoided subjective error, but also improved the representativeness of soil samples, and avoided the possibility of moving along a certain direction due to cultivation, fertilization, and other operations. According to the cultivation depth of the sample plot and the characteristics of the growing community, the sampling depth is generally 20cm. The depth and weight of soil and the ratio of upper and lower layers of soil should be uniform at each sampling site. Soil samples to take about 1kg is appropriate, such as too much, can be eliminated by four points. The collected samples are packed in ziplocks with labels indicating sampling place, date, number, and sampling person. At the same time, sampling records and photos should be taken.

Plant survey method

The plant data were collected by using the field vegetation survey method combined with the Franco-Swiss school and the Anglo-American school. The height and basal diameter of vegetation in herb and shrub layers were measured by tape measure, and the height of individual natural state of Yunnan pine was measured by visual method, and the average value was estimated by several people. Measure DBH of individual tree layer with DBH ruler. The total coverage of each quadrat was estimated by multiple people on average, and the species, number of plants, DBH, height and coverage of plants in tree layer and the species, number of plants, height and coverage of plants in shrub layer and herb layer were recorded in each quadrat. At the same time, we observed the difference of plant distribution in vegetation layer and disturbance mode in two plots with different years of returning to farmland.

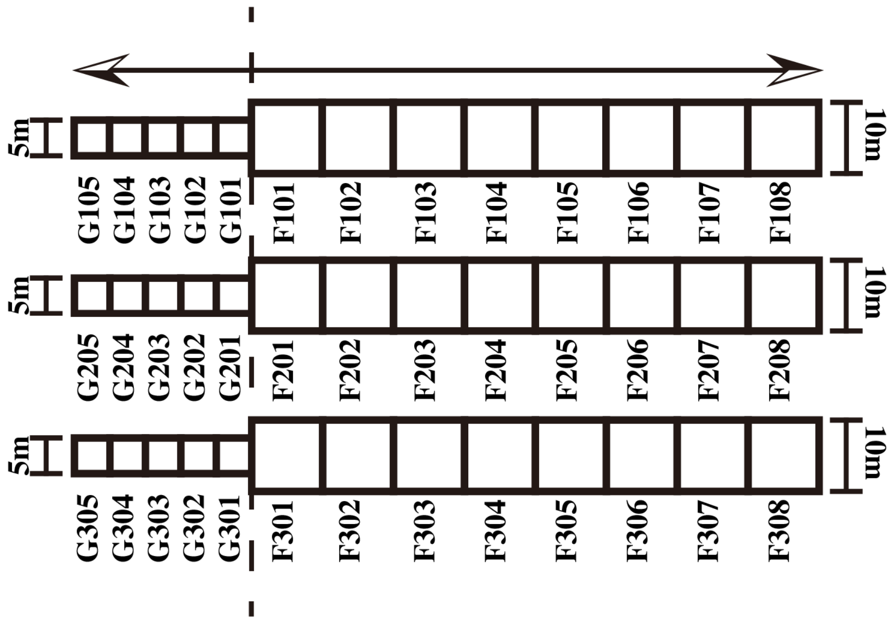

Figure S1. The pattern of the three transects set, and the labels of the quadrats within the transect, correspond to the Quadrat ID in Table S1.

Table S1. A summary of field investigation data, including the importance value of vegetation community (IV), pondus Hydrogenii value of soil (pH), organic matter content of soil (OM). We use ‘type + the order of transect + the count of quadrats’ form to denote the quadrat ID (e.g., A101 denotes the first quadrat starting from the margin of forest in the first transect at abandoned land; refer to the Fig. S1).

Quadrat ID	IV	PH	OM
G105	7.037272	6.13	26.2767
G104	8.077483	6.23	23.9676
G103	9.018211	6.17	19.6596
G102	7.255649	6.14	29.8656
G101	10.250000	5.8	17.4703
F101	4.673810	5.863	21.4447
F102	4.736803	5.6	26.2623
F103	4.432715	5.65	27.4632
F104	5.291915	6	25.1658
F105	6.572740	5.82	20.6571
F106	5.759040	5.87	22.4827
F107	5.555540	5.62	32.1375
F108	5.476267	5.42	46.0166
G205	7.327929	6.02	27.2727
G204	7.057649	6	30.1043
G203	8.241515	6.33	27.7592
G202	6.858090	6.2	24.7429
G201	8.207165	6.19	28.5183
F201	5.129980	5.76	40.5941

F202	5.039310	5.5	58.5131
F203	4.983112	5.91	51.3142
F204	4.503228	5.65	36.9662
F205	4.576935	5.85	54.3416
F206	5.388480	5.7	37.547
F207	4.166675	5.49	39.9661
F208	5.058309	5.58	47.9264
G305	7.382650	6.23	30.5598
G304	7.132546	6.1	29.3195
G303	9.135767	6.12	28.6489
G302	7.260363	6.04	30.8491
G301	7.880058	6.1	31.4891
F301	5.293718	6.07	40.6983
F302	4.391637	6.45	46.4566
F303	5.566288	5.73	41.7965287
F304	5.135773	5.35	35.4635317
F305	5.510915	5.39	35.0953
F306	5.178179	5.62	40.9455
F307	5.106776	5.6	45.0534949
F308	5.144768	5.44	42.9382

S2 Some addition to the object-based image classification

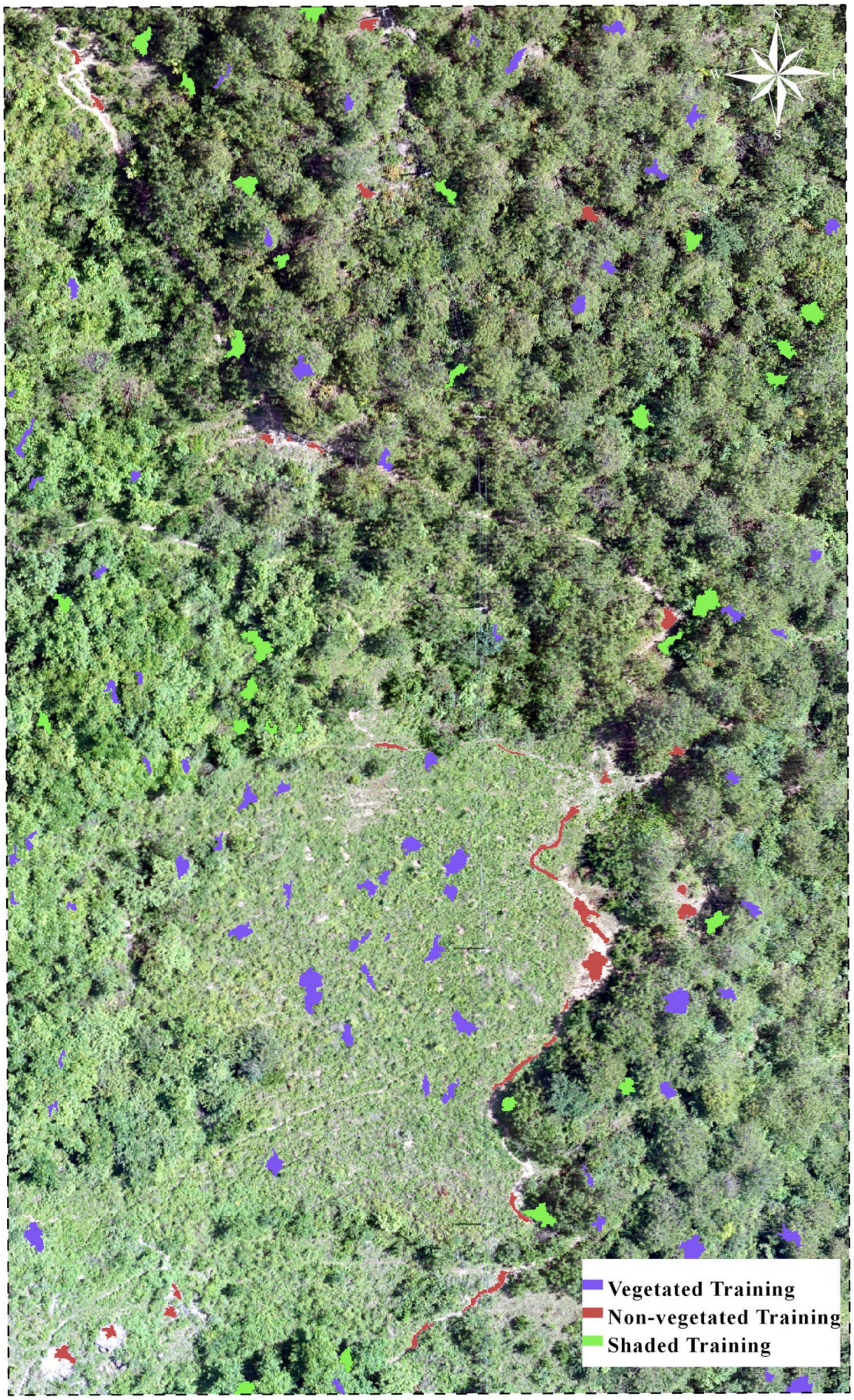

Figure S2. A set of training samples for training RF classifiers. All training samples are added to the classifier in the form of objects. Combined with field survey data and visual inspection, and a total of 138 training sample points are obtained which are 30 shaded, 38 non-vegetated, and 70 vegetated.

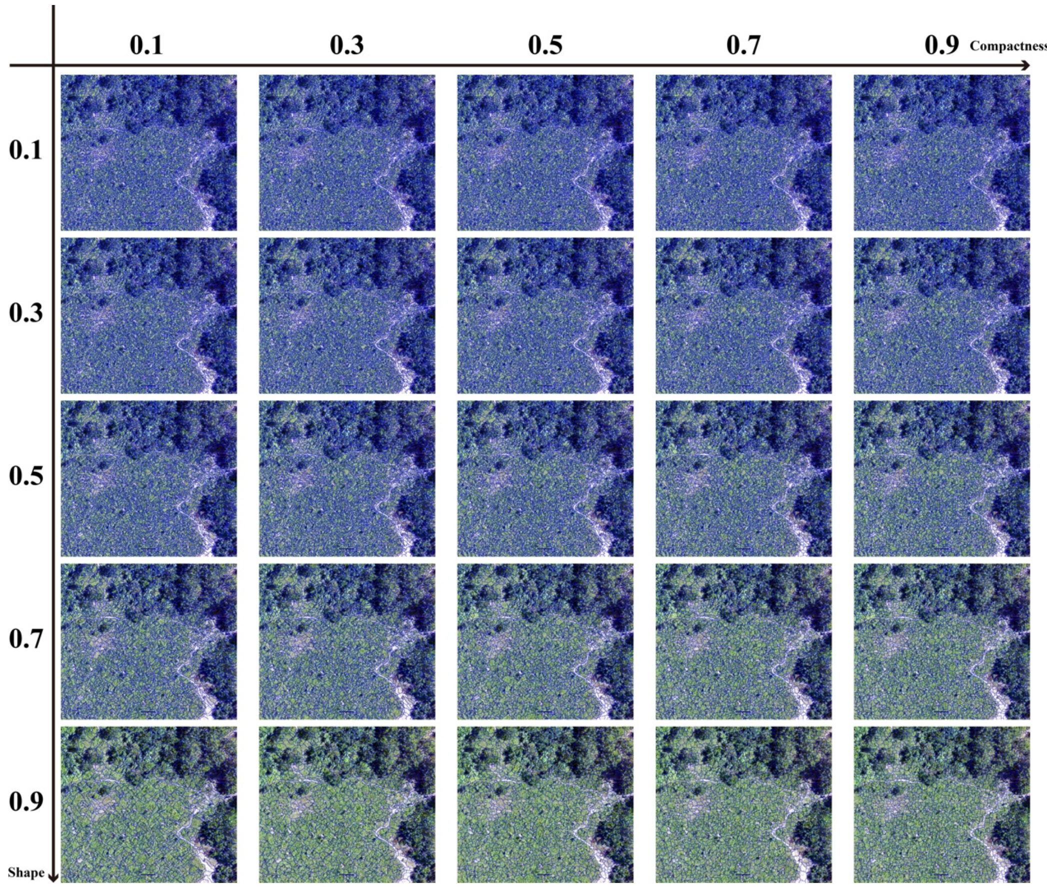

Figure S3. When the scale of segmentation is 10, one of the variables of shape and compactness is controlled to filter the appropriate parameter settings. Through manual inspection, we determined that the best shape is 0.5 and the compactness is 0.5.

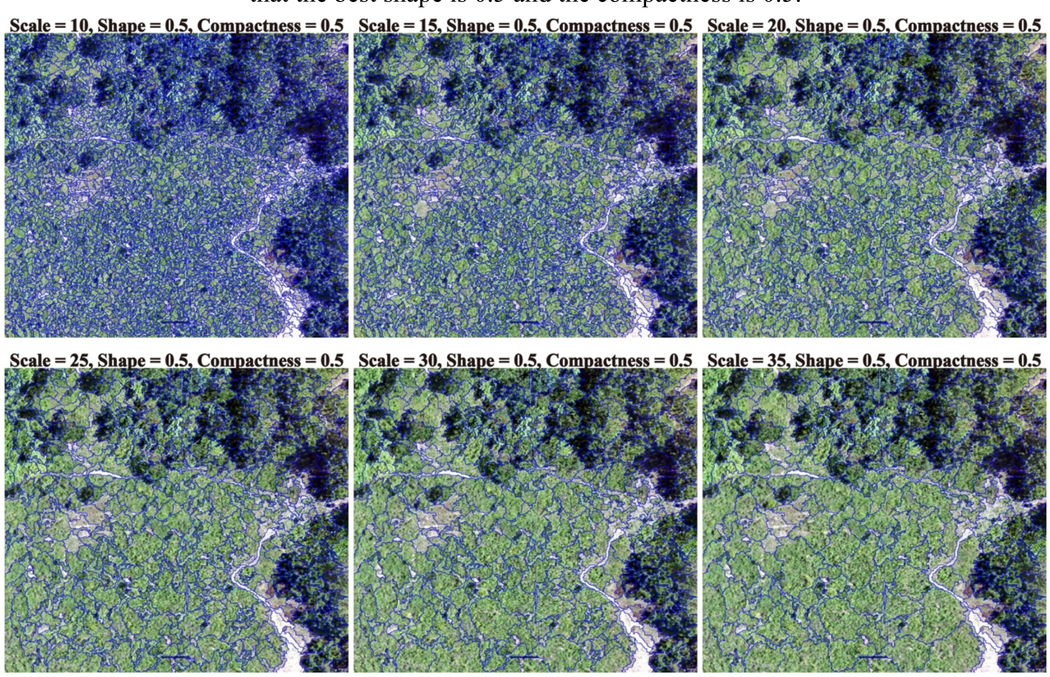

Figure S4. Controls the shape and compactness and changes the scale of segmentation. Through manual inspection, the segmentation effect is the best when the scale is 20, and less under-segmentation occurs.

S3. Geostatistical modeling

Five major geostatistical models are used. They are, Empirical Bayesian Kriging (EBK), Ordinary Kriging (OK), Simple Kriging (SK), Universal Kriging (UK), Disjunctive Kriging (DK). In order to determine the most optimal model for the prediction of unknown terrain changes, we conducted statistical modeling based on the same training data set and the optimal schemes of the respective models. Before modeling, the training samples are declustered, detrended (first order) and processed based on normal score conversion. The geostatistical wizard in ArcGIS Pro is used to complete the modeling work of the above five models. The results of prediction and cross validation provide support for selecting the most optimal model (Figure S2; Table S2).

The most optimal model is selected through comparing the statistical indicators (Table S2). The EBK is selected as the model adopted base on two standards which are the unbiasedness of prediction and the uncertainty of prediction. Unbiasedness is screened by the Mean Standardized Error (MSE). The closer the MSE is to 0, the closer it is to the true value. The uncertainty evaluation is mainly based on the difference between the Average Standard Error (ASE) and the Root-Mean-Square Error (RMSE). The closer the difference approaches zero, the better the prediction of terrain variation. On the whole, the ASE of each model are less than the RMSE, which reflects that all the models underestimate the terrain variation.

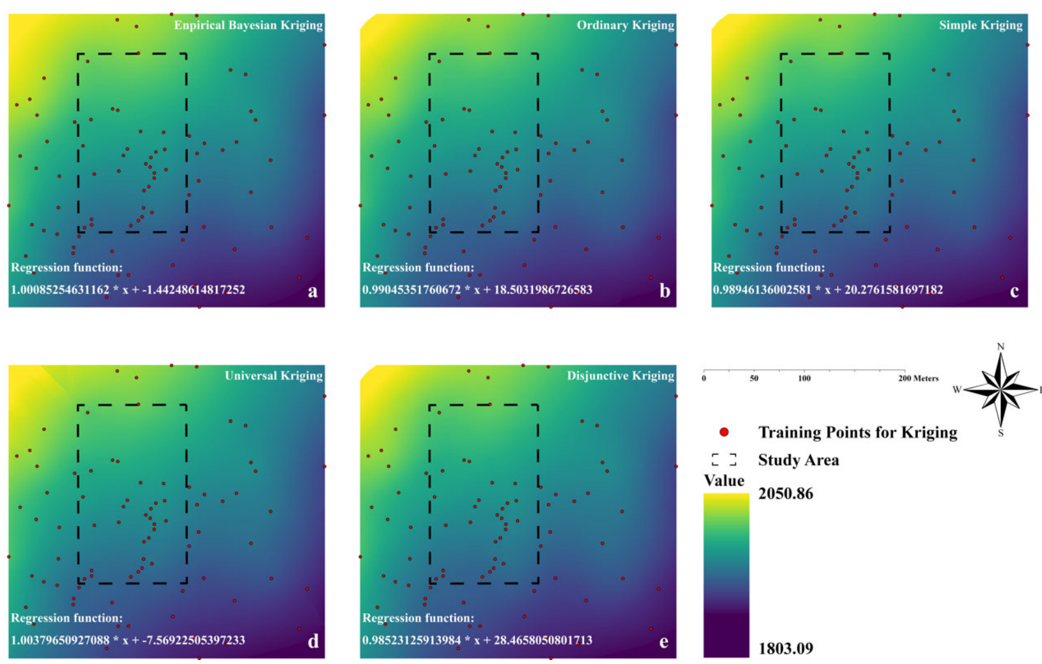

Figure S5. Topographic prediction results based on five different geostatistical models.

Table S2. Summary of cross validation results

Indicators	EBK	OK	SK	UK	DK
Count	82	82	82	82	82
Mean Error	0.1181	-0.2200	-0.3398	0.2565	-0.2712
Root-Mean-Square Error	4.9085	6.0977	6.2003	4.3335	5.9051
Mean Standardized Error	0.0074	-0.0399	-0.0671	0.0721	-0.0382

Root-Mean-Square Standardized Error	0.8379	1.4003	1.5400	1.1795	1.7238
Average Standard Error	4.3618	3.0172	2.9802	3.1348	2.2528

S4 Landscape metrics selection

Table S3. Four indices used to quantify the characteristics of the ecotones in the landscape.

Landscape metrics	Description	Formula
Total Area (TA) (m^2)	That is, total area of a class.	$TA = \sum_{j=1}^{n} a_{ij}$
Percentage of Landscape (PLAND) (%)	It equals the percentage the landscape comprised of the corresponding patch type.	$PLAND = \frac{\sum_{j=1}^{n} a_{ij}}{A} * (100)$
Total Edge (TE) (m)	It equals the sum of the lengths of all edge segments involving the corresponding class.	$TE = \sum_{k=1}^{m} e_{ik}$
Shape Index (SI)	The shape index is an indicator of the shape complexity of the corresponding class.	$SI = \frac{0.25 * P_{ij}}{\sqrt{a_{ij}}}$

i denotes the class ***i***, ***j*** denotes the patch ***j*** within the class ***i***. a_{ij} denotes the area of patch ***j*** within class ***i***. The ***A*** equals the total area of the landscape. e_{ik} denotes the edge length of ***k*** within the class ***i***. The P_{ij} equals the perimeter of the patch ***j*** within the class ***i***. A series of metrics at CLASS level selected are referred from the FRAGSTATS v4 (McGarigal et al., 2012).

Reference

McGarigal, K., Cushman, S. A., & Ene, E. (2012) FRAGSTATS v4: Spatial Pattern Analysis Program for Categorical and Continuous Maps. Computer software program produced by the authors at the University of Massachusetts, Amherst. Available at the following web site: http://www.umass.edu/landeco/research/fragstats/fragstats.html