

Interactive comment on “Quantifying the effect of land use and land cover change on green water and blue water in northern part of China” by X. Liu et al.

X. Liu et al.

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Thank you very much for your comments.

Comment # 1) In Table 3, the land cover percent in different period is strange, which should be explained.

Answer # 1): Agriculture and stock-raising are the main productive activities within the Laohahe Catchment, thus grassland and cropland are the dominant kinds of vegetation. The major driving force of land cover and land use change is population growth and local/national development policy. Since 1950, there have been four times of large-scale reclamations in the catchment. However conversion of cropland to forest-land or

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grassland was also progressing at the same time. That was the main reason for the land cover change in the different period. In addition, Table 3 shows that the percentages of the main vegetation types from 4 land cover maps, 1980, 1989, 1996 and 1999. These land cover maps were interpreted from Landsat MSS, TM and ETM+ images with a variety of reference data. In order to drive the distributed hydrological model, the original land use data were transferred from the resolution of 28.5 meters to 30 second and reclassified into main vegetation types, including forest land, grass land and crop land. The precision of land use data at a certain extent was reduced by upscaling and reclassification. That also could cause the strange change of land cover data in different period.

Comment # 2) The resistance is key parameter to calculate evaporation. What is the method to determine them?

Answer # 2): The detailed parameterization schemes of radiation balance, land surface resistance and interception in the two-source potential evapotranspiration model can be referred to the paper by Yuan et al. (2008). The following equations show the method of calculating land surface resistance.

1. Aerodynamic resistances The aerodynamic resistances, r_a and r_{as} , are derived by integrating the eddy diffusion coefficients within and above the canopy, which was called K-theory. (Shuttleworth & Gurney 1990, Zhou et al. 2005).

Equation (1) and (2). (http://cn.f11.yahoofs.com/users/4534c03czd05a28a7/5f8e/___sr_/5879.jpg?photoSwDJBfJnIDusE)

Where K is the eddy diffusion coefficients, h is the vegetation height (m), n is the eddy diffusivity decay constant of the vegetation, K_h is the eddy diffusion coefficient at the top of canopy (m^2s^{-1}), z_{0g} is the roughness length of ground (m), z_0 is the roughness height of canopy (m), d_0 is the zero plane displacement of canopy (m), K is von Karman's constant (equal to 0.41).

2. Bulk boundary-layer resistance of the canopy The bulk boundary-layer resistance

of canopy is calculated equivalent to all leaf boundary layers in parallel (Shuttleworth & Wallace 1985, Shuttleworth & Gurney 1990)

Equation (3),(4) and (5). (http://cn.f11.yahoofs.com/users/4534c03czd05a28a7/5f8e/___sr_/cb39.jpg?phoSwDJBzBw4ep6)

Where w is the canopy characteristic leaf width (m), estimated using Eq. (5), u_h is the wind speed at the top of canopy (ms^{-1}), w_{max} is the maximum leaf width of vegetation (m).

3. Bulk stomatal resistance of canopy while the soil moisture at field capacity The bulk stomatal resistance of canopy is equal to all single stomatal resistance of canopy in parallel, affected not only by leaf area index but also by the environmental factors, such as solar radiation, vapour pressure deficit, air temperature at canopy and soil moisture content at root zone. It is often expressed as the form (Jarvis 1976, Irannejad & Shao 1980, Mo et al.2004, zhou et al.2005):

Equation (6), (7), (8), (9) and (10) (http://cn.f11.yahoofs.com/users/4534c03czd05a28a7/5f8e/___sr_/592f.jpg?phoSwDJBzBw4ep6)

Where r_{min} is the minimal stomatal resistance (sm^{-1}), R_{sd} is the incoming shortwave solar radiation (wm^{-2}), D_0 is the air water vapor deficit (kPa), h is the vegetation height (m), T_a is air temperature (K), θ , θ_f (f is subscription) and θ_{wilt} (wilt is subscription) are soil moisture content, the field capacity and the soil moisture content at wilting point (m^3m^{-3}), respectively. For potential evapotranspiration, the soil moisture is assumed at field capacity, thus $F_4=1$.

4. r_{sp} is the soil surface resistance while the soil moisture at field capacity. In this study, $r_{\text{sp}}=300(\text{sm}^{-1})$.

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