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Water safety under climate change

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1. Water resources under climate change

In the past 50 years, China's water resources have decreased significantly due to natural factors and human activities. The Haihe River Basin has the most significant reduction, with precipitation decreasing by 9%, surface water by 49%, and total water resources by 31%.
1. Water resources under climate change

The past, present and future water cycles in the Haihe River Basin were simulated and predicted, and the evolution of water resources at different time scales was systematically studied, then six laws were revealed. These laws are of universal significance in northern China and are reflected to varying degrees worldwide.

The water circulation flux in the basin is strengthened, and the proportion of the cross-basin water vapor circulation flux in the total water circulation flux decreases under the sea-land water vapor circulation.
The relationship between surface and groundwater circulation processes in the basin is weakened, and the cyclic repetition between surface water and groundwater decreases, while the non-repetition increases by 65%.

<table>
<thead>
<tr>
<th>Time</th>
<th>1956-1979</th>
<th>1980-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>1812.8</td>
<td>1596.2</td>
</tr>
<tr>
<td>Surface water</td>
<td>326.2</td>
<td>158.9</td>
</tr>
<tr>
<td>Groundwater resources</td>
<td>284.9</td>
<td>222.7</td>
</tr>
<tr>
<td>Non-repetition</td>
<td>84.7</td>
<td>139.9</td>
</tr>
</tbody>
</table>

Unit: 100 million m$^3$
The relationship between the soil and groundwater cycle in the basin is weakened, the amount of groundwater supplied by soil under water is reduced, and the cycle of groundwater cycle renewal is prolonged.

The soil aeration zone is thickened and the deep infiltration decreases.

Shallow groundwater total storage variable in plain area

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The total effect of human activities makes the vertical flux of water cycle increase, the horizontal flux decrease, and the runoff coefficient decrease from 0.18 to 0.10.
1. Water resources under climate change

Under the dual drive of climate change and human activities, both narrow water resources and broad water resources decreased, but the former (28%) decreased much more than the latter (11%).
Through quantitative attribution analysis, it was found that human activities contributed 62% and natural variation accounted for 38% of the above water cycle evolution rules.

Natural climate variability is the main cause of the decline in precipitation over the past 50 years in the Haihe River Basin.

Greenhouse gas emissions and solar activity volcanic eruptions are two factors that contribute to the temperature increase in the Haihe River Basin over the past 50 years, with contributions of 84% and 16% respectively.

Natural climate variability and regional human activities are two factors that have contributed to the decline of water resources in the Haihe River Basin over the past 50 years, with contributions of 38% and 62% respectively.
2. The issue of water security

Contradiction between supply and demand of water resources

Serious water pollution

Degradation of aquatic ecosystems

Extreme / emergencies frequently occur
2. The issue of water security

70% of China's water is concentrated **in the flood season**, and nearly 40% of the water needs to be allocated for use throughout the year. Dams are needed to regulate floods and ensure water resources security. In addition to the imperfection of the engineering facilities system, the contradiction between supply and demand of water resources is prominent in North China, Northwest China, Southwest China and coastal cities. Water shortage is about 50 billion m$^3$ in normal years.
2. The issue of water security

The national compliance rate of water functional zones is 51.8% for surface water functional zones throughout the year, and the groundwater quality is generally not satisfactory. Water pollution is complex, chronic and basin-wide, and has become the most serious and prominent problem of water security.
2. The issue of water security

Affected by factors such as rapid economic and social water use and land development and utilization, water ecosystems are seriously degraded, rivers are cut off, lakes are shrinking, wetlands are reduced, aquatic species are reduced, and habitats are degraded. The function of freshwater ecosystem presents a trend of "partial improvement and overall degradation".
Global climate change has exacerbated the rate of natural water cycle and increased the probability of extreme weather events such as rainstorms, droughts and typhoons. In recent years, the frequency of flood and drought disasters has increased, and the drought area of the main agricultural areas in northern China has shown an expanding trend. In addition, urban waterlogging has become a new feature of flood disaster at this stage.
2. The issue of water security

The root cause of water safety problems

- Population growth and economic growth
- Lagging behind in water conservancy construction
- Weak public awareness of water saving
- Extensive use of water
- Agglomeration of economic and social development
2. The issue of water security

**Watershed water cycle** is the objective basis for the formation and evolution of water resources. Whatever the manifestation of water security problems is, it can be attributed to the **unbalances** caused by water cycle sub-items or associated processes.

- **Water shortage problem**: the imbalance of evolution between natural water cycle and social water cycle
- **Flood event**: evolution of natural water cycle processes under climate change
- **Ecological environment**: water chemistry and ecological process evolution associated with water cycle are unbalanced
3. Water security strategy

**Four principles**

**Strengthen demand management.** Water saving means pollution control. Increase ecological flow. Do hard prevention.

**Two hands**

- Water saving priority
- Spatial equilibrium
- System governance
- Population economy and resource environment balance. Increase ecological space and adjust industrial layout

The government and the market are working together. Let the market drive development and take various measures to form a benign mechanism.

- The mountains, water, forests, fields and lakes are coordinated. Adopt comprehensive means to govern.
3. Water security strategy

Response measures

Water-saving society construction

Water environmental protection
Water resources security

Water ecological civilization construction

The most stringent water resources management

Water pollution control action
Thanks for your attention.