

Supplementary Materials

Assessment methods for ecosystem services

1. Water conservation

Water conservation was estimated using the Seasonal Water Yield module in InVEST, which was developed to provide an evaluation of the contribution of land parcels for baseflow and quick flow, estimating not only the baseflow yield in a watershed but also the monthly surface runoff [93,94].

To implement the Seasonal Water Yield module, we used the digital elevation model (DEM), land cover, climate, soil data, and other non-spatial variables as input parameters. The model was then run with those input parameters and the default function of precipitation seasonality (α), the function of local topography and soils (β_i), and the fraction of pixel recharge (γ) parameters of the model [46].

2. Soil conservation

Soil erosion and soil conservation were measured using the revised universal soil loss equation (RUSLE), which is an empirical soil loss model revised by the Universal Soil Loss Equation (USLE) [47]:

$$SC = R \times K \times L \times S \times (1 - C \times P) \quad (S1)$$

where SC is the amount of soil conservation, R is the precipitation erosion coefficient, K denotes the soil erodibility coefficient, L is the slope length factor, S is the slope steepness factor, C is the crop management factor, and P is the soil and water conservation factor.

3. Carbon sequestration

Carbon sequestration is achieved by organisms converting inorganic carbon into organic compounds through photosynthesis [7]. In this study, carbon sequestration can be evaluated by net primary productivity (NPP). The NPP was calculated through the process-based Carnegie-Ames-Stanford Approach (CASA) model, assuming plant productivity is correlated with the photosynthetically active radiation absorbed or intercepted by the green foliage [95].

4. Habitat quality

Habitat quality was quantitatively estimated using the habitat quality module in the InVEST model, which was designed to establish the relationship between different land use types and threat sources [48]. Within the model, habitat quality serves as a representation of biodiversity by estimating the degradation of habitat and land cover in conjunction with threats [93]:

$$Q_{xj} = H_j \left[1 - \left(\frac{D_{xj}^z}{D_{xj}^z + k^z} \right) \right] \quad (S2)$$

where Q_{xj} represents the habitat quality in parcel x of land use type j , H_j represents the habitat suitability of land use type j , D_{xj} is the habitat degradation in parcel x of land use type j , k is the half-saturation coefficient, and z is the normalized constant.

5. Food supply

According to the linear correlation between grain production and NDVI, NDVI can be used to spatialize various grain production to realize the quantification of food supply services based on the total output of various grain production [49]. Based on the Statistical Yearbook of Hubei Province, this study allocated the production of agriculture, forestry, fishery, and animal

husbandry of each city in the Wuhan metropolitan area to the pixel of cropland, forest, water, and grassland according to the NDVI value. The specific allocation method is as follows:

$$G_{ij} = \frac{NDVI_{ij}}{NDVI_{sumj}} \times G_{sumj} \quad (S3)$$

where G_{ij} is the output value of the j grain production in the i pixel, G_{sumj} is the total output value of the j grain production in each city, $NDVI_{ij}$ is the NDVI value of the land type corresponding to the j grain production in the i pixel, and $NDVI_{sumj}$ is the sum of NDVI values within the land type corresponding to the j grain production.

6. Ecological recreation

Recreation potential can be used as an indicator to quantify and evaluate ecological recreation, namely, the ability of the ecosystem to provide recreational opportunities without human input [50]. Therefore, we calculated ecological recreation based on six landscape indicators (naturalness, protected area, water presence, landscape diversity, terrain roughness, and mountain density), which were considered to contribute equally to recreation potential, normalized and overlaid to calculate the recreation potential index [50,96].