Assessment indicators for modernization of large scale irrigation districts

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1. Challenges faced by large scale irrigation districts and necessities of modernization

Large scale irrigation districts (>20000 ha² in China)

By the end of 2016, the number of large scale irrigation districts in China is 458, and total irrigation area is 17.7 million ha², accounting for 26.6% of the total farmland irrigation area of whole country. Irrigation water consumption of large scale irrigation districts is 110.93 billion m³, accounting for about 33% of the total irrigation water use in China.

Distribution of large scale irrigation districts in China

The Chinese government has put forward development strategy in the near future:

- Adhere to the "five development concepts": innovation, coordination, green, opening and sharing.
- Promote synchronous development of new industrialization, informatization, urbanization and agricultural modernization.
- Implement rural revitalization strategy and national water-saving action project.
- Guarantee national grain safety.
- Adhere to civilization developing path of production development, life prosperous, healthy ecology, and to build China more beautiful.

National development targets:

- By 2020, an all-around well-off society will be established.
- By 2035, national modernization will be basically realized.
- By 2050, a prosperous, strong, democratic, civilized, harmonious and beautiful modern country will be built up.
The large irrigation districts in China are facing many challenges:

1. An increase in climate events, an increase in occurrence probability of disaster of drought and water logging for grain production.
2. The irrigation area of large scale irrigation districts accounts for 14.4% of the cultivated land of whole country, grain production accounts for 26% of the total in China. The large scale irrigation districts undertake more aggravated task of grain production.
3. More difficulty in water distribution, backwardness in management methods, weakness in service capacity and low efficiency in management, which are far from the requirements of "optimal allocation, efficient water use" and agricultural modernization.
4. The large intensity, improper irrigation and other human activities in large scale irrigation districts may have a negative effect on this ecosystem.

To scientifically plan construction and development of large scale irrigation districts in the future, to promote irrigation districts modernization, to realize the mode change from traditional to high efficient water-saving irrigation, to promote agricultural production mode reform, provide important practical significance for improvement of agricultural production capacity, increase of farmers’ income and ecological environment improvement.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inlet</th>
<th>Outlet</th>
<th>Average Reduction Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃-N</td>
<td>0.31</td>
<td>0.06</td>
<td>80.6%</td>
</tr>
<tr>
<td>TH</td>
<td>0.98</td>
<td>0.54</td>
<td>44.9%</td>
</tr>
<tr>
<td>TP</td>
<td>0.41</td>
<td>0.32</td>
<td>26.3%</td>
</tr>
<tr>
<td>COD</td>
<td>22.4</td>
<td>16.5</td>
<td></td>
</tr>
</tbody>
</table>

| Effect of ditch type artificial wetland treatment |
Four priorities and four overall plans:
- Give priority to renovation and construction of aging projects, and overall plan new project construction.
- Give priority to improving and restoring existing irrigation area, and overall plan to develop new irrigation area.
- Give priority to adoption of mature new technology and products, and overall plan to apply traditional technology and methods.
- Give priority to meet urgent needs of the people's livelihood, overall plan to improve ecological environment.

2.2 Principle of modernization development

2.3 Modernization construction contents and standards

2.3.1 Security guarantee

(1) Design standard of waterlogging control in rural regions should be up to more than 10 year frequency, and in some important towns it should be up to more than 20 year frequency.

(2) Flood-control project of farmland should meet design standard, which should be up to 20 years frequency in irrigated areas, and up to 100~50 years frequency in important areas or in irrigation districts with area of over 200 thousand hm².

(3) Establish early warning system for natural disasters (flood, drought, wind, hail and so on), perfect disaster prevention system, decision-making and emergency response system to meet the requirements of agricultural modernization on disaster prevention.

2.3.2 Irrigation and drainage facilities

(1) The irrigation area should reach the standard which ensure stable yields despite occurrence of normal drought or waterlogging, and the water saving irrigation area should be more than 90% of the total irrigation area.

(2) Water source project of irrigation districts meets the requirement of water supply for irrigation and is in good condition, the means of dispatching is advanced and the water quality meets the standard.

(3) Irrigation canals (pipes) and distribution project of are complete, and the completeness rate is above 98%. The water efficiency of canal system is more than 55%.
(4) Drainage engineering are complete and in good condition, and the standard of farmland drainage should be up to 10 years frequency. Under the conditions of meeting the requirements of drainage, regard "good for water, close to water, active with water, and protect water" as targets, and also give consideration to ecological conservation and landscape according to local conditions.

(5) Field engineering is reasonable layout and complete, farmland is leveling and field scale is moderate; irrigation technology is advanced and reaches the standard of water saving. The completeness rate of field engineering should be up to more than 95%, and the irrigation water use efficiency in field is more than 90%.

(6) Management facilities in irrigation districts are complete and perfect, and water distribution and drainage control facilities are complete and in good condition. Key water distribution and drainage control facilities can be automatic controlled and remote controlled. The water outlets in main, branch and lateral canals (pipes) is equipped with metering facilities, the water measuring facilities in final fixed canals in field should meet management requirements.

(7) Agricultural production facilities, such as roads and bridges in irrigation districts, are complete, and meet the requirements of agricultural mechanization and modern agricultural production. Field road and forest belt arrangement are coordinate with irrigation and drainage canals. The forest belts of farmland in the windy and sandy areas are set up to meet the relevant national standards.

(8) Design life of irrigation and drainage engineering is more than 30 years.

Management and service

(1) Management system is complete and perfect. Establish modern management system for irrigation districts. The number of professional staffs per 1000 hm² is less than or equal to the number of authorized staffs. Under the guidance of administrative management organization, water user cooperative organizations can realize self management on field projects, and their management area can cover whole irrigation area.

(2) Management institution is complete and perfect. Regulations, rules, or measures for engineering and water management are formulated. Management method of "total amount control and quota management" for irrigation water is introduced. Water price and water fee collecting system is reasonable.

(3) Management ability meet the requirements of modern management. Use GIS, RS, GPS and internet technology to manage irrigation districts. Decision supporting system can be used for irrigation management. "total amount control and quota management" for irrigation water management is implemented. Quantity of professional staffs above college degree accounts for more than 90% of total staffs. Technical and professional training is institutionalized.

(4) Irrigation and drainage service is timely and efficient, provide high quality services for irrigation and drainage in accordance with the requirements of modern agricultural production. A website for information publication is established to provide irrigation forecasting, irrigation planning, water fee and other information for the users timely. Management of irrigation district is open and transparent.

(5) The fund of Irrigation districts can meet the normal demand of maintenance and operation, and have policy guarantee.
Efficiency and benefit
Irrigation water use efficiency reaches water-saving irrigation standard (above 50% for large scale irrigation district), water productivity reaches or be more than 1.4kg/m³.

Ecological environment
Water quality in irrigation districts meets the requirements of water functional zone, and the ecological system is healthy. The drainage water quality meets the discharge requirements. The groundwater level is balanced for many years, and suitable. There is no serious salinization in the irrigation area.

3. Evaluation indicators of large scale irrigation district modernization

3.2 Evaluation indicator system
The modernization of irrigation districts is a process, and at different stages it will have different standards. But in order to guide the modernization of irrigation districts, some important indicators are concluded to form evaluation indicator system for large irrigation district modernization in a certain period (15-20 years) in China.
The evaluation indicators is divided into 5 categories as above mentioned, including security guarantee, irrigation and drainage facilities, management and service, efficiency and benefit, and ecological environment. There are 20 indicators in total, including 18 quantitative evaluation indicators and 2 qualitative evaluation indicators.

3.1 Formulating principles of evaluation indicator system
Comprehensiveness and systematicness
Evaluation indicator can fully reflect the key factors of irrigation area modernization of irrigation districts.
Simplicity
Meaning of the indicators should be clear and specific, to avoid intersecting and repeating, meanwhile the number of indicators should be minimized as possible without affecting the overall and systematic principle.
Data easy to obtained
The evaluation indicators should be obtained easily from statistical yearbook, industry statistical bulletin and so on, or by means of investigation, analysis, measurement, statistics and other methods.

<table>
<thead>
<tr>
<th>First level indicator</th>
<th>Second level indicator</th>
<th>Third level indicator</th>
<th>Indicator value calculation</th>
<th>Target value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security guarantee</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Flood control project</td>
<td>Standard reaching rate of dikes</td>
<td>Length of standard-reaching dike/total length of dike</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>2. Village waterlog control</td>
<td>Standard reaching rate of water storage projects</td>
<td>Quantity of standard-reaching water storage projects/total quantity of water storage projects</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>3. Flood and drought disaster</td>
<td>Standard reaching rate in Village waterlog control</td>
<td>Area of standard-reaching village waterlog control/Total residential area of villages</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proportion of flood and drought disaster area to cultivated land area</td>
<td>Annual average flood and drought disaster area in the last 5 years/Cultivated land area in the same period</td>
<td>≤5%</td>
<td></td>
</tr>
</tbody>
</table>
3. Evaluation indicators of large scale irrigation district modernization

<table>
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<tr>
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<th>Target value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation and drainage</td>
<td>Microdrainage</td>
<td>Rate of drainage ditches in good condition</td>
<td>Length of drainage ditches (in good condition)</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>Water saving irrigation</td>
<td>Completion of water saving irrigation</td>
<td>Proportion of irrigation water use efficiency</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Farmland waterlogging control</td>
<td>Rate of farmland waterlogging</td>
<td>Standard rate of soil loss</td>
<td>Less than 10%</td>
</tr>
</tbody>
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</tr>
</thead>
<tbody>
<tr>
<td>Efficieny and benefit</td>
<td>15. Benefit</td>
<td>Output per km² of irrigated area</td>
<td>Total irrigated agricultural output in irrigation area/actual irrigation area</td>
<td>More than 30% above the average</td>
</tr>
<tr>
<td></td>
<td>16. Irrigation water use efficiency</td>
<td>Grain yield per cubic meter of water consumption</td>
<td>Total grain yield in irrigation area/total water consumption of irrigated grain in irrigation districts</td>
<td>Above 1.4kg/m³</td>
</tr>
<tr>
<td></td>
<td>17. Drainage (return water)</td>
<td>Irrigation water efficiency</td>
<td>Irrigation water efficiency/Threshold value of irrigation water efficiency</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>18. Ground water exploitation</td>
<td>Rate of ground water exploitation</td>
<td>Proportion of groundwater tunnel area</td>
<td>Less than 10%</td>
</tr>
<tr>
<td></td>
<td>19. Water and soil loss</td>
<td>Rate of soil and water loss</td>
<td>Proportion of soil loss in irrigation area</td>
<td>Less than 10%</td>
</tr>
</tbody>
</table>

4. Countermeasures for modernization of large scale irrigation district

4.1 Research on key problems

1. Modernization construction theory and engineering construction standard of irrigation districts
2. Modern planning and design technology of irrigation districts
3. Information management technology based on GIS, RS and GPS, irrigation forecast at large scale and irrigation decision support system
4. Irrigation water efficiency threshold and water saving potential in irrigation districts
5. Practical water saving technology of surface irrigation
6. Health standards, monitoring and evaluation methods of ecosystem in the irrigation districts
7. Model and method of “total amount control and quota management” for irrigation water use
8. Modern management system and mechanism in irrigation districts
9. Investment model and construction management mechanism of the modernization construction in irrigation districts
10. Technology of monitoring and evaluation of irrigation districts at large scale
4. Countermeasures for modernization of large scale irrigation district

4.2 Formulation of modern technical standards for large scale irrigation districts
Research and determine the modernization mood, construction standards and reconstruction strategy of irrigation districts. Formulate technical standards and norms for irrigation and drainage engineering, new technology application, irrigation water use, irrigation project operation and management, information technology, and other aspects. Speed up the establishment of the standard system for irrigation district modernization, operation and management.

4.3 Comprehensive and systematic assessment of large scale irrigation districts
Carry out comprehensive survey and systematic assessment of water source, engineering condition, management and service level, efficiency and benefit, ecology and environment in irrigation districts, find the existing problems and key weak links, in contrast to modernization construction standard, decide reasonable countermeasures for water saving improvement and modernization in large scale irrigation districts.

4.4 Carry out modernization demonstration of large scale irrigation districts
Select representative irrigation districts in different area in China, to carry out the large irrigation district modernization plan. According to the standards for irrigation area modernization, carry out demonstration from the aspects of planning concept, technical standard, new technology application, management reform, informatization and environment-friendly improvement measures, etc. Build a advanced model to guide the modernization construction of large scale irrigation districts.

4.5 Plan as a whole and push on gradually
According to the requirements of national and agricultural modernization development, draw up modernization plans of large scale irrigation districts timely, make development objectives and principles clear, plan the construction arrangement and tasks rationally, put forward implementing guarantee. Every irrigation district formulate modernization construction plan based on the conditions of soil and water resources, engineering facilities condition, management ability and level. The large irrigation districts in developed areas and good conditions should take the lead in realizing modernization. Establish an evaluation system for the irrigation area modernization.

Pipeline water delivery technology
◆ A new product developed by CIDDC—automatic lifting buried hydrant
Operation process:
a. no Irrigation, 30-40cm underground;
b. elevating above the ground;
c. connecting with the water carrier;
d. disconnecting with the water carrier after irrigation;
e. back to the underground after irrigation (30-40cm below the surface).

Automatic lifting buried hydrant
A new product developed by CIDDC --- automatic lifting buried sprinkler

Operation process:

a. when it is not irrigating, it is 30-40cm below the surface;
b. it is lifted above the ground for irrigation;
c. it is irrigating;
d. irrigating stop;
e. when the irrigation ends, it is back underground (30-40cm below the surface).

THANK YOU!