## **SWAT 2013 Toulouse France**



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July 17-19, 2013

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the in-house research arm of the U.S. Department of Agriculture

#### **Terrace Distribution in China**



#### **Terraces in Loess Plateau**









### **Terraces in Southwest China**







#### Terraces in Southeast Hilly Area of China



## **US** Terraces









## Sino-US Terrace Differences



|                | US Terrace                             | Chinese Terrace           |
|----------------|--|---------------------------|
| Туре           | Normal terrace                         | Mainly bench terrace      |
| Original Slope | Mostly Less than 10%                   | Mainly between 5% and 46% |
| Barrier        | Soil                                   | Soil or stone bank        |
| Drainage       | Underground pipe or grass water<br>way | Lined channel             |

#### Current methods to simulate terraces in SWAT

- Previous studies have represented terraces by changing the value of :
- ✓ Runoff effect: curve number (CN2)
- Erosion effect: slope length and USLE
   control practice factor (USLE P-factor)



#### **References:**

Arabi, M., J. R. Frankenberger, B. A. Engel, and J. G. Arnold. 2008. Representation of agricultural conservation practices with SWAT. *Hydrological Processes* 22(16): 3042-3055.
Waidler, D., M. White, E. Steglich, C. A. Jones, and R. Srinivasan. 2011. Conservation Practice Modeling Guide for SWAT and APEX. TR-399. College Station, Texas: Texas A&M University System.

# Terrace algorithm development

- Segment simulation
- ✓ Runoff: SCS curve number
- ✓ Erosion: MUSLE method
- ✓ Nutrients: nitrogen & phosphorous
- Plant growth: optimal growth & stress

Cut





Cut

#### Map of normal terrace

Soil layer 2

Soil layer 1

## Terrace storage effects



#### ✓ Terrace output







## SWAT Incorporation



The terrace algorithms were integrated into SWAT at the HRU level by creating a "sub-HRU" area with its own shape and soil system.

- Separate: soil, topography,
  - crop management
- ✓ Share: ground water
- ✓ Link: terrace output

(drainage, overland flow)

# Flowchart of the terrace simulation algorithm

The terrace algorithm code was incorporated in SWAT model version 488. The terrace simulation activation subroutine is called in the HRU loop of a terraced HRU.



#### Model testing



#### **Ottawa IAMS Site**



#### **Terraced Experimental Plots in China**

Yunnan Province,

China

A previously published 2 year long runoff, sediment and total nitrogen dataset collected on 2 natural rainfall runoff plots (one control plot and one terrace plot) in southwest China was used for calibration and validation.



#### Terraced field scale plots in Kansas, US

Franklin,

KS

2004

ND

The modified SWAT model was evaluated using a 4-year long 6-plot event runoff and sediment data set with 5 years of plant yield data collected on a natural rainfall terraced field in southeast Franklin County, Kansas.



#### Watershed application tool development

The tool creates and modifies terrace inputs for the relevant HRU's in a watershed, and facilitates the application of the terrace model at watershed scale.



#### Watershed application – Study Area



Cropland 41%

Forest: 14%

**Slopes: 2 – 64%** 

#### Upstream of Chejiachuan station of the Weihe River Basin

#### Watershed application – Problem



Weihe River Basin

Weihe River

Weihe river is the largest branch of the Yellow River. In recent years, the runoff and water resources have decreased a lot under similar rainfall level. Why? Water conservation measures in the upstream areas? Dams on the main reaches?

## **Preliminary Results**

Model setup:

- No change of land cover in the terrace.
- No adjustment of CN with slope.
   Results: No changes in runoff, ET, and groundwater







## Conclusions

- A process-based terrace algorithm was developed in SWAT to simulate the environmental effects of terraces, including normal terrace used in the US and bench terrace.
- Application results indicated successful performance of the terrace model at field and watershed scales.
- More applications on different types of terraces and soils will be needed for further validation and improvement of the model.
- Future development of a GIS tool to determine the terrace parameter values at the watershed scale will help effectively apply the model at larger spatial scales.





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# Thanks for your attention!