Effects of the South to North Water Diversion Project on Evaporation over North China Region

Ji CHEN (陈骥)
Dept. of Civil Engr., The University of Hong Kong, Pokfulam Hong Kong, China
General Layout of South-to-North Water Diversion Project

Legend

- East Route Project
- Middle Route Project
- West Route Project
- River Basin
- River Network
## South to North Water Diversion Project

<table>
<thead>
<tr>
<th>Stages</th>
<th>East Route (10^9 m^3)</th>
<th>Middle Route (10^9 m^3)</th>
<th>West Route (10^9 m^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2010</td>
<td>Phase I (8.9)</td>
<td>Phase I (9.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phase II (10.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011-2030</td>
<td>Phase III (14.8)</td>
<td>Phase II (13.0)</td>
<td>Phase I (4.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase II (9.0)</td>
</tr>
<tr>
<td>2031-2050</td>
<td></td>
<td></td>
<td>Phase III (17.0)</td>
</tr>
</tbody>
</table>

Planned water diversion of SNWDP in various stages
(Figures shown in table are the accumulated amount of water diversion)

(Source: http://www.nsbd.gov.cn)  **Total 45 billion m^3**
Basic Setting of Model

Variable Infiltration Capacity (VIC) Macro-scale Model

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial resolution</strong></td>
<td>$1^\circ \times 1^\circ$</td>
</tr>
<tr>
<td><strong>Number of Grids</strong></td>
<td>389</td>
</tr>
<tr>
<td><strong>Mode of Operation</strong></td>
<td>Water Balance Mode</td>
</tr>
</tbody>
</table>
VIC Model Input

Input Data Files

- Soil Parameter
- Vegetation Parameter
- Meteorological Forces

Parameter Files **DO NOT VARY** with time

Forcing Files **VARY** with time
# Soil Parameters

<table>
<thead>
<tr>
<th>Soil Texture &amp; Bulk Density</th>
<th>5 minute FAO-UNESCO digital map of the world [FAO 1995]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remaining characteristics</td>
<td>A statistical exploration of relationships of soil moisture characteristics to the physical properties of soils [Cosby et al., 1984]</td>
</tr>
</tbody>
</table>
## Typical Soil Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness of Soil Layer 1 (m)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Thickness of Soil Layer 2 (m)</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Thickness of Soil Layer 3 (m)</td>
<td>0.18</td>
<td>0.25</td>
</tr>
<tr>
<td>Saturated Hydrologic Conductivity (mm/day)</td>
<td>100</td>
<td>850</td>
</tr>
<tr>
<td>B-value of Infiltration Curve</td>
<td>0.05</td>
<td>0.25</td>
</tr>
<tr>
<td>Expt-value of Infiltration Curve</td>
<td>9.0</td>
<td>17.0</td>
</tr>
</tbody>
</table>
Vegetation Parameters

- AVHRR-based, 1km, Global Land Classification [Hansen et al., 2000]
- 11 types of vegetation
- Percentage area in grid cell & root depth distribution
Distribution of Bare Ground
Distribution of Crop Land

Legend
- River Network
- River Basin Boundary
- Province Boundary

Crop Land
- 94.0%
- 1.0%
Meteorological Forcing Data File

- Types of Input Data
  - Daily precipitation
  - Maximum daily temperature
  - Minimum daily temperature
  - Daily wind speed

Source of the input data: Chinese Meteorological Data Center

- 50 years data
  - January 1, 1951 to December 31, 2000
  - 40-year data (1961-2000) used in the study
Variation of Annual Precipitation from 1961 to 2000

- Yangtze River
- Yellow River
- Huaihe River
- Haihe River


Annual Precipitation (mm/year)
Precipitation before construction of South-to-North Water Diversion Project
Evaporation before South-to-North Water Diversion Project
Runoff before construction of South-to-North Water Diversion Project
Types of Water Diverted Considered

- Industrial
- Domestic
- Uses of Diverted Water
  - Agricultural
Water Diversion

- **East Route Project**
- **Source:** Brief Introduction of SNWDP General Planning, China Water Resources 2003-1B

<table>
<thead>
<tr>
<th>Province</th>
<th>Total Water Diverted ($10^9$ m$^3$)</th>
<th>Water for Irrigation ($10^9$ m$^3$)</th>
<th>Percentage for Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiangsu</td>
<td>3.107</td>
<td>0.711</td>
<td>22.8%</td>
</tr>
<tr>
<td>Anhui</td>
<td>0.328</td>
<td>0.197</td>
<td>60.0%</td>
</tr>
</tbody>
</table>
Water Diversion

- Middle Route Project
- Source: Sino-Italian Cooperation Program for Environment Protection

<table>
<thead>
<tr>
<th>Province</th>
<th>Total Water Diverted ($10^9$ m$^3$)</th>
<th>Water for Irrigation ($10^9$ m$^3$)</th>
<th>Percentage for Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hubei</td>
<td>1.10</td>
<td>0.91</td>
<td>82.7%</td>
</tr>
<tr>
<td>Henan</td>
<td>5.40</td>
<td>1.53</td>
<td>28.3%</td>
</tr>
<tr>
<td>Hebei</td>
<td>4.88</td>
<td>2.02</td>
<td>41.4%</td>
</tr>
</tbody>
</table>
# Water Diversion

- **West Route Project**
- **Source:** Brief Introduction of SNWDP General Planning, China Water Resources 2003-1B

<table>
<thead>
<tr>
<th>River Section</th>
<th>Total Water Diverted (10^9 m^3)</th>
<th>Water for Irrigation (10^9 m^3)</th>
<th>Percentage for Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longyangxia ~ Lanzhou</td>
<td>2.5</td>
<td>0.3</td>
<td>12.0%</td>
</tr>
<tr>
<td>Lanzhou ~ Hekou</td>
<td>3.5</td>
<td>0.2</td>
<td>5.7%</td>
</tr>
<tr>
<td>Longmen ~ Sanmenxia</td>
<td>5.0</td>
<td>0.5</td>
<td>10.0%</td>
</tr>
</tbody>
</table>
Area Affected by South-to-North Water Diversion Project

Legend

River Network  River Basin Boundary  Province Boundary

Grid Points Affected by ERP

Grid Points Affected by MRP

Grid Points Affected by WRP

Influenced Area of ERP

Influenced Area of MRP

Influenced Area of WRP
Crops Considered

Major Crops in North China

- Winter Wheat
- Summer Maize
Dates of Irrigation

• Agro-phenological Atlas of China

Winter Wheat

- Sowing date
- First tillering date
- Jointing date

Summer Maize

- Sowing date
- Jointing date
- Heading date
# Dates of Irrigation

<table>
<thead>
<tr>
<th>Season</th>
<th>ERP</th>
<th>MRP</th>
<th>WRP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Winter Wheat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earliest</td>
<td>Oct 8</td>
<td>Sep 5</td>
<td>Sep 5</td>
</tr>
<tr>
<td>Latest</td>
<td>Apr 3</td>
<td>May 5</td>
<td>May 1</td>
</tr>
<tr>
<td><strong>Summer Maize</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earliest</td>
<td>Jun 1</td>
<td>Jun 11</td>
<td>Jun 16</td>
</tr>
<tr>
<td>Latest</td>
<td>Sep 2</td>
<td>Aug 15</td>
<td>Aug 15</td>
</tr>
</tbody>
</table>
Percentage change in evapotranspiration after construction of SNWDP

Legend:
- Grid Points Affected by ERP
- Grid Points Affected by MPR
- Grid Points Affected by WRP
- River Network
- River Basin Boundary
- Province Boundary

Evapotranspiration Percentage Change
- 2.80%
- 0.00%
Yellow River basin
987339.8 km²
Huai River basin
46846.6 km²
Haihe irrigat/Precip

Haihe △Evap/Evap_{bef}

Hai River basin
218373.3 km²
Conclusion

• The effect of irrigated water from the South to North Water Diversion Project on regional evapotranspiration over North China is considerable.

• Annually, the maximum percentage of the evaporation difference over the region will be about 2.8%.

• However, the daily scale data show that the percentage of the difference may reach 18%.
Thank You!