The Research Progress and Comprehensive Treatment of Lake Eutrophication in China
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1. Current Situation of Lake Eutrophication in China
1. Methods to assess Eutrophication in China

TLI is mainly used as follows.

- **TLI(chla) =** $10 \times 2.5 + 1.086 \ln \text{chl}_a$
- **TLI(TP) =** $10 \times 9.436 + 1.624 \ln \text{TP}$
- **TLI(TN) =** $10 \times 5.453 + 1.694 \ln \text{TN}$
- **TLI(SD) =** $10 \times 5.118 - 1.94 \ln \text{SD}$
- **TLI(COD$_{Mn}$) =** $10 \times 0.109 + 2.661 \ln \text{COD}_M$

Unit: chla: mg/m$^3$, SD: m, Others: mg/L

### Assessing Standards

<table>
<thead>
<tr>
<th>TLI(Σ)</th>
<th>0</th>
<th>30</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nutrient Level</strong></td>
<td>Low</td>
<td>Medium Nutrient Level</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High Nutrient Level (Eutrophication)</td>
</tr>
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</tr>
</tbody>
</table>
2. Current Situation of Lake Eutrophication in China

Main Lake region in China

- Lakes in Eastern Plain Area
- Lakes in Northeast Plain and Mountain Area
- Lakes in Qinghai-Tibet Plateau Area
- Lakes in Inner Mongolia-Xinjiang Plateau Area
- Lakes in Yunan-Guizhou Plateau Area

Distribution of Lake in China

Statistics of Area and Runoff Volume of Inner and Outer Rivers in China

- Area of Inner Rivers: 64%
- Area of Outer Rivers: 36%
- Volume of Inner Rivers: 94%
- Volume of Outer Rivers: 6%

Number of Lakes ≥ 2742 (> 1 km²)
Total Area: 91020 km²
Based on investigation of 26 lakes in China, the number of eutrophication lakes in China in the 1970s, 1980s and 1990s is 27%, 61% and 85% respectively. In 2000, it develops faster and China has become a heavy eutrophication country in the world.
### Total Area of Eutrophication Lakes

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (km²)</td>
<td>3800</td>
<td>5000</td>
<td>6700</td>
</tr>
</tbody>
</table>

### Distribution of Eutrophication Lakes in China

<table>
<thead>
<tr>
<th>Region</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>56.7</td>
</tr>
<tr>
<td>Midland</td>
<td>29.9</td>
</tr>
<tr>
<td>West</td>
<td>13.4</td>
</tr>
</tbody>
</table>
Sea gourds of Kunming Lake

Kunming Lake

Waterweeds of Chao Lake

Taihu Lake

Meiliang Bay of Taihu Lake
Annual water quality of Taihu Lake

Example-Taihu Lake
Annual Water Quality of Chaohu Lake

Permanganate Index (mg/L)

Total Phosphorus (mg/L)

Total Nitrogen (mg/L)

Nutrient Condition Index
Area of Blue Algae Bloom in Taihu Lake from 1950 to 2006

1950's

1970's

1980

1987

1994

2000

2006
2. Research Progress of Lake Eutrophication in China
Since the 1950s, China has started to concern about lake eutrophication and carry out specific research on aquatic organisms, planktons, and types of eutrophication. Especially in recent 20 years, Chinese researchers have done a lot of basic study on lake eutrophication control and econological restoration. In practices, many successful experiences have been achieved. Major research fields include:

- Study on eutrophication source, limiting factors and adjusting strategies
- Study on form, release patterns, influence factors and transformation mechanisms of source nutrient in lakes
- Study on rules of transport and transformation of N and P from agricultural non-point pollution
- Application of Remote Sensing Technology in dynamic monitoring of lake eutrophication
- Study on models of lake eutrophication prediction
Sample Collection of Water and Hydrophyte

Environment monitoring

Water collection

Hydrophyte collection

Sediment collection
Remote Sensing Monitoring of Water Quality

Sequence remote sensing monitoring of water quality for long period
2. Insufficiencies

In the Field of Research:
Domestic study on nutrient source is much more focusing on monitoring and research of regular nutrient indices (TN, ammonia nitrogen, nitrate nitrogen, TP, COD, SS). It lacks analysis on identification, labelling, transport and transformation of nutrient of different forms, especially lacking basic research on transport and transformation of P (Dissolved Phosphorus and Particulate Phosphorus).

In the Field of Technical Promotion:
In the Chinese mainland, there is some difference in technical level, such as remote sensing monitoring and building of pollution data base, especially between western and eastern coastal area.

In the Field of Policy:
Some local authorities only pursue economic benefits and encourage the fast expansion of industries and enterprises. Some enterprises with high pollution and high energy consumption still exist.
3. Solutions of Eutrophication Treatment in China
Characteristics of water remains largely.
Characteristics of water changes constantly.
General Thoughts on Comprehensive Treatment of Basins

1. Keep natural circulation of water and secure it as clean water source for down areas.

2. Regulate social circulation of water and reduce anthropogenic pollution.

3. Preserve or restore ecological condition of lakes. Balance the ecosystem and play its functions.
General Thoughts on Comprehensive Treatment of Basins

- Population and Distribution
- Economic Developing Patterns
- Circular Economy
- Cleaner Production

Wastewater from:
- Towns and villages
- Industrial wastewater
- Village sewage
- Farmland runoff
- Other non-point wastewater

Pollution source

Monitoring

Management

Treatment

Low Polluted Water

Rivers

Lake Basins

Lakes
General Thoughts on Comprehensive Treatment of Basins

COD

Population

Population and farmland

Coffee

If precipitation is 1500mm/a, runoff is 70% and water consumption is 500ℓ/capital/d.

If annual discharge of P is 70%, COD is 70% and N is 50%.

Environment Limit: 150P/km²

Environment Limit: 800P/km²