# Assessing the Hydrological Impacts of "Grain for Green" Policy in the Loess Plateau of Northern China

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# **Global Soil Degradation**



#### Soil erosion risk assessment



# **Program:** Grain for Green

- The program of "Grain for Green" began in 1999. It represents the largest vegetation restoration activity in China.
- It will re-vegetate around 14.67 million ha of cropland, 4.4 million of which are to be on cultivated land with a slope of at least 25 degrees.
- During the first three years, the program had extended to 20 provinces, 400 counties and 27 thousand villages.
- In 2002, Grain for Green was launched nation wide (Fu et al. 2006; Su et al. 2012).

#### Soil erosion control and ecosystem restoration





## **Research Question**

How is the "Grain for Green" program affecting the ecohydrological processes of the region (Fu et al. 2006; Wang et al. 2011; Su et al. 2012; Xu et al. 2012)?



#### 109°0'E 109°30'E 110°0'E 110°30'E -37°0'N 37°0'N-Zhidan An sai Bao ta -36°30'N Yan chang 36°30'N-Г.Г.\_\_ГК 04.59 18 27 Kilometers 109°0'E 109°30'E 110°0'E 110°30'E

#### Yanhe Watershed:

- 108° 38′-110° 29′E
- 36° 21′–37° 19′N
- 7725 km<sup>2</sup>
- 495 m to 1795 m above sea level





# **Conservation and re-vegetation programs in the Yanhe Watershed**

Program	Implementation Period
<b>Comprehensive Treatment Project in the Xinghe Watershed</b>	1987.3-1997.9
<b>Comprehensive Treatment Project in the Yanhe Watershed</b>	1994.10-2002
<b>Grain for Green Program</b>	1999-2008



## **Grain for Green**





Landuse	% for Year 2000	% for Year 2008
Forest	4.52	4.78
Shrubland	7.11	8.02
Grassland	45.68	68.32
Cropland	42	18.17
Urban area	0.33	0.35
Water	0.36	0.36

#### Assessment of the hydrological impacts of the "Grain for Green" program in the Yanhe Watershed



## **Distributed Large Basin Runoff Model**

- The Distributed Large Basin Runoff Model (DLBRM) is being applied to assess the hydrological impacts of the "Grain for Green" program in the Yanhe Watershed.
- The DLBRM was developed jointly by the NOAA Great Lakes Environmental Research Laboratory and Western Michigan University (Croley and He 2005;2006; He and Croley 2007; 2010). It has been applied to over 40 U.S. watersheds and the Heihe Watershed of Northwest China.
- The DLBRM divides the Yanhe Watershed into over 7,000 1- km<sup>2</sup> grid cells.
- Each cell of the watershed is composed of moisture storages of the upper soil zone (USZ), lower soil zone (LSZ), groundwater zone (GZ), and surface.



Schematic of Distributed Large Basin Runoff Model (DLBRM)



## **Hydrologic Station Data**



# Soil Type Data



- Soil types:
  - Dark-purple loess soil, 3.11%
  - Loess soil, 86.38%
  - Red clay soil, 5.30%
  - Alluvial soil, 5.21%



Figure 4. Comparison of the simulated and observed discharges in the Yanhe River for 1971.( r= 0.495, RMSE= 0.033

#### **Research Challenges**

- Data availability: e.g., unavailable soil attribute data such as available water capacity (%) of USZ and LSZ, permeability (cm/hr) of USZ and LSZ.
- Data compatibility: incompatible Chinese and U.S. land use and soil classification systems; and data format, etc.
- DLBRM applicability to the Yanhe Watershed.
- Lack of long term, accurate, representative streamflow and groundwater data for model calibration and confirmation.

# Summary

- The DLBRM is first calibrated against the observed streamflow data and then to be used to simulate the hydrology of the Yanhe Watershed prior to (2000) and after the implementation of the "Grain for Green" program (2008), respectively.
- Preliminary simulation results show that surface runoff and interflow accounts for 75% and 22% of the outflow, respectively, indicating the surface runoff is the main component of the discharge.
- Work is underway to assess the hydrological impacts of the "Grain for Green" program. Such results, once verified with field data, may be applicable to similar watersheds.

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