Agricultural water consumption management

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January 30, 2024, Chiang Rai, Thailand
Outline

- Background and concept
- ETWatch
- Agricultural Water Management
- Capacity building activities
- Outlook
Most arid and semi-arid regions in the world are suffering serious water crises. Where water gone?

Water surface shrinkage of Aral Sea

Water surface shrinkage of Ebinur Lake

Water surface shrinkage of AiDing Lake

Groundwater funnel in North China
**ET is the real water loss**

**Evapotranspiration**: the canopy transpiration and soil evaporation

- ET is the actual water consumption.
- ET is the important segment of water circulation, which is 70-80% of rainfall at arid/semi-arid region.
- ET is equally important to precipitation, hydrological observation.

Most water resources are used for agriculture, and reducing agricultural water consumption and improving agricultural water management are key to sustainable development in arid and semi-arid region.

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![Diagram of water cycle with ET, Precipitation, Runoff, Irrigation arrows]
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■ ETWatch
■ Agricultural Water Management
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Sub models

- Net-radiance model
- Surface soil heat flux model
- Aerodynamic roughness length model
- Atmospheric Boundary Layer model
- Vapor pressure deficit model
- Canopy conductance model
- Sensible heat flux model
- Latent heat flux model
- Bare soil evaporation model
- Water surface evaporation model
- Ice snow sublimation model
- Latent heat flux model
- ET fusion model
- Coupling water and carbon processes Model
- Field scale ET allocation model
ETWatch Cloud Platform

API List

Homepage http://www.etwatch.cn/

Register

Login
Application: ETWatch in China

- 1m ET and 30m ET in Heihe River Basin, 2000-2014
- 250m ET and 30m ET in Ebinur Lake 2009-2015
- 250m ET in Turpan Basin 2006-2016
- 5m ET in Ertanggou, 2012-2013
- 30m ET in Turpan Oasis, 2008-2016
- 1m ET and 30m ET in Hai Basin, 1984-2018
- 30m ET in Beijing, 2002-2018
- 30m ET in Tianjing, 2002-2018
- 30m ET in Hebei, 2002-2018
- 30m ET in Turpan Oasis, 2008-2016
- 1km ET in Three north region 2003-2009

- 5m-1km ET data
- Multi-party independent validation:
  - annual accuracy, 97%
  - daily accuracy, 90-93%
ETWatch for China Geological Survey

- ETWatch is used for water resource assessment nationwide, basin by basin for organizations over the country.
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Case Study in Ertangou basin

- Turpan is located at Xinjiang Province of China.
- **Aiding Lake** is located in Turpan, with multi-year average precipitation of 16mm/year, which is the lowest altitude in mainland China.
- Influenced by water amount from the upper reaches of Ertangou basin, as well as the increase in agricultural water consumption from the down reaches of Ertangou basin, AiDing Lake almost dries up and disappears.
ET Management Concept

- How much water was consumed in Basin?
- How much water can be consumed by human activities?
- What is main factors caused groundwater depletion?
- How to reduce water consumption?

**ACW = P – ETn – Uncontrollable Outflow**

- **P**: Precipitation
- **ETn**: evapotranspiration from natural landscapes

\[ ET_n = ET_{forests} + ET_{grassland} + ET_{wetland} + ET_{bareland} + ET_{fal} + ET_{urban} \]
Available consumption water (ACW) in Ertanggou

Precipitation was 107.99 million m³, ETn was 20.82 million m³, ACW in Ertanggou was 87.17 million cubic meters.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units: $10^4$ m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
</tr>
<tr>
<td>Precipitation</td>
<td>12,824</td>
</tr>
<tr>
<td>Natural water consumption</td>
<td>2,224</td>
</tr>
<tr>
<td>Available consumption water (ACW)</td>
<td>10,600</td>
</tr>
</tbody>
</table>
The actual groundwater deficit in Ertangou from 2008-2013 was approximately 66.7 million cubic meters.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available consumption water (ACW)</th>
<th>Actual water consumption</th>
<th>Groundwater deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>106.0</td>
<td>164.2</td>
<td>-58.2</td>
</tr>
<tr>
<td>2009</td>
<td>105.0</td>
<td>160.9</td>
<td>-55.9</td>
</tr>
<tr>
<td>2010</td>
<td>57.0</td>
<td>142.1</td>
<td>-85.1</td>
</tr>
<tr>
<td>2011</td>
<td>42.0</td>
<td>172.5</td>
<td>-130.5</td>
</tr>
<tr>
<td>2012</td>
<td>94.0</td>
<td>148.1</td>
<td>-54.1</td>
</tr>
<tr>
<td>2013</td>
<td>118.0</td>
<td>134.1</td>
<td>-16.1</td>
</tr>
<tr>
<td>AVE.</td>
<td>87.0</td>
<td>153.7</td>
<td>-66.7</td>
</tr>
</tbody>
</table>

What is happened in the Ertangou?
Rapid development of irrigated agriculture in the Ertangou

- The increase in irrigated agricultural area in 2012 over 1990 was 56%
- The new additional water consumption in Ertangou was about 51.57 million cubic meters from 1990 to 2012
Agricultural target water consumption in Ertanggou

Population growth control objectives in Turpan-- The growth rate of less than 3‰. Industrial average growth speed was is 3.58% from 2008 to 2013 in Turpan. Industrial, domestic, and agricultural target ET were calculated based on industrial and domestic water consumption survey data in Ertanggou in 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>Target water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basin</td>
</tr>
<tr>
<td>2008-2013</td>
<td>8,717</td>
</tr>
<tr>
<td>2020</td>
<td>8,717</td>
</tr>
<tr>
<td>2030</td>
<td>8,717</td>
</tr>
</tbody>
</table>

- The groundwater was not be over exploitation in Current stage and agricultural target ET is 8297 million m³.
- Agricultural target ET will be 7,935 million m³ in Ertanggou in 2020.
- Agricultural target ET will be 7,816 million m³ in Ertanggou in 2030.
Crop type proportion and ET intensity of crops

Combined crop type proportion and annual ET dataset, the ET intensity of crops was $441 \text{ m}^3/\text{mu}$, equal to $661 \text{ mm}$.

\[
\text{ET}_{\text{crop}} = \sum_{i=1}^{N} \text{Frac}_i \times \text{ET}_i
\]

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>ET(mm)</th>
<th>ET(m³/mu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape</td>
<td>851</td>
<td>567</td>
</tr>
<tr>
<td>Cotton</td>
<td>584</td>
<td>389</td>
</tr>
<tr>
<td>Cotton and melon</td>
<td>610</td>
<td>407</td>
</tr>
<tr>
<td>Double Melons</td>
<td>679</td>
<td>453</td>
</tr>
<tr>
<td>Others</td>
<td>577</td>
<td>385</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>661</strong></td>
<td><strong>441</strong></td>
</tr>
</tbody>
</table>
In 2013, the protected cropland area was $20.8 \times 10^4$ mu, which also was beyond the limitation of ACW of agricultural.
KM system of Turpan

Knowledge management system was built from 2013 to 2016, and it consist of following fours sub-systems: General information of Turpan water resources, Water consumption management, Water conservations management, Water policy making. KM include 20 kinds of dataset, Volumes of data is 5TB.

- Including crop types, irrigation area, farm name, water consumption, water source, water sources change for City, County, Country ET analysis.
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Customised ETWatch-Egypt system and training

- Unit of participants
  - National Authority for Remote Sensing & Space Sciences (NARSS), Egypt.
  - Agriculture research center, Egypt
  - Water Management Research Institute, Egypt
Train technicians to carry out ET monitoring and ET analysis of different irrigation methods

The modern irrigation may save water consumption.

But if planting three crops in a year will consume more water as 2014.

ET:
1280.5mm in 2014
990.9mm in 2015
China-Lebanon joint laboratory on modern agriculture and water management

- Joint construction units

Aerospace Information Research Institute, Chinese Academy of Sciences (AIRCAS)

National Center for Remote Sensing, National Council for Scientific Research, Lebanon (CNRS-L)

China Irrigation and Drainage Development Center, Ministry of Water Resources
Construction of Water and Heat Flux Observatories networks in Bekaa Valley, Lebanon

- Eddy correlation observation system, 1 sets
- Net radiation system, 2 sets
- Tree-stem sap flow system, 4 sets
Systems, ET datasets, water use efficiency and agricultural water productivity

Evapotranspiration systems

ET datasets

water use efficiency

Agricultural water productivity
Technician training for five Arab countries in the Middle East

- Training in ET monitoring, observation and agricultural water management methods in irrigation districts
- Technical staff of the National Centre for Remote Sensing of Lebanon, the Lebanese Agricultural Research Institute, Tunisia, Jordan, Yemen, etc.
CropWater plan

- Field-scale crop **water consumption monitoring**
- Carrying out a **comprehensive analysis** and assessment of agricultural water use and proposing agricultural water management strategies focusing on optimizing crop cropping structures and improving the efficiency of agricultural water use.
- Capacity-building activities **for different countries**

### Field scale crop ET impact factors

- **Crop type**
- **Crop growth**
- **Plant density**
- **Soil moisture**

### Field ET allocation method

\[
ET_{field_i} = \frac{ET_{1km}}{AF_{field_i}}
\]

### Estimation of ecological water consumption based on target water levels

\[
ET = F(H,A)
\]

### Target ET(ETt)

**Target ET Optimization**

- **Trade-off strategy**

\[
ET \leq W - (EC+ES)
\]

- **No**
- **Yes**

### Improve WUE

- **Optimizing crop planting structures**

- **Return cropland to save water**

### Target Ecological Water Consumption Adjustment (EST)

- **No Trade-off strategy**

### Design of ET-based Water Rights Administration System for Xinjiang China
Thank you!

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