# Supplementary materials S1

Table S1 The neighborhood weights for individual land use.

| | Cropland | Forest | Grassland | Water | Construction land | Unused land |
|---|---|---|---|---|---|---|
| SSP1-2.6 | 0.3 | 1 | 0.7 | 0.5 | 0.7 | 0.01 |
| SSP2-4.5 | 0.5 | 0.7 | 0.3 | 0.4 | 0.8 | 0.01 |
| SSP5-8.5 | 0.8 | 0.6 | 0.4 | 0.3 | 1 | 0.01 |

Table S2 Cost Matrix of land use pair of SSP1-2.6 scenario.

| Land use type | Cropland | Forest | Grassland | Water | Construction land | Unused land |
|---|---|---|---|---|---|---|
| Cropland | 1 | 1 | 1 | 1 | 1 | 1 |
| Forest | 0 | 1 | 0 | 0 | 0 | 0 |
| Grassland | 0 | 1 | 1 | 1 | 0 | 0 |
| Water | 0 | 0 | 0 | 1 | 0 | 0 |
| Construction land | 1 | 1 | 1 | 1 | 1 | 1 |
| Unused land | 1 | 1 | 1 | 1 | 1 | 1 |

Table S3 Cost Matrix of land use pair of SSP2-4.5 scenario.

| | Cropland | Forest | Grassland | Water | Construction land | Unused land |
|---|---|---|---|---|---|---|
| Cropland | 1 | 1 | 1 | 1 | 1 | 1 |
| Forest | 1 | 1 | 1 | 0 | 1 | 1 |
| Grassland | 1 | 1 | 1 | 1 | 1 | 1 |
| Water | 1 | 0 | 1 | 1 | 0 | 1 |
| Construction land | 1 | 0 | 1 | 0 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Unused land | 1 | 1 | 1 | 1 | 1 | 1 |

Table S4 Cost Matrix of land use pair of SSP5-8.5 scenario.

| | Cropland | Forest | Grassland | Water | Construction land | Unused land |
|---|---|---|---|---|---|---|
| Cropland | 1 | 0 | 0 | 0 | 1 | 0 |
| Forest | 1 | 1 | 0 | 0 | 1 | 0 |
| Grassland | 1 | 1 | 1 | 1 | 1 | 0 |
| Water | 1 | 0 | 0 | 1 | 1 | 0 |
| Construction land | 0 | 0 | 0 | 0 | 1 | 0 |
| unused land | 1 | 1 | 1 | 1 | 1 | 1 |

# Supplementary materials S2

2.3.3.1 Single ESs assessment

2.3.3.1.1 Water yield

Through the use of the water yield module in the InVEST model, we were able to determine the water yield in BTH. According to the Byduko curve and the principle of water balance, this module is used to calculate water yield. The calculation formula is:

$$Y_j = \left(1 - \frac{AET_j}{P_j}\right) \times P_j \quad \text{(S1)}$$

where $Y_j$ is the annual water yield of the land use type grid $j$, mm; $AET_j$ is the annual evaporation of the land use type grid $j$, mm; $P_j$ is the annual precipitation of land use type grid $j$, mm.

2.3.3.1.2 Carbon storage

The carbon storage module in the InVEST model evaluates the carbon storage capacity of the ecosystem based on four carbon pools, including the aboveground biochar, underground biochar,

soil carbon, and dead organic carbon. The calculation formula is as follows:

$$C_{tot} = C_{above} + C_{below} + C_{soil} + C_{dead} \quad \text{(S2)}$$

where $C_{tot}$ is the total carbon storage of the region, t·hm$^{-2}$; $C_{above}$ is the storage of the aboveground biochar, t·hm$^{-2}$; $C_{below}$ is the storage of underground biochar, t·hm$^{-2}$; $C_{soil}$ is the soil carbon storage, t·hm$^{-2}$; $C_{dead}$ is the storage of the dead organic carbon, t·hm$^{-2}$.

2.3.3.1.3 Habitat quality

The assessment of habitat quality is based on the habitat quality module of the InVEST model. Habitat quality is assessed by calculation after considering factors such as habitat suitability, habitat sensitivity to threat factors, and the distance between the habitat and threat factors. The calculation formula is as follows:

$$Q_{xj} = H_j \times \left(1 - \frac{D_{xj}^z}{D_{xj}^z + k^z}\right) \quad \text{(S3)}$$

where $Q_{xj}$ is the habitat quality of grid $x$ in land use type $j$; $H_j$ is the habitat suitability; $D_{xj}$ is the habitat threat level in grid cell $x$; $k$ is a half-saturation constant, usually half of the maximum value of $D_{xj}$ ; $z$ is a normalization constant, usually 2.5.

2.3.3.1.4 Food product

The assessment method based on the food production capacity per unit area was adopted. The calculation formula is as follows:

$$\mathrm{FP} = \sum_{K=1}^{K} \sum_{c=1}^{C} A_{cK} \cdot P_{cK} \quad \text{(S4)}$$

where $A_{cK}$ is the area of $C$ food provided by land use type $K$; $P_{cK}$ is the yield of $C$ food per unit area provided by the land use type $K$.