Supplementary information

Quantification of ecosystem services

1. Water retention

This study used the following Water Balance Equation to calculate the water conservation capacity of the ecosystems (Ouyang et al., 2016), which was closely related to factors that include precipitation, evapotranspiration, surface runoff and land cover type:

$$TQ = \sum_{i=1}^{j} (P_i - R_i - ET_i) \times A_i \tag{1}$$

$$R_i = P_i \times a_i \tag{2}$$

where TQ is the total amount of water retention (m^3), Pi denotes precipitation on pixel i (mm), Ri represents surface runoff on pixel i (mm), ETi is evapotranspiration on pixel i (mm), Ai is the area of pixel i, j is the total number of pixels. The surface runoff (Ri) is the product of precipitation and surface runoff coefficient, αi is the average surface runoff coefficient on pixel i (%). Runoff coefficient values were estimated from publications (Ouyang et al., 2016; Gong et al., 2017) on surface runoff across a range of ecosystems.

2. Carbon sequestration

NPP was estimated using the Carnegie-Ames-Stanford Approach (CASA) method (Potter et al., 1993), the formula is as follows:

$$NPP(x,t) = TSOL(x,t) \times FPAR(x,t) \times r \times \mathcal{E}(x,t) \tag{3}$$

$$\mathcal{E}(x,t) = T_{\varepsilon 1}(x,t) \times T_{\varepsilon 2}(x,t) \times W_{\varepsilon}(x,t) \times \varepsilon_{max} \tag{4}$$

where, $NPP(x, t)$ is the net primary productivity at the pixel x in the month t (gC m^{-2}); $TSOL(x, t)$ is total solar radiation (MJ m^{-2}); $FPAR(x, t)$ is the fraction of total incoming photo synthetically active radiation absorbed by vegetation canopy (MJ m^{-2}); r is the ratio of the effective solar radiation against the total solar radiation (wave length ranges 0.4–0.7 μm), the value of this study was 0.5; $\mathcal{E}(x, t)$ is light use efficiency of $FPAR(x, t)$ into organic dry matter (gC MJ^{-1}); $T_{\varepsilon 1}(x, t)$ and $T_{\varepsilon 2}(x, t)$ are temperature stress coefficients; $W_{\mathcal{E}}(x, t)$ is a moisture stress coefficient; $\mathcal{E}_{max}$ is the maximal light use efficiency of the specific biome under an ideal condition, which was based on the study of Zhu et al. (2007).

3. Soil loss by wind erosion

Soil loss by wind erosion (SL) was assessed quantitatively using the Revised Wind Erosion Equation (RWEQ) (Van Pelt et al., 2004). The formula is as follows:

$$SL = \frac{2 \times Z}{S^2} \times Q_{max} \times e^{-(x/S)^2} \tag{5}$$

$$Q_{max} = 109.8 \times (WF \times EF \times SCF \times K' \times COG) \tag{6}$$

$$S = 105.71 \times (\ ) WF \times EF \times SCF \times K' \times COG - 0.3711 \tag{7}$$

where, SL is the amount of sand transported by the wind at a point x downwind (kg m^{-2}); z is the length from the upwind direction (m); Q_{max} is the maximum amount of sand that can be transported downwind (kg m^{-1}); and S is the length of the land where the soil transfer amount reaches 63.2% of the maximum transfer amount (m); WF is the weather factor (kg m^{-1}); *EF* and *SCF* are the soil erodibility factor (dimensionless) and soil crust factor (dimensionless), respectively; and *COG* is the comprehensive vegetation factor (dimensionless), which was calculated by the fractional vegetation cover depending on the effect of withered vegetation and growing vegetation on wind erosion (Gong, 2014). In particular, the instruction manual for the RWEQ model specifies that the wind speed input parameter should be an average of wind speed data collected every 1 to 2 min (Fryrcar et al., 2001), which is difficult to achieve. In this study, we converted daily mean wind speed data into minute wind speed data using a formula based on Guo et al. (2013).

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