A tentative discussion on the monitoring of water resources in China

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Outlines

- Introduction
- Hydrometric network development
- Application of monitoring technology
- remarks
1. Introduction

1.1 Precipitation in China

The annual rainfall in average in China is about 650mm, which is unevenly temporally distributed:

- 70% in flood season (4 months)
- 30% in dry season (8 months)
Unevenly spatially distributed:

Northern China
- Rainfall: 19%
- Population: 47%
- Farm land: 64%
- GDP: 45%

Southern China
- Rainfall: 81%
- Population: 53%
- Farm land: 36%
- GDP: 55%
1.2 Water resources in China

China is a country with limited water resources. According to the 2nd national water resources assessment in early 21 century:

- the total amount of water resources in the country:
  \[2,841 \text{ b.m}^3, \text{ the 6th in the world}\]

- The amount of water availability per capita:
  \[2,185 \text{ m}^3, \text{ <1/3 of the world average}\]
1.3 Problems facing

Following with the rapid economic development & increasing impact of climate changes in last decades, contradictions between water supply & water demand in China is outstanding:

- **water scarcity** in the north is intensified
- **water pollution** in the south is serious
- **water utilization efficiency** is poor in comparison with those in developed countries

All these increase the vulnerability of regional water shortage and deterioration of eco-environment system.
Water problem in China

Number of cities short of water

- Total: 661
- Scarcity: 400
- Severe: 110

March, 2010, Southwest China
Water diversion projects across the country

- Yellow River
  - Luanhe - Tianjin
  - Luanhe - Tangshann
  - south-north (west route)

- Yangtze River
  - Three-Gorge
  - central route
  - south-north (east route)
  - Shanghai

International conference on water resources assessment and seasonal prediction
1.4 The new water policy

- To solve water problems and improve the water environment conditions, Chinese government also promoted the stringent water resources management system as a key government policy on water in 2009.

- The new policy focus on the administrative divisions as units, pushing the local governments at all levels to take full responsibility for the rational and effective management of regional water.

- Government performance on rational water consumption and effective water conservation at their administrative regions are examined every year.
Process of policy development

- Promote the **water policy** (by 2009)
- Establish control indices of the water volume, efficiency of water use, and water pollution as three “red lines (by 2012).
- Establish **evaluation standards** and implementation regulations (by 2014).
- Establish monitoring system, e.g., the **interprovincial monitoring planning** (by 2014)
- Carry out **assessment** (by 2015)
## The controlling indices of water utilization

<table>
<thead>
<tr>
<th>year</th>
<th>volume control</th>
<th>efficiency improvement</th>
<th>pollution control</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>*620 billion.m³</td>
<td>irrigation water utilization efficiency reach 0.53, industrial value-added water consumption reduce by 30%</td>
<td>no less than 60% of main rivers and lakes satisfy the national water quality standards (COD, ammonia-nitrogen)</td>
</tr>
<tr>
<td>2020</td>
<td>670 billion.m³</td>
<td>irrigation water utilization efficiency above 0.55</td>
<td>Full coverage</td>
</tr>
</tbody>
</table>

*indices are further divided for each local region*
2. The hydrometric network development in China

Monitoring of water resources is the basis for the management of water. Water resources monitoring in China is usually distinguished as:

- dynamic monitoring for natural water cycle
- metering monitoring for water utilization

(water survey for areas without monitoring)
After decades of development, a comprehensive hydrometric network has been established in the country, which provides basis for water management. In total, there are 93,617 different kinds of monitoring stations across the country.

### Hydrological monitoring stations in China

- **Soil moisture**: 1927
- **Water quality**: 12869
- **Groundwater**: 16990
- **Evaporation**: 21
- **Precipitation**: 46980
- **Water level**: 9890
- **Experiment**: 58
- **Basic flow station**: 3172
- **Specific flow station**: 1710
Distribution of hydrological monitoring stations in China
2.1 monitoring for natural water cycle

(1) Surface water monitoring
The average density of national hydrological stations is 1,966 km²/site, which provide full coverage of major river basins all over the country. With the data collected, hydrological characteristics & water resources conditions of river basins can be evaluated.

- Where, there are about 1,700 forecast sections (for flood & water regulation) in the country, distributed on the major river stems and large tributary control sections.
However, the existing network was mainly developed for better understanding the hydrological regime of catchments. It cannot satisfy the intensified demand of water management policy at administrative divisions. Therefore, we carried out monitoring network planning on interprovincial boundary rivers, the principles are:

- major river stems and their first tributaries,
- rivers whose catchment areas greater than 1000 km$^2$,
- key interprovincial water transfer project or interbasin water diversion project channels,
- water vulnerable areas or serious pollution areas of the interprovincial boundary water bodies.

Based on above principle, a total number of 841 monitoring stations are planned on interprovincial boundary water sections.
Outcome of the planning monitoring sites on interprovincial boundary waters distributed by 7 main river basins

<table>
<thead>
<tr>
<th>basin</th>
<th>Basin area (M.km²)</th>
<th>Planning stations</th>
<th>Of which existing stations</th>
<th>Of which planned new stations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>automatic monitoring sites</td>
</tr>
<tr>
<td>Yangtze river</td>
<td>180</td>
<td>248</td>
<td>87</td>
<td>161</td>
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<td>4</td>
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<td>133</td>
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<td></td>
<td>24</td>
</tr>
<tr>
<td>Yellow river</td>
<td>368</td>
<td>85</td>
<td>60</td>
<td>25</td>
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<td>8</td>
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<tr>
<td>Huaihe river</td>
<td>33</td>
<td>89</td>
<td>34</td>
<td>55</td>
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<td>13</td>
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<tr>
<td>Haihe river</td>
<td>32</td>
<td>199</td>
<td>103</td>
<td>96</td>
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<td>17</td>
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<tr>
<td>Songliao river</td>
<td>80</td>
<td>100</td>
<td>49</td>
<td>51</td>
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<td></td>
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<td>43</td>
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<td></td>
<td>8</td>
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<tr>
<td>Pear river</td>
<td>122</td>
<td>62</td>
<td>14</td>
<td>48</td>
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<td>36</td>
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<td>12</td>
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<tr>
<td>Taihu lake</td>
<td>27</td>
<td>58</td>
<td>12</td>
<td>46</td>
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<td></td>
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<td>9</td>
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<td>4</td>
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<tr>
<td>total</td>
<td>841</td>
<td>359</td>
<td>482</td>
<td>39</td>
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<td>357</td>
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<td>86</td>
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</tbody>
</table>
Planning hydrological monitoring stations for interprovincial boundary rivers
Example of planning monitoring sections along boundary waters of JiangSu province, ZheJiang provinces and Shanghai Municipality in east China
Analysis shows that,

- in the planning, there are **367 interprovincial boundary rivers** whose drainage areas are above 1000 km².
- where, monitoring stations for **333 tranboundary rivers** at their provincial administrative sections are deployed, accounting for **91% of the total 367 rivers**.
- with the planning monitoring capacity, an average **88% of total inflow and outflow for provincial administrative waters** can be effectively monitored.
- taking into account the work of water survey for un-gauged areas, **the planning can meet the increasing needs of regional water management for provincial administrative divisions**.
Analysis result of the planning monitoring sites on interprovincial waters whose drainage area above 1000 km²

<table>
<thead>
<tr>
<th>basin</th>
<th>rivers drainage area &gt;1000 km²</th>
<th>rivers with planning stations</th>
<th>percentage</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>367</td>
<td>333</td>
<td>91%</td>
<td></td>
</tr>
<tr>
<td>Yangtze river</td>
<td>123</td>
<td>105</td>
<td>85%</td>
<td>Rivers without monitoring stations mostly located in mountainous region with little water demands.</td>
</tr>
<tr>
<td>Yellow river</td>
<td>70</td>
<td>63</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Huaihe river</td>
<td>31</td>
<td>31</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Haihe river</td>
<td>46</td>
<td>46</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Songliao river</td>
<td>53</td>
<td>48</td>
<td>91%</td>
<td></td>
</tr>
<tr>
<td>Pear river</td>
<td>43</td>
<td>39</td>
<td>91%</td>
<td></td>
</tr>
<tr>
<td>Taihu lake</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
(2) Groundwater monitoring

Up to now, we have 16,990 groundwater monitoring stations in total. Through monitoring, the dynamic of regional groundwater level & groundwater storage changes can be outlined.

However, most of the existing groundwater monitoring sites are distributed in northern China, which are manual monitoring based. Moreover, nearly half the sites are supplemental stations which are monitored 3-4 time/ year, and only about half of the sites are monitored at regular base at once a week.
State groundwater automatic monitoring system

Groundwater monitoring centre of MWR

River basin monitoring centre

Provincial monitoring centre

Perfection centre stations

Automatic transmission

Processing & submission

Data management

Decision support

State flood defense & drought relief command system

(main plains of 3.5 million km²)

10298 automatic monitoring sites
(3) Water quality monitoring

- More than 12,000 quality monitoring sections are located at water source, waste water outlets to rivers, and international water borders across the country. They cover nearly 80% main water bodies of the country.

- Again, to strengthen the water quality monitoring, we further promoted a planning on surface water quality monitoring with total number of 16,392 sections, which would provide strong support to the country’s water protection goals by year 2020.
example of water quality monitoring sites on Yangtze river
2.2 Monitoring for water utilizations

In comparison with natural water cycle monitoring, monitoring for water utilization is relatively weak. Currently, statistic method such as water consumption quotas is still widely used. And about 30% of industrial and 70% of agricultural water have not yet been directly measured.

Based on such circumstance, monitoring of water consumptions are strengthened by focusing on important users in following principle:

- **centralized public and industrial users** with annual surface water consumptions above 300 million m$^3$
- **licensed public and industrial users** with annual groundwater consumptions above 50 million m$^3$
- **users taken water from vulnerable and sensitive water-bodies** for specific purpose
With above principle, a state project on water resources monitoring capacity-building has been further put forward. Through the project, online monitoring of 8558 key water users can thus be effectively delivered.
3. Application of monitoring technology

(1) Monitoring for water level

- automatic monitoring of water level is extensively applied in China. And we have more than 90% of the surface water level which is automatically monitored.
- The float type, pressure type & bubble type water level meters are the major automatic monitoring instruments in China.
(2) Monitoring for discharge

We usually classify as velocity-area method, hydraulics method, tracer method and volumetric method.

- **For open channel flow monitoring**, velocity-area method is most commonly used for nearly 80% of the national basic hydrological sites.
- **For pipe flow monitoring**, velocity-area method and volumetric method are extensively used for industrial and domestic pipe flows, while indirect measurement such as electricity meter & water quota are the typical methods for groundwater exploitations.
monitoring with rotor type flow meter

monitoring with the velocity-area method of current profiler type

Hydraulic structure

Water metering

Wedging monitoring
(3) Monitoring for water quality

- Water quality monitoring generally can be either manual monitoring or automatic measurement. While **manual sampling and laboratory analysis** is the main method for water quality monitoring in China.
Online monitoring of reservoir water quality (Guangdong)

Water quality touring vehicle

Automatic quality monitoring station at Three-Gorges
4. Remarks

Above demonstration show that,

- a comprehensive hydrometric network has been developed in China. The distribution of hydrological sites and monitoring elements are basically in consistent with regional economic and social development patterns of the country. And the monitoring technology applied are mature.

- due to unbalanced economic development of the country, the monitoring network has also been developed unevenly. Which cannot satisfy the demand of the new water management policy.
The hydrometric network planning on transboundary waters, as well as the projects on capacity-buildings for both quantity and quality monitoring can satisfy the demand of new water management policy. And there is an urgent need to accelerate their implementations.

considering the cost of human resources for stationary monitoring stations, it is desire to actively promote the automatic monitoring ability in the country.
Thanks for your attention!