# Response to Professor Adam Wei:

**Comment:** More descriptions on SWAT model are needed to further clarify runoff prediction with CN values, calculation of soil profile water content or accumulated plant evapotranspiration and time steps involved.

**Answer:** Runoff curve numbers listed in the National Engineering Handbook (NRCS, 1986) are typical curve numbers for average moisture condition (condition II) that is, $CN_2$. NRCS defines three antecedent moisture conditions: I—dry (wilting point), II—average moisture and III—wet (field capacity). The corresponding curve numbers are $CN_1$, $CN_2$ and $CN_3$. $CN_1$ and $CN_3$ are calculated by $CN_2$ .

SWAT adjusts the daily curve numbers with soil profile water content or accumulated plant evapotranspiration. When the former adjustment is applied, the following equation is used:

$$S = S_{\max} \cdot \left[1 - \frac{SW}{SW + \exp(w_1 - w_2 \cdot SW)}\right]$$

where $S$ is the daily retention parameter (mm), $S_{\max}$ is the maximum value of the retention parameters (mm), $SW$ is the soil profile water content excluding the amount of water held in the profile at wilting point (mm), $w_1$ and $w_2$ are shape coefficients.

$S_{\max}$ is calculated by $CN_1$ :

$$S_{\max} = \frac{25400}{CN_1} - 254$$

$w_2$ is a function of $S_{\max}$, $CN_3$, soil profile water content at field capacity(mm) and soil profile water content when completely saturated; $w_2$ is a function of $S_{\max}$, $CN_3$, soil profile water content at field capacity(mm) and $w_2$.

When the daily retention parameter ($S$) is adjusted with accumulated plant evapotranspiration, the following equation is used:

$$S = S_{prev} + E_0 \cdot \exp\left(\frac{-cncoef - S_{prev}}{S_{\max}}\right) - R - Q$$

where $S_{prev}$ is the retention parameter for the previous day (mm), $E_0$ is the potential evapotranspiration for the day (mm), *cncoef* is the weighting coefficient for calculating the daily retention coefficient based on plant evapotranspiration, *R* is the daily rainfall (mm), and *Q* is the surface runoff (mm).

The daily curve number value is adjusted by the retention parameter calculated for that soil moisture content or accumulated plant evapotranspiration:

$$CN = \frac{25400}{S + 254}$$

All above is presented in the theoretical documentation of SWAT (Neitsch et al., 2005) in detail. The sentence "SWAT adjusts the daily curve numbers with soil profile water content or accumulated plant evapotranspiration" (P9073-L1-3) just meant that the daily curve numbers were not constant during simulation of SWAT. However, the typical curve numbers ($CN_2$) were still the most important parameter for runoff simulation. The detailed introduction listed above, if necessary, will be added into the revised manuscript.

**Comment:** The study used the first 3 years as a warm up period (1995 to 1997) without the model calibration so that the influence of model parameters was excluded. This is different from the commonly-used calibration/validation approach. More clarifications or explanations are needed on this approach.

**Answer:** The study used vegetation condition derived from Landsat TM imagery of 1999 for delineating land type units. It's why we chose hydrological data from 1998 to 2002 to evaluate the simulation. The purpose of simulation was to compare the performance of Hydrological Response Units (HRUs) and land type units, so no calibration was performed for the model for excluding the influence of model parameters. What's more, the hydrological data were limited: discharges were observed daily at the Ansai monitoring center from April to October, but observed on fixed dates in other months. Totally there were 56 monthly mean discharges (7 monthly data per year multiply 8 years) applicable. So the commonly-used calibration/validation approach was not applied in this study.

However, if we use 1 year (1995) as warm-up period, and use the following 3 years (1996-1998) as calibration period, and the last 4 years (1999-2002) as validation period, a reasonable results can still be gained (shown in table3).

The results came to a similar conclusion: model based on land type units performed better than that on HRUs; and there was a declining trend of model performance following the increase of units delineation thresholds.

The model simulated the runoff better in validation period (1999-2002) than in calibration period (1996-1998). The land use map used in this study was for year 2000. In 1998, land use changed dramatically in the studied area, for it's in the pilot region of the Grain for Green Project in China. Much crop land was fallowed or afforested that year. Land use map for year 2000 would lead to deviations for the simulation before 1998. It could also indicate that determination of land use type and vegetation condition is important for hydrological simulation.

Table 3. Simulation performance based on HRUs and land type units

| Discretized units | Threshold for units delineation | Number of units | $E_{ns}$ for monthly runoff in calibration period (1996-1998) | $R^2$ for monthly runoff in calibration period (1996-1998) | $E_{ns}$ for monthly runoff in validation period (1999-2002) | $R^2$ for monthly runoff in validation period (1999-2002) |
|---|---|---|---|---|---|---|
| HRUs | 0 | 256 | 0.496 | 0.547 | 0.593 | 0.758 |
| | 5 | 83 | 0.386 | 0.500 | 0.486 | 0.749 |
| | 12 | 60 | 0.262 | 0.450 | 0.326 | 0.702 |
| Land type units | 0 | 1547 | 0.617 | 0.642 | 0.757 | 0.792 |
| | 5 | 285 | 0.545 | 0.646 | 0.758 | 0.798 |
| | 12 | 85 | 0.443 | 0.651 | 0.737 | 0.795 |

**Comment:** It seems that water and residential districts are not used for land type unit delineation (Table 3). Were those land types explicitly considered in the hydrological simulation? I am sure they are important for hydrology.

**Answer:** Table 3 in the article showed the factors for land type unit delineation. The phrase "not applicable" meant that the factors were assumed to be unique or didn't exist in the corresponding land use types: vegetation condition was assumed to be unique in residential districts and water; and soil and slope was not considered in the rainfall-runoff processes in water bodies.

All the land used types were explicitly considered in the hydrological simulation when the units delineation threshold was set to 0. When the threshold was greater than 0, the units which take less area than the threshold would be excluded.

**Comment:** There are quite descriptions on the methods mentioned in the Results section. They should be moved to the Methods section. On the contrary, some results mentioned in the Discussion section (e.g., the section on page 9075-Lines 15-19) may be better placed in the Results section.

**Answer:** The Results and Discussion sections were adjusted based on the suggestion. The parts of units delineation factors, subbasin definition and units delineation thresholds setting were transferred to the Methods section. Parameter calibration mentioned in the Discussion section was added into the Results section.

**Specific comments:** P9065-L14: Minute should be replaced with minimum; P9066-L2: References should be added for the statement on the most common method for predicting runoff volume; P9066-L13: Water should be replaced with true; P9071-L10-11: The sentence "the hydrological condition...." is hard to understand; P9074-L6-8: the whole sentence is not clear; Table 4: Amount of units should be better replaced with number of units; Figure 1: What are gauge stations? Do you mean climate station? It is better to use hydrometric station for streamflow and meteorological station for climate; Figure 2: The scale bar should be changed to show exact numbers (e.g., 1 or 2 km).

**Answer:** Some changes, additional explanation and references was implemented in the article according to the specific comments. Some more standardized terms such as “hydrometric station”, “precipitation station” and “meteorological station” were applied. Thanks for the comments.