Supplementary Materials

1 Detailed description on the LUF quantification of this research

1.1 Provision of work

In this study, provision of work (PW) was used to describe the utilization of natural resources (agriculture) to support employment. PW indicates the number of agricultural employments provided for each grid. The main category involved in PW is cropland for agricultural production. Agricultural output was closely related with agricultural labor, and net primary productivity (NPP) was widely considered to represent the productivity of agricultural ecosystems (Peng *et al.*, 2017). Therefore, agricultural statistical yearbook data, cropland data, and NPP data were applied to spatially quantify PW. Owing to imbalances in agricultural production and employment intensity among different counties along the Jiangsu coast, we calculated the average agricultural employment density in each county by dividing the total agricultural employment-population by the total cropland. The area of cropland in each grid was then multiplied by the average agricultural employment density. Lastly, to account for spatial differences in agricultural employment population distributions in cropland with diversified productivity gradients, we used NPP data to modify the spatial distribution of PW. The detailed valuation formula is as follows (1):

$$PW_i = \frac{POP_x}{A_x} \times A_i \times \left(\frac{\mathrm{NPP_i}}{\mathrm{NPP_x}} + 1\right) \qquad (1)$$

Here, PW_i represents the agricultural employees of grid i. POP_x denotes the population of the primary industry for county x. A_x and A_i are the areas of agricultural land for county x and grid i, respectively. $\mathrm{NPP_x}$ and $\mathrm{NPP_i}$ are the net primary productivities of county x and grid i, respectively. The population of the primary industry for each county was obtained from the statistical yearbooks for Lianyungang, Yancheng, Nantong, which were downloaded from the China National Knowledge Infrastructure (CNKI, https://www.cnki.net/). The land use data for 2000, 2010, and 2018 were obtained from the Resource and Environmental Science Data Center (http://www.resdc.cn). The NPP data were calculated using the CASA model, and details are shown in the CR calculation portion.

1.2 Recreation

Recreation is defined as the regional potential for entertaining people, which is expressed by the influence of local natural and recreational attractions(Xu *et al.*, 2017). RE was comprehensively estimated according to the grade of the attraction and the distance from the attraction. According to the standards for rating the quality of tourist attractions in China, ordinal values of 9, 7, 5, and 3 were assigned to 5A-, 4A-, 3A-, and 2A-grade scenic spots. Ordinal values of 9, 7, 5, 3, and 1 were assigned to buffer areas with distances of 0 – 1 km, 1 – 5 km, 5 – 10 km, 10 – 20 km, and > 20 km from the tourist attractions(Xu *et al.*, 2017). Lists of tourist attractions are publicly available on city-level culture and tourism websites, and their positions are determined according to the Baidu Map API system

(http://api.map.baidu.com/lbsapi/getpoint/). We converted coordinate points into vector data to create multi-distance buffers and assigned values to different buffers according to the above rules. Using an overlay tool, RE maps were generated by summing all the assigned maps of the scenic spots (2000, 2010, 2018). Finally, the RE maps were converted into a grid format with a grid size of 1 km × 1 km. All steps were performed using ArcGIS 10.5 (Esri, 2017).

1.3 Culture

Culture (CU) referred to the pleasant experience provided by landscapes (Yu *et al.*, 2019). CU meant non-material benefit that is hard to estimate (Graves *et al.*, 2017). Therefore, Therefore, we must establish uniform evaluation criteria to ensure that CU is comparable across landscapes.In this study, the method for assessing the value equivalent factor in unit area was used to quantify CU economic values (Graves *et al.*, 2017). This method first provides the value equivalents of various services for different ecosystems through quantifiable standards and then assesses the economic value of such services combined with the ecosystem in the area (Costanza *et al.*, 1997). CU evaluation primarily involves an integrated method for dynamic evaluation of the Chinese terrestrial ES, which combined the actual agricultural development over time (Xie *et al.*, 2015). Firstly, we collected the sown area and averaged the profit per unit area of rice, wheat, and corn to calculate the value of a standard unit ES value equivalent factor using Formula (2)(Xie *et al.*, 2015). In order to ensure that the CU economic value could be compared over time, the average profit per unit area was considered the comparable value (Year of 1952=100). Then, we extracted the land categories with the CU values (cropland, grassland, forest, water bodies, and wetland) from the land use data and determined the areas in each geographic grid. Finally, the spatial distribution of CU was corrected by regional grain yield indicators and equivalent factors using Formula (3) (Graves *et al.*, 2017).

$$D = \frac{1}{7} \times (S_r \times F_r + S_w \times F_w + S_c \times F_c) \qquad (2)$$

$$CU_i = \frac{1}{7} \times \sum_{j=1}^{5} A_{ij} \times U_i \times D \times k \qquad (3)$$

Where CU_i is the total values for landscape aesthetics of grid i (Year of 1952 = 100), A_{xj} is area of j land-use types (cropland, grassland, forest, water bodies, and wetland) in grid i, U_i is the equivalent factor (Gaodi, 2015). k is corrected factor, which equal, the ratio of grain yield per unit area in national- and city-levels, D_y is economic value of a standard unit ES value equivalent factor, S_r, S_w and S_c are the sown area proportion of rice, wheat, and corn, respectively, F_r, F_w, and F_c are the average net profit per unit area of rice, wheat, and corn in study area (1,952 = 100), respectively. Agricultural data were obtained from Statistical Yearbook in Lianyungang, Yancheng, Nantong, and "Compilation of national agricultural product cost benefit information", downloaded from CNKI (https://www.cnki.net/).

Table 2 Landscape Aesthetics equivalent value per unit area

Land use type	cropland	forest	grassland	wetland	water body
Value	0.06	1.06	0.56	4.73	1.89

1.4 Residential carrier& Economic support

Residential carrier (RC) refers to the provision of space for living, which is closely associated with population distribution (Liu *et al.*, 2018;Peng *et al.*, 2017). Economic support (ES) indicates the economic value generated by irreversible land use; therefore, build-up land (i.e., residential land and construction land mainly for mining and transportation) can provide ES (Liu *et al.*, 2018). Night lighting satellite data can sensitively detect the low-intensity lights emitted by small-scale residential lights, city lights, fires, and even traffic-produced light, which can comprehensively characterize the population distribution and economic activity (Henderson *et al.*, 2012). Therefore, the spatial modeling of RC and ES in this study combined the statistical, night light, and corresponding land-use data.

As for the RC, the total population of each county was allocated to the residential units according to the nighttime light intensity variation by the following equations:

$$RC_x = \frac{POP_j}{RA_j} \times RA_i \times \left(1 + \frac{RNL_i}{RNL_j}\right) \qquad (4)$$

Where RC_x is population of grid i (Person). POP_j is population of county j. RA_i and RA_j are the area of residential land in grid i and county j. NL_i and NL_j are nighttime light value of residential land in grid i and county j, respectively.

As for the ES, the non-agricultural economic output values of each county were allocated to the build-up land units according to the nighttime light intensity variation by the following equations:

$$ES_i = \frac{GDP_{2j} + GDP_{3j}}{NL_j} \times NL_i \qquad (5)$$

Where ES_i is non-agricultural economic output of grid i. GDP_{2j} and GDP_{3j} are the comparable output values of second and third industry for county j (Comparable value calculated based on the GDP of the corresponding industry in 1952). NL_i and NL_j are nighttime light value of residential land in grid i and county j, respectively.

The total population and output values of the second and third industry of each county were from the statistical yearbook in Lianyungang, Yancheng, Nantong that downloaded from CNKI (https://www.cnki.net/). The urban, rural settlements and construction land were extracted from land use data. The nightlight data came from DMSP/OLS (2000,2010) and NPP/VIIRS (2018) that were downloaded from National Centers for Environmental Information (NOAA, https://ngdc.noaa.gov/eog/download.html).

1.5 Food production

FP is the primary output of land for agricultural production activities, which implies that the terrestrial and freshwater ecosystems produced the desired products, which is a key function to fulfill basic human needs and guarantee food security (Liu *et al.*, 2018). Previous studies have aimed to quantify FP through food yields and economic value, but only few have focused on the output of nutrition for different foods (Peng *et al.*, 2017;Shen *et al.*, 2020;Yu *et al.*, 2019). Therefore, our research was based on the perspective of nutritional supply to evaluate regional food safety and supply potentials. FP was expressed through the yield of food calorie provided by agricultural land use (Wang *et al.*, 2011). Similar to the previous studies, different ecosystems contributed diversified types of food, including rice, wheat, corn, soybean, peanuts,

potato, and sugarcane produced on cropland; pork, beef, mutton, cow milk, poultry, and eggs produced on grassland; freshwater fish produced on waterbody (Shen *et al.*, 2020;Wang *et al.*, 2011). Considering the significant differences in production potential among different counties, the average grain yield of each county combined with the coefficient of food nutrient composition were used to calculate FP.

$$FP_i = \sum_{x=1}^{3} \sum_{t=1}^{13} \frac{Y_{tj}}{A_{xtj}} \times A_{xtj} \times E_t$$

Where FP_i is yield of food calorie in grid i (kcal). Y_{tj} is yield of food t in j county，from city-level Statistical Yearbook. A_{xtj} and A_{xti} are the area occupied by land use type x corresponding to food t in county j and grid i. E_t is calorie of food i, from "Ingredient list of Chinese food (2004)" (Yang, 2005).

Table 3 Calorie composition of different foods

Food categories	Calorie /kcal/100g
rice	346
wheat	317
com	335
soybean	359
peanuts	298
potato	329
sugarcane	64
pork	395
beef	106
mutton	203
cow milk	54
eggs	144
fresh water fish	103

1.6 Transport

Transport function (TR) refers to the convenience of interflow of goods, materials, and individuals (Liu *et al.*, 2018). In our research, TR was expressed as regional accessibility assessed by cumulative cost time of arriving to the nearest regional center (Jin *et al.*, 2009;Liu *et al.*, 2018). The time cost of a vehicle traveling per 1 km was assigned to the road grids according to different road. The time cost of railway, highway, national highway, and provincial and county roads were 0.6 min /km, 0.5 min/km, 0.75 min /km, 1 min /km, and 1.5 min /km, respectively (Liu *et al.*, 2018;Pan *et al.*, 2015). Considering the incomplete operations of highways and railways, the time cost of the 1km grid around highways and railways was 60 min /km. The time cost of the rest grids was 10 min /km, according by pedestrian walking speed (approximately 6km/h) (Jin *et al.*, 2009). Finally, the time cost grid and the residential land polygons were input into the tools of Cost Distance in ArcGIS 10.5, which generated the regional accessibility pattern. Jiangsu Road Data was obtained from Yangtze River Delta Science Data Center, National Earth System Science Data Sharing Infrastructure, and National Science & Technology Infrastructure of China (http://nnu.geodata.cn:8008/).

1.7 Water regulation

Our research quantitatively evaluated the function of water regulation (WR), which reflects the water yields of different land use systems and is one of the important LUFs supporting the global hydrological cycle (Fan *et al.*, 2018). The water yield model of Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) software (3.1.3, https://naturalcapitalproject.stanford.edu/) was an estimation method based on the Budyko theory and water balance, which was widely applied to estimate grid-scale water yield (Sharp *et al.*, 2018). Based on this model, the water yields is the difference between precipitation and evaporation (Zhang *et al.*, 2014;Zhang *et al.*, 2019). In addition, the model also considered the spatial difference of soil permeability under different land use types and the influence of topography and surface roughness on surface runoff (Fan *et al.*, 2018;Zhang *et al.*, 2019). The model for evaluating WR is as follows (Sharp *et al.*, 2018):

$$WY_i = \left\{1 - \frac{AET(i)}{P(i)}\right\} \times P(i)$$

Where WY_i is annual water yield of grid i. $AET(i)$ is evapotranspiration. $P(i)$ is precipitation. The data requirements of the water yield model include: (1) Average Annual Precipitation, interpolated by precipitation of weather stations, which was download from National Meteorological Science Data Center (http://data.cma.cn/); (2) Root restricting layer depth was replaced by soil profile deep, from A China Dataset of Soil Properties for Land Surface Modeling (http://data.casnw.net/portal/) ; (3) Average Annual Reference Evapotranspiration, which was calculated by ET0 calculator 3.2 (FAO, http://www.fao.org/nr/water/eto.html); (4) Plant Available Water Content is field moisture capacity minus wilting coefficient, which is calculated by soil texture, bulk density and organic matter content according to (Zhou *et al.*, 2005) ; (5) Land use/land cover (Xu *et al.*, 2018) and Watersheds(Xu, 2018) are provided by Data Center for Resources and Environmental Sciences , Chinese Academy of Sciences (RESDC, http://www.resdc.cn/); (6) Biophysical parameters table referred to the Invest User Guide(Sharp *et al.*, 2018) and the research of and (Fu *et al.*, 2013;Gu *et al.*, 2018).

Table 4 Biophysical parameters for InVEST model

Land-use type	Evapotranspiration coefficient	root depth
cropland	0.75	300
Forest	1	5000
Shrub forest	1	2000
Open forest	1	3000
Other forest	1	700
Grassland	0.65	500
Water body	1	1
wetland	1	300
ocean	1	1
Urban	0.3	1
Rural resident	0.3	1
Construction land	0.3	1
Bare land	0.5	1

1.8 Biodiversity conservation

BC provides habitat for individuals and communities. Habitat quality corresponds to ability of an ecosystem to provide survival and development conditions for a population, and, to a certain extent, it determines the level of regional biodiversity maintenance (Fan *et al.*, 2018;Shen *et al.*, 2020). Hence, for the quantification of BC, the habitat quality model in the InVEST software was used to determine the habitat quality of the Jiangsu coast. The information required by this model involve the threat degree of various sources, the distance and decay of such threats, and the sensitivity of each landscape type to threats (Liu *et al.*, 2018;Sharp *et al.*, 2018). The formula for evaluating BC is as follows:

$$Q_{xj} = H_j \left\{ 1 - \left(\frac{D_{xj}^z}{D_{xj}^z + k^z} \right) \right\}$$

Where Q_{xj} is the habitat quality at grid x of habitat j [0,1], D_{xj} is the threat level at grid x of habitat j, H_j is the habitat suitability of habitat j, z is set as 2.5, and k is the half saturation constant, which was set at 0.5. The data requirements of the habitat quality model include: (1) Land use/land cover(Xu *et al.*, 2018) (RESDC, http://www.resdc.cn/); (2) Threat sources data, which are GIS raster data that represent the spatial distribution and intensity of each threat，including urban, rural, industrial and mining land, rail, main road (i.e. expressway, national highway and provincial Highway), minor road (i.e. prefectural highway and country highway), aquaculture area, bare land, cropland in our study (Sharp *et al.*, 2018). Among them, Road data were extracted from the Jiangsu Road Data set (1990-2015, http://nnu.geodata.cn:8008/), while the remaining of the threats were extracted from land use data; (3) threat factors table including the relative impact of each kind of threat on the natural habitat and the distance at which habitat degradation occurs, which refers to the InVEST user's guide and previous studies (Sallustio *et al.*, 2017;Sun *et al.*, 2019) (see Table 5); (4) The Sensitivity table which contains information regarding the sensitivity of the LULC types belonging to the habitats to each threat, set empirically with reference to the InVEST user's guide and previous studies (Chu *et al.*, 2015;Sun *et al.*, 2019;Wu *et al.*, 2015) (see Table 6).

Table 5 Threat factors parameters for InVEST model

THREAT	MAX_DIST	WEIGHT	DECAY
Urban	10	1	Exponential
Rural	9	0.9	Exponential
Industrial and mining land	5	0.9	Exponential
Rail	7	0.6	linear
Main road	3	0.6	linear
minor road	1	0.4	linear
aquaculture area	3	0.7	Exponential
Bare land	5	0.2	linear
Cropland	8	0.7	linear

Table 6 Sensitivity parameters for InVEST model

LULC	HABITAT	L_crop	L_urban	L_rural	L_indus	L_bare	L_rail	L_mainr	L_minor	L_aquic
Forest	1	0.8	0.9	0.85	0.8	0.5	0.75	0.8	0.7	0.2
Cropland	0.4	0.2	0.8	0.75	0.6	0.5	0.6	0.7	0.6	0.5

Grassland	0.9	0.4	0.7	0.5	0.65	0.8	0.6	0.3	0.2	0.2
Residential	0	0	0	0	0	0	0.5	0.6	0.5	0.4
Transport	0	0	0.7	0.7	0	0	0	0	0	0.3
Industrial	0	0	0	0	0	0	0.5	0.6	0.5	0.4
Wetland	1	0.5	0.8	0.8	0.9	0.5	0.75	0.7	0.6	0.9
Water	0.9	0.75	0.9	0.8	0.95	0.4	0.75	0.7	0.5	0.6
Aquiculture	0.4	0.2	0.7	0.7	0.7	0.4	0.3	0.3	0.3	0.2
Bare land	0.5	0.7	0.6	0.6	0.4	0	0.4	0.4	0.4	0.5

1.9 Climate regulation& Soil conservation

Our research quantified climate regulation (CR) and soil conservation (SC), both of which are important functions that affect the climate change and hydrological cycle. Carbon sequestration is the transformation process where inorganic carbon is incorporated into organic compounds through photosynthesis, which can significantly mitigate climate change and can be reflected by NPP (Fan *et al.*, 2018;Peng *et al.*, 2018;Shen *et al.*, 2020). The CR for a given cell can be expressed as:

$$CR = 1.63 * NPP$$

Where CR is the carbon sequestration of grid i，which is calculated from the NPP, and 1.63kg CO_2 is fixed by 1kg dry matter (Chen *et al.*, 2018). NPP were calculated through NPP evaluated module V1.0 developed by Zhou *et al.* (2005) and running on ENVI 5.3. The input data included: (1) Normalized Difference Vegetation Index (NDVI) is from terra product (MOD13Q1， https://e4ftl01.cr.usgs.gov/MOLT/MOD13Q1.006/); (2) Vegetation types data comes from Land Cover Products of China (Ran *et al.*, 2010) (GLC2000, http://data.casnw.net/portal/); (3) Monthly average temperature, precipitation and solar radiation were average of five-year monthly data around 2000,2010,2018, which were download from National Meteorological Science Data Center (http://data.cma.cn/).

Soil conservation was the function of covering vegetation to prevent soil loss (Liu *et al.*, 2018). SC was assessed in sediment delivery ratio model in InVEST (3.1.3), which was equal to the potential soil loss under the non-vegetation scenario minus the actual soil loss (Peng *et al.*, 2017).

$$SC = RKLS - USLE$$

$$RKSL = R \times K \times L \times S$$

$$USLE = R \times K \times L \times S \times C \times P$$

Where SC is soil conservation per pixel. $RKSL$ is potential soil erosion per pixel. $USLE$ is soil loss per pixel. R is rainfall erosivity factor, which is calculated by Wischmeier formula (Wischmeier *et al.*, 1978). K is soil erodibility factor, which is calculated by EPIC model (Williams, 1990). L and S are slope length and steepness, and that are extracted by DEM (Geospatial Data Cloud, http://www.gscloud.cn/). C is land cover and management factor, calculated according to vegetation coverage (Cai *et al.*, 2000). P is support practice factor, its assignment refers to Hu *et al.* (2018).

2 Tables of this research

Table S1. Changes and area proportion in LUMF and LUFs by trend types.

LUFs	Average increase of improved pixels	Proportion of improved pixels	Average decrease of deteriorated pixels	Proportion of deteriorated pixels
LUMF	0.35	54.78	-0.30	34.89
BC	1.71	32.36	-1.78	28.78
CR	1.62	32.26	-1.70	30.75
ES	2.43	11.37	-2.08	5.81
FP	1.96	24.37	-1.73	28.54
CU	1.82	17.31	-1.35	23.71
PW	1.42	22.49	-1.47	23.43
RC	2.03	26.87	-1.92	20.45
RE	1.36	39.68	-1.00	9.66
SC	1.15	14.26	-1.16	14.05
TR	1.56	32.70	-1.34	25.61
WR	1.34	19.03	-1.38	18.46

* BC: biodiversity conservation; CR: climate regulation; ES: economic support; FP: food production; CU: culture; PW: provision of work; RC: residential carrier; RE: recreation; SC: soil conservation; TR: transport; WR: water regulation.

Table S2. The diversity scores (number of effective LUFs) of each bundle in 2000, 2010 and 2018 respectively.

Year	LUFB1	LUFB2	LUFB3	LUFB4
2000	7.96	8.80	6.78	8.98
2010	8.04	8.86	6.51	8.90
2018	7.90	8.86	6.37	8.79
Mean	7.97	8.84	6.55	8.89

Table S3. The main trade-offs and synergies among LUFs in each cluster. Exploratory factor analysis is used to extract the main factors from the multiple-provided LUFs accompanied by the correlations among the provision of LUFs, that is, the trade-offs and synergies of LUFs. The analysis was tested using a KMO and Bartlett Spherical test ($p < 0.01$). Factor loadings ≥ 0.35 are regarded as the vital components in each factor, and are shown in bold red.

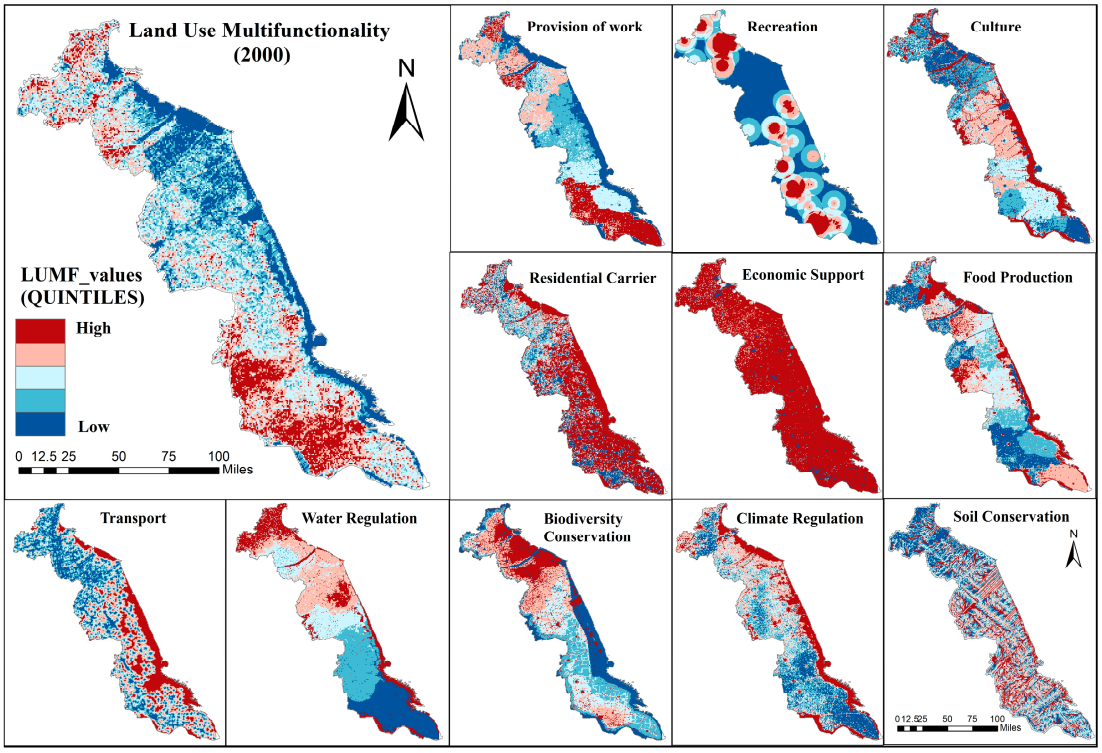
Year	Bundles	Trade-offs and synergies	The factor loadings of land use functions after rotation											Variance explained (%)	Cumulative variance
			BC	CR	SC	WR	ES	FP	RC	TR	CU	PW	RE		
2000	LUFB1	Trade-offs among CU, CR, PW and WR	-0.09	**0.41**	0.27	**0.78**	0.05	0.06	-0.01	0.04	**-0.75**	**0.70**	-0.23	17.79	17.79
		Trade-offs among BC, FP and RE	**-0.39**	-0.12	-0.15	0.11	-0.13	**0.83**	-0.13	-0.16	0.23	0.32	**0.74**	15.00	32.80
		Trade-off between BC and TR	**-0.60**	-0.23	-0.06	-0.04	0.13	-0.21	0.10	**0.80**	-0.21	0.32	0.30	12.41	45.21
		Trade-off between ES and RC	0.14	0.27	-0.10	-0.01	**-0.52**	-0.03	**0.83**	0.01	-0.01	-0.09	0.09	9.75	54.95
	LUFB2	Synergies among FP, PW and RE	0.31	0.16	0.17	0.18	0.00	**0.71**	-0.18	-0.04	-0.15	**0.74**	**0.61**	15.17	15.17
		Trade-offs among WR, TR, BC and CU	**0.67**	-0.03	0.04	**-0.38**	-0.25	0.24	0.13	**-0.57**	**0.56**	-0.33	0.00	13.42	28.60
		Synergies among CR, RC and WR	0.23	**0.56**	0.02	**0.44**	-0.02	0.06	**0.81**	0.15	0.01	-0.16	0.15	11.68	40.28
		Trade-offs among WR, ES and SC	0.00	-0.04	**0.74**	**-0.49**	**0.44**	-0.01	0.04	0.28	0.04	-0.07	0.25	10.30	50.58
	LUFB3	Synergies among CR, PW, RC and TR	-0.05	**0.56**	-0.02	-0.20	-0.04	0.25	**0.63**	**0.69**	0.15	**0.71**	0.10	16.62	16.62
		Synergy between BC and CU	**0.88**	-0.02	-0.16	-0.01	-0.24	0.07	0.10	0.03	**0.88**	0.00	0.09	14.98	31.59
		Synergy between FP and WR	0.02	0.30	0.18	**0.75**	-0.29	**0.74**	-0.15	-0.13	0.05	0.15	-0.11	12.63	44.22
		Synergy between RE and SC	-0.11	0.19	**0.62**	0.08	0.31	-0.06	-0.11	0.28	0.00	-0.13	**0.77**	11.36	55.58
	LUFB4	Synergies among FP, PW and WR	0.24	0.23	-0.28	**0.82**	0.15	**0.67**	0.21	0.05	-0.17	**0.71**	0.23	17.85	17.85
		Trade-offs among PW, BC, CU and RE	**0.71**	-0.07	-0.27	0.04	-0.15	0.25	**0.47**	-0.13	**0.69**	**-0.40**	-0.03	14.04	31.89
		Trade-off between CR and ES	0.14	**0.75**	0.23	0.03	**-0.74**	0.02	0.32	-0.12	-0.04	0.06	-0.09	11.97	43.85
		Trade-offs among RE, RC and TR	-0.22	0.05	-0.28	0.03	0.07	-0.12	**0.47**	**0.69**	0.05	-0.04	**-0.62**	11.18	55.03
2010	LUFB1	Trade-offs among PW, WR, FP and CU	-0.03	0.34	0.00	**-0.36**	0.03	**0.69**	-0.10	-0.01	**0.84**	**-0.71**	0.29	18.42	18.42
		Trade-offs among BC, RE, TR and WR	**-0.73**	0.07	-0.02	**0.52**	0.09	0.27	-0.21	**0.62**	-0.09	0.13	**0.47**	14.23	32.65
		Synergies among CR, RC and WR	0.09	**0.57**	0.05	**0.43**	0.14	0.00	**0.72**	-0.08	-0.11	-0.23	0.14	10.49	43.14

		Trade-offs among ES, RE and SC	0.10	0.01	**0.78**	0.07	**-0.45**	-0.17	-0.13	-0.06	0.03	-0.16	**0.45**	10.00	53.14
	LUFB2	Trade-offs among WR, PW and RE	-0.19	-0.04	0.28	**-0.66**	-0.01	0.13	-0.17	0.31	-0.05	**0.57**	**0.76**	14.54	14.54
		Trade-offs among CU, ES, RC and TR	-0.01	0.17	-0.04	0.07	**0.53**	0.09	**0.65**	**0.46**	**-0.63**	-0.09	0.06	12.35	26.88
		Trade-offs among TR, FP and PW	0.16	0.05	-0.17	0.03	0.20	**0.81**	0.07	**-0.42**	0.08	**0.52**	0.11	11.19	38.07
		Synergy between BC and SC	**0.75**	0.01	**0.68**	-0.09	0.04	-0.02	0.11	-0.13	0.13	0.00	-0.06	9.86	47.93
		Trade-off between CR and ES	-0.10	**0.87**	0.11	0.14	**-0.42**	-0.05	0.15	-0.15	-0.11	0.07	0.08	9.42	57.35
	LUFB3	Trade-offs among ES, BC, CU and RE	**0.85**	0.07	-0.14	-0.14	**-0.54**	0.23	0.04	0.00	**0.83**	0.00	**0.43**	18.07	18.07
		Synergies among CR, PW, RC and TR	-0.03	**0.53**	0.01	0.07	-0.11	0.26	**0.70**	**0.74**	0.03	**0.54**	-0.07	15.33	33.40
		Synergies among FP, PW, RE and WR	-0.07	0.29	**0.53**	**0.70**	0.04	**0.50**	-0.14	0.04	-0.06	**0.42**	**0.42**	13.48	46.88
	LUFB4	Trade-offs among ES, BC, CR and CU	**0.64**	**0.60**	0.01	0.12	**-0.66**	0.04	0.26	-0.26	**0.65**	0.21	-0.04	16.51	16.51
		Trade-offs among CU, SC, PW and WR	0.08	0.33	**-0.49**	**0.77**	-0.17	-0.01	0.05	0.01	**-0.40**	**0.61**	0.03	13.71	30.22
		Synergy between RC and TR	0.07	0.04	-0.15	0.05	0.10	0.07	**0.82**	**0.68**	0.04	-0.22	0.00	11.29	41.51
		----	-0.10	-0.23	0.01	0.12	-0.06	-0.01	-0.09	0.12	0.24	-0.11	**0.95**	9.84	51.36
		----	-0.01	0.18	0.19	0.04	0.08	**0.92**	-0.13	0.28	0.10	0.19	0.00	9.62	60.97
2018	LUFB1	Trade-offs among CR, FP, CU, BC, PW and WR	**0.39**	**-0.67**	0.15	**0.75**	0.05	**-0.64**	-0.04	0.25	**-0.80**	**0.72**	-0.13	25.73	25.73
		Synergy between BC and RC	**0.51**	0.21	-0.08	0.13	-0.12	-0.25	**0.87**	0.18	-0.16	-0.02	-0.07	11.01	36.74
		Synergy between RE and TR	-0.16	0.09	0.32	0.26	0.10	-0.08	0.06	**0.47**	0.03	-0.13	**0.84**	10.60	47.35
		Trade-offs among SC, ES and TR	0.18	0.03	**0.66**	0.09	**-0.62**	0.09	-0.04	**-0.45**	0.01	0.00	0.09	9.75	57.09
	LUFB2	Trade-offs among WR, PW and RE	0.09	0.01	0.18	**-0.68**	0.14	0.25	0.09	0.01	-0.12	**0.75**	**0.75**	15.80	15.80
		Trade-offs among FP, ES, RC and TR	0.06	0.09	0.01	-0.18	**0.40**	**-0.66**	**0.45**	**0.70**	-0.06	-0.17	0.06	12.45	28.25
		Synergy between BC and CU	**0.78**	0.03	0.07	0.10	0.06	0.01	-0.28	0.01	**0.76**	0.14	-0.09	11.91	40.16
		Synergy between ES and SC	0.12	**0.72**	**-0.61**	0.07	0.15	0.32	0.23	-0.01	-0.14	0.07	-0.18	10.48	50.64
	LUFB3	Synergies among CR, PW, RC and TR	0.06	**0.56**	-0.06	0.01	0.00	0.13	**0.68**	**0.78**	-0.05	**0.58**	0.16	16.07	16.07
		Trade-offs among ES, BC and CU	**0.75**	0.12	-0.14	-0.20	**-0.64**	0.17	0.00	-0.08	**0.75**	-0.03	0.09	14.98	31.04
		Synergy between FP and WR	-0.04	0.13	0.05	**0.82**	-0.22	**0.77**	-0.06	-0.12	-0.26	0.21	0.07	13.39	44.44

		Synergy between RE and SC	-0.12	-0.02	**0.73**	0.00	0.04	0.15	-0.07	0.18	0.13	0.09	**0.74**	10.80	55.24
	LUFB4	Trade-offs among ES, CR, FP and CU	0.23	**0.58**	-0.05	-0.14	**-0.62**	**0.70**	0.01	-0.12	**0.64**	0.09	-0.03	15.57	15.57
		Trade-offs among SC, BC, PW and WR	**0.64**	0.18	**-0.35**	**0.78**	-0.10	0.05	0.03	-0.04	-0.13	**0.60**	0.01	14.16	29.73
		Synergy between RC and TR	0.21	0.08	-0.26	-0.19	0.08	-0.24	**0.73**	**0.73**	0.14	-0.17	-0.02	12.24	41.97
		----	-0.03	-0.25	-0.05	0.10	0.31	0.12	-0.07	0.07	0.31	-0.31	**0.88**	10.54	52.51

3 Figures of this research

1: 2000



2: 2010

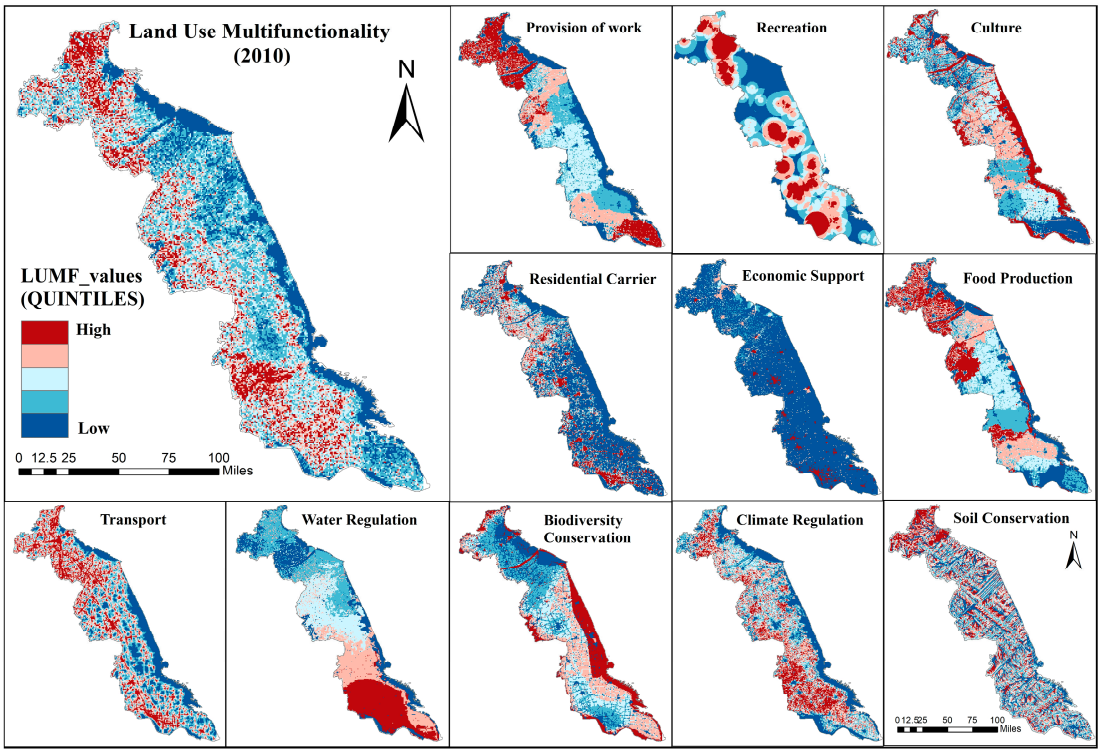


Figure S1. Spatial distribution of eleven land use functions in 2000 and 2010 by the quintiles.

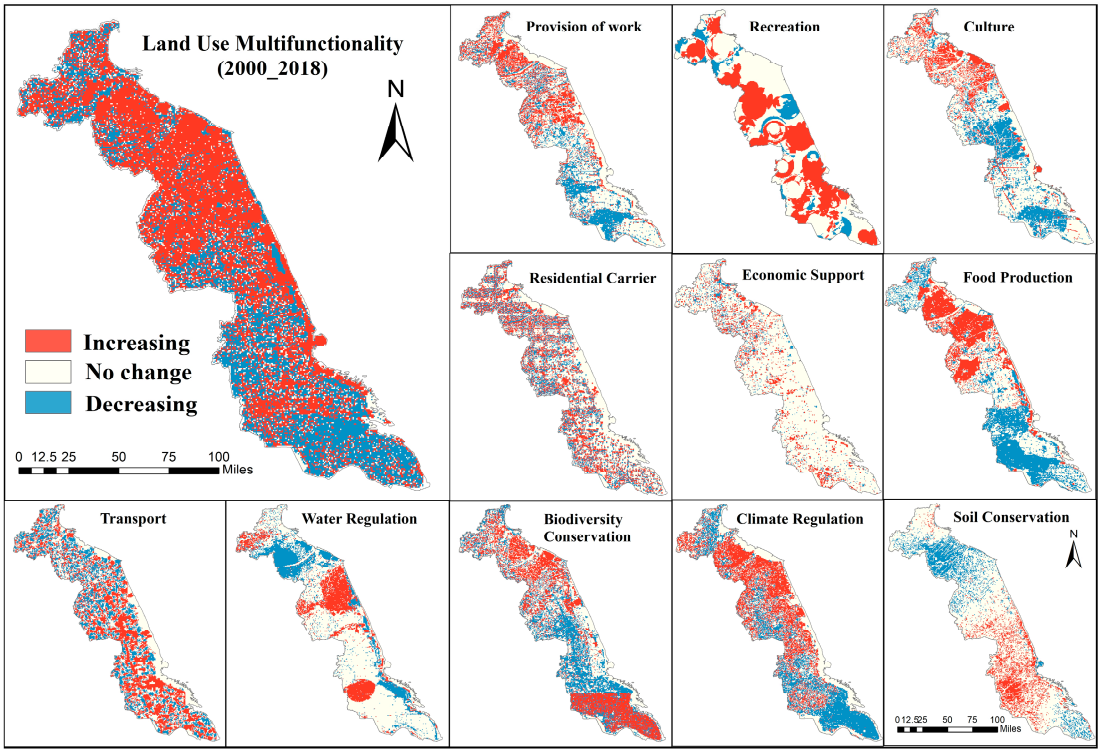
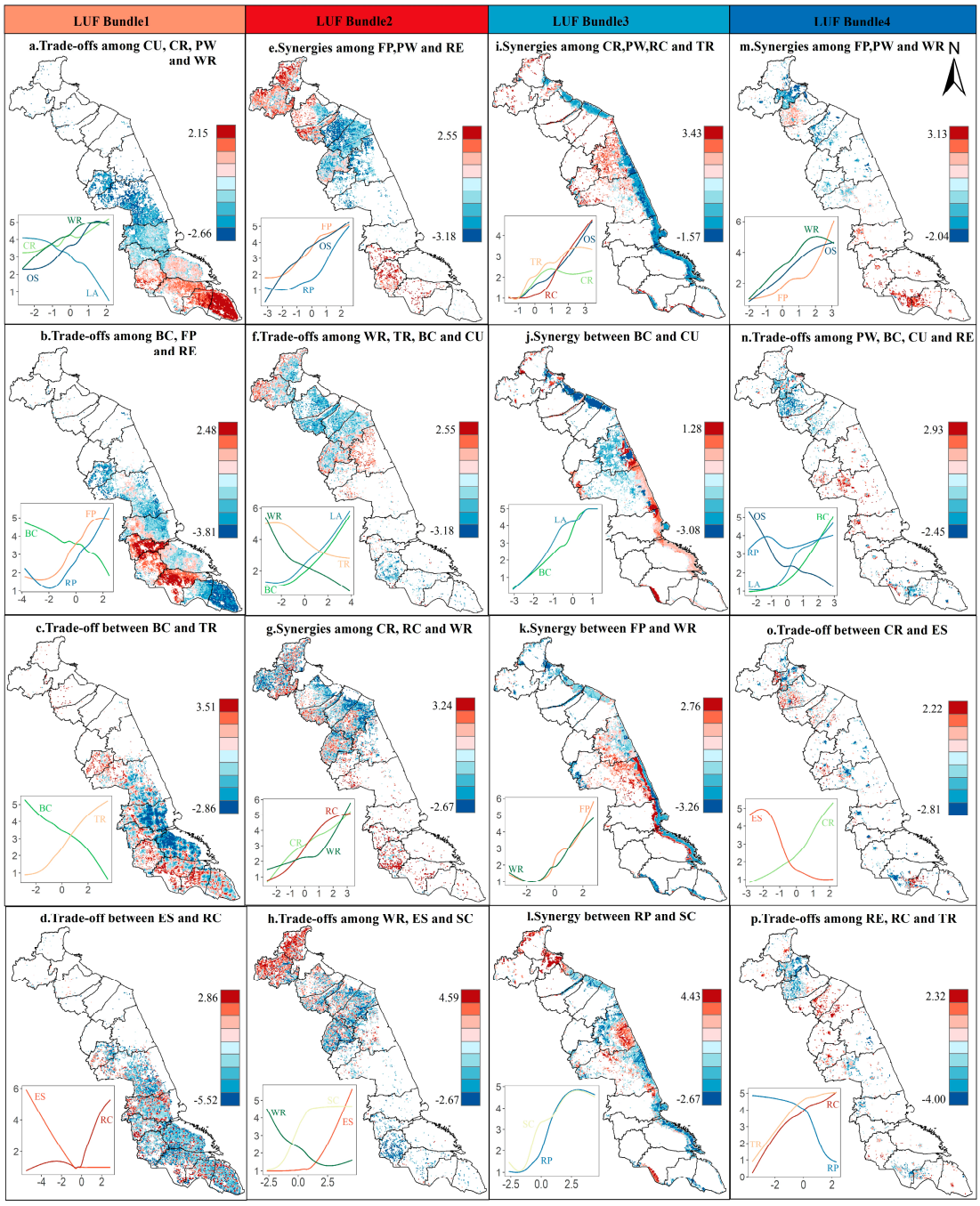


Figure S2. Map of trends in grid values of land use functions across the Jiangsu coastal area from 2000 to 2018.

1. 2000


LUF Bundle1
LUF Bundle2
LUF Bundle3
LUF Bundle4
a.Trade-offs among CU, CR, PW and WR
2.15
-2.66
WR
CR
OS
LA
e.Synergies among FP,PW and RE
2.55
-3.18
FP
OS
RP
i.Synergies among CR,PW,RC and TR
3.43
-1.57
OS
TR
CR
RC
m.Synergies among FP,PW and WR
N
3.13
-2.04
WR
OS
FP
b.Trade-offs among BC, FP and RE
2.48
-3.81
FP
BC
RP
f.Trade-offs among WR, TR, BC and CU
2.55
-3.18
WR
LA
TR
BC
j.Synergy between BC and CU
1.28
-3.08
LA
BC
n.Trade-offs among PW, BC, CU and RE
2.93
-2.45
OS
BC
RP
LA
c.Trade-off between BC and TR
3.51
-2.86
BC
TR
g.Synergies among CR, RC and WR
3.24
-2.67
RC
CR
WR
k.Synergy between FP and WR
2.76
-3.26
FP
WR
o.Trade-off between CR and ES
2.22
-2.81
ES
CR
d.Trade-off between ES and RC
2.86
-5.52
ES
RC
h.Trade-offs among WR, ES and SC
4.59
-2.67
SC
WR
ES
l.Synergy between RP and SC
4.43
-2.67
SC
RP
p.Trade-offs among RE, RC and TR
2.32
-4.00
RC
TR
RP

2. 2010

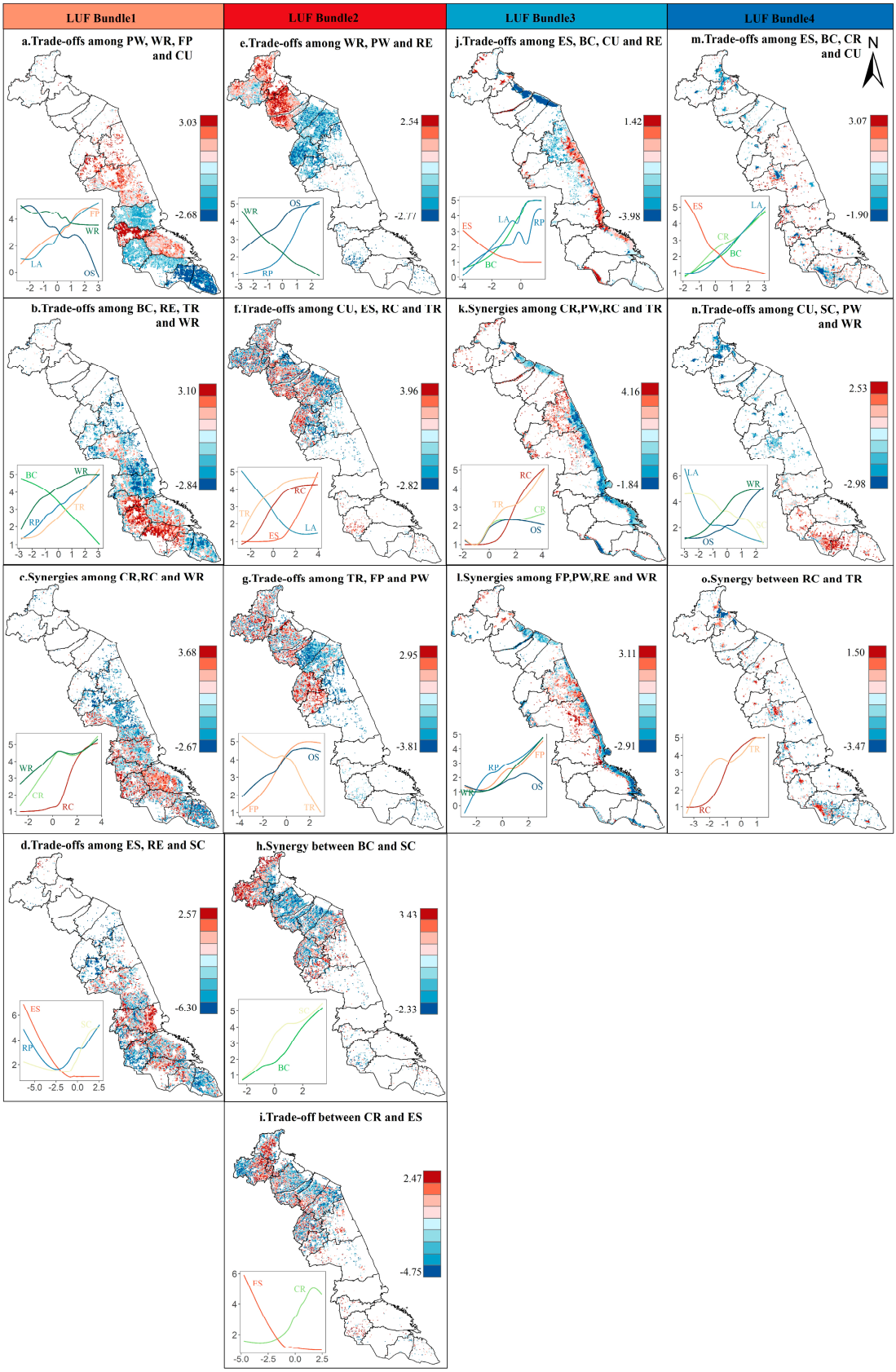


Figure S3. Spatial variations in factor scores of trade-offs and synergies among multiple provided functions in four bundles (2000, 2010). The inset shows the responses of the sub-function to the factor score, and the nonlinear curves between them are fitted by GAM. As

for the trade-offs among bundled functions, blue areas indicate high values in positive factors and low values in negative factors; red areas indicate low values in positive factors and high values in negative factors. Regarding the synergies among bundled functions, blue areas indicate that the values of all factors are high, while red areas indicate that all these functions have low values.

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