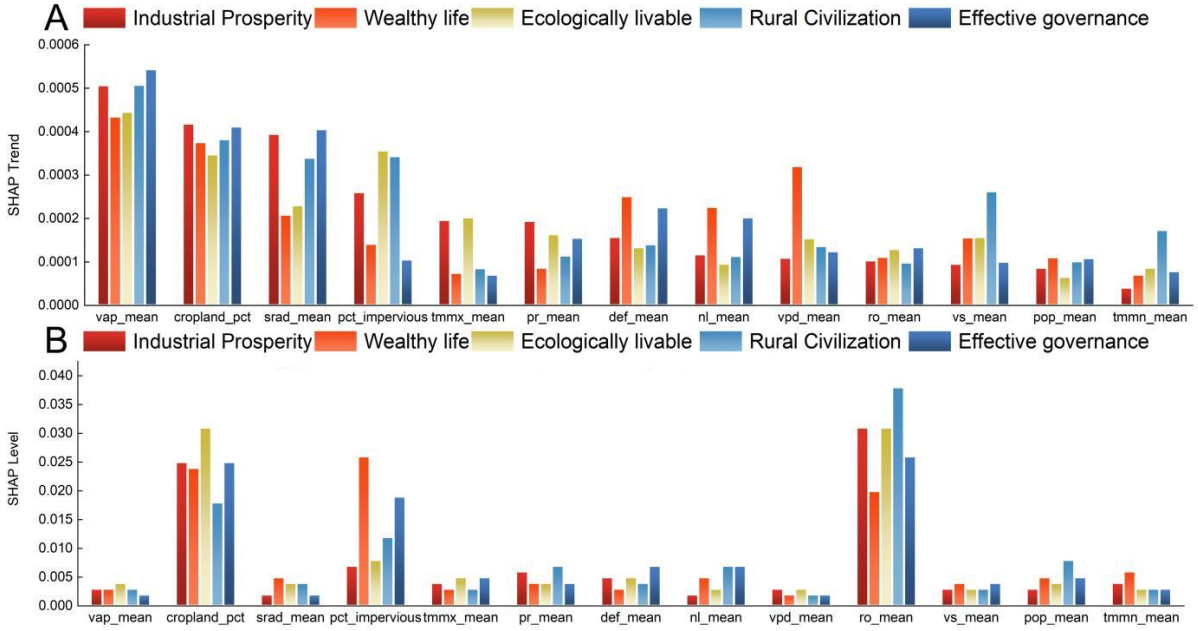
Supplementary Information

for

Functional village types shape divergent rural ecological resilience trajectories in the Yangtze River Delta

Supplementary Fig. S1. Comparison of SHAP importance across the five functional village types for the trend model (A) and the level model (B). Bars represent the mean SHAP values of key predictors in each village type.



Supplementary Table S1. Functional types and village designations.

Type (functional village type)	Village designations
industrial-prosperity villages (IP villages)	National Model Villages and Towns for Local Specialty Products National Key Rural Tourism Villages National Scenic Tourism Villages
ecologically livable villages (EL villages)	National Forest Villages China's Most Attractive Leisure Villages China's Beautiful Leisure Villages Top 100 Beautiful Villages in China Model Beautiful and Livable Villages
rural-civilization villages (RC villages)	Traditional Villages of China Historic and Culturally Significant Villages of China National Civilised Villages and Towns
effective-governance villages (EG villages)	National Model Villages for Rural Governance National Model Villages for Democracy and Rule of Law
wealthy-life villages (WL villages)	National Model Villages with Billion-Yuan Specialty Industries Taobao Villages

Supplementary Table S2. Predictive performance of type-specific XGBoost models (20% held-out validation set).

Functional type (abbr.)	Mode	N (clean)	Train	Test	RMSE	MAE	R^2

Industrial Prosperity (IP)	Level	715	572	143	0.022049	0.015429	0.909099
Industrial Prosperity (IP)	Trend	712	569	143	0.001358	0.001009	0.445511
Ecological Livability (EL)	Level	1090	872	218	0.027351	0.016290	0.884180
Ecological Livability (EL)	Trend	1088	870	218	0.001214	0.000903	0.665450
Rural Civilization (RC)	Level	1839	1471	368	0.024531	0.017045	0.919811
Rural Civilization (RC)	Trend	1837	1469	368	0.001116	0.000841	0.708941
Effective Governance (EG)	Level	767	613	154	0.025675	0.017181	0.897847
Effective Governance (EG)	Trend	766	612	154	0.001392	0.000939	0.520831
Wealthy Life (WL)	Level	962	769	193	0.025099	0.018162	0.880726
Wealthy Life (WL)	Trend	959	767	192	0.001157	0.000875	0.589636

Supplementary Table S3. Ecological resilience indicator framework.

System level	Criterion level	Primary indicator	Secondary indicator
Ecological resilience	Resistance	Ecosystem services	Water yield
Ecological resilience	Resistance	Ecosystem services	Soil retention
Ecological resilience	Resistance	Ecosystem services	Carbon storage
Ecological resilience	Resistance	Ecosystem services	Habitat quality
Ecological resilience	Adaptability	Topographic exposure and landscape structure	Elevation
Ecological resilience	Adaptability	Topographic exposure and landscape structure	Slope
Ecological resilience	Adaptability	Topographic exposure and landscape structure	SHDI
Ecological resilience	Adaptability	Topographic exposure and landscape structure	SHEI
Ecological resilience	Adaptability	Topographic exposure and landscape structure	LPI
Ecological resilience	Recovery	NDVI	Normalised Difference Vegetation Index (NDVI)
Ecological resilience	Recovery	Vegetation cover	Green-area ratio (GR)
Ecological resilience	Recovery	Water area ratio	Water-area ratio (WR)

Supplementary Table S4. Mann–Kendall trend categories for ERI.

Sen slope condition	Mann–Kendall Z statistic	Trend category
$\beta > 0$	$\lvert Z\rvert > 1.96$	Significant increase
$\beta > 0$	$\lvert Z\rvert \le 1.96$	Slight increase (non-significant)
$\lvert\beta\rvert \le 0.001$	$\lvert Z\rvert \le 1.96$	Stable (no significant trend)
$\beta < 0$	$\lvert Z\rvert \le 1.96$	Slight decrease (non-significant)
$\beta < 0$	$\lvert Z\rvert > 1.96$	Significant decrease